The relationship between socio-economic status and malaria: a review of the literature

Background paper prepared by

Eve Worrall[a], **Suprotik Basu**[b] , and
Kara Hanson[a]

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[a] London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, UK
[b] The World Bank, 1818 H St. NW, Washington DC 20433, USA

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Abbreviations used

CQ	Chloroquine
DALYs	Disability adjusted life years
DHS	Demographic and health survey
DSS	Demographic surveillance system
FGD	Focus group discussions
GDP	Gross domestic product
IDB	Inter-American Development Bank
IPT	Intermittent presumptive treatment
ITN	Insecticide treated nets
KAP	Knowledge, attitudes and practice
LHYH	Low to high income households
MICS	Multiple indicator cluster surveys
PAHO	Pan American Health Organization
SES	Socio-economic status
USAID	US Agency for International Development
VLYH	Very low income households

Executive summary

Malaria is frequently referred to as a disease of the poor or a disease of poverty. A better understanding of the linkages between malaria and poverty is needed to guide the design of coherent and effective policies and tools to tackle malaria and poverty together. While recognising that there are a large number of dimensions of potential vulnerability to malaria that encompass social, demographic and geographic elements, the key focus of this work is on differences among socio-economic groups. The aim of this review was to document and review critically the evidence available on two key issues: malaria incidence or vulnerability to the effects of malaria by socio-economic status (SES); and the utilisation, effectiveness and accessibility of malaria control interventions by SES.

The burden of malaria is greatest among the world's poorest countries. However, studies examining malaria incidence by socio-economic status on a smaller (micro) scale have not been able to provide as consistent a picture as those examining macroeconomic data, with results on the distribution of malaria incidence between poor and less poor population groups often mixed and contradictory.

Most studies that use material assets as a proxy for SES have failed to establish a positive relationship between asset ownership and reduced incidence of febrile episodes (as a proxy for malaria) at the household level. However, the evidence with regard to vulnerability to the consequences of malaria by groups of lower SES is more consistent. This may reflect lower access to effective means of treatment once infected. The lack of consistent socio-economic differentials in malaria incidence is not necessarily counterintuitive given the epidemiology of malaria transmission. Vulnerability to the consequences of infection, on the other hand, has much less to do with non-discriminatory environmental factors, and more to do with inequities in access to prevention and treatment.

Expenditure on prevention is more strongly correlated with income and SES than expenditure on treatment. Although, the relative burden of malaria treatment expenditure is likely to be greater for poorer than less poor households. In addition, the expense for treatment is less discretionary.

The cost of treatment, as well as distance travelled to reach health centres, were mentioned frequently as barriers to access. In addition, there is some evidence to suggest that richer households are more likely to use antimalarials to which there is less parasite resistance. Multi-country studies show differences in the types of care sought by the wealthy and the poor, with the poor more frequently opting for care outside the modern sector and the wealthy more frequently opting for care involving the modern sector.

Finally, though few ante-natal clinics in Africa currently provide IPT, there is considerable range with regard to utilization of ante-natal clinics by the poor;

this point merits further discussion given the interest in using ante-natal clinics to deliver malaria services and commodities.

Conclusions

Studies need to adopt a more common methodology to permit comparisons. Problems of data comparison were an important limitation on the review and restricted the conclusions that could be drawn from the literature

Qualitative research should be encouraged to obtain more in depth, locally-relevant, and descriptive data on malaria control inequities and care-seeking behaviour. Descriptive and locally-specific data on the care-seeking process for malaria are required to inform programmatic efforts to target the poor.

A greater focus on inequity is needed in studies from inception to inform programmes that seek to reach the poor. Few studies focused on the questions of equity asked in this review, reflecting a gross neglect in malaria research requiring immediate attention to reduce the malaria burden and reach the Millennium Development Goals.

There is a need for evidence about the effectiveness of interventions aimed at reducing inequities in access to effective prevention and treatment. So far, few interventions have been carried out aiming to reach the poor, limiting opportunities to review successes and failures of attempts to target the poor.

Introduction and aims

Malaria is frequently referred to as a disease of the poor or a disease of poverty. Even a cursory examination of the global distribution of malaria is sufficient to accept this claim on a macro scale, given the concentration of malaria in the world's poorest continents and countries. However, on a more micro scale the evidence is less consistent and more difficult to collect, analyse and understand. Malaria is also said to cause poverty and prevent or reduce people's ability to escape poverty; however the evidence about the relationship between poverty and malaria incidence, and the causal pathways between the two, is scant. Moreover, the evidence which does exist is often contradictory and inconsistent or of poor quality, making it difficult to develop effective policies on the basis of sound evidence. A better understanding of the linkages between malaria and poverty is needed to guide the design of coherent and effective policies and tools to tackle malaria and poverty together.

Recent years have seen a renewed interest in issues of health equity e.g. (Evans *et al.*, 2001; Macinko and Starfield, 2002). In this review, we use an equity lens to examine the relationship between malaria and poverty. A definition of equity commonly used in the literature is "the absence of potentially remediable, systematic differences in one or more aspects of health across populations or population groups defined socially, economically, demographically, or geographically" (International Society for Equity in Health, 2003). The scope of this review can be clarified in terms of a number of elements of this definition. First, we can define the relevant aspects of health. In the context of malaria, these can be expressed in terms of differentials in malaria incidence; differentials in vulnerability to the consequences of infection, for example, the risks of mortality or sequelae of severe malaria; or in terms of access to or use of effective means of preventing or treating malaria. In this review we address all three of these dimensions.

Second, while recognising that there are a large number of dimensions of potential vulnerability to malaria that encompass social, demographic and geographic elements, the key focus of this review is on differences among socio-economic groups. Using this criterion, the literature that was identified as relevant to this review is defined as those studies that compare malaria incidence, vulnerability or uptake of interventions across socio-economic groups. The aim of this review, therefore, was to document and review critically the evidence available on two key issues: malaria incidence or vulnerability to the effects of malaria by socio-economic status (SES); and the utilisation, effectiveness and accessibility of malaria control interventions by SES.

Structure of review

The review is structured as follows. Firstly, a description of the literature search methods and limitations is given. This is followed by a brief overview of the measurement of SES in developing countries and a more detailed

discussion of the methods used within the studies reviewed. The results of the review are then presented, divided into two main sections in which the available evidence is described, discussed and critically reviewed. Part 1 addresses the evidence on the incidence of malaria or vulnerability to malaria by SES; and Part 2 reviews the evidence relating to utilisation of interventions by SES. The third section identifies the key gaps in knowledge, and concludes with some recommendations for future research.

Methodology

A literature search was carried out in the UK on published literature using electronic data bases (BIDS, Medline, PubMed) and the following key words: Malaria and: equity, socio-economic status, poverty, poor, income, wealth, burden, treatment seeking & poor; malaria incidence and poor, poverty, socio-economic status. Studies were included if they were published after 1990. The review was limited to studies in English and therefore will neglect some evidence from Francophone Africa, Latin America and other non-English speaking regions. References obtained through electronic databases were cross-referenced and followed up by hand.

Unpublished and grey literature from the UK was found by following up references in published and unpublished articles and communicating with colleagues working in the area. A separate search of the grey literature was carried out in the USA using the same key words, cut-off points and boundaries. The majority of the grey literature used in this review was recovered from World Bank intranet databases. Key informants at PAHO, IDB, USAID, Abt Associates, and within the World Bank were solicited and were able to provide additional sources that were not found in the initial database searches. Finally, internet search engines were used to find study results from organisations that had not been solicited directly for assistance.

The necessarily limited scope of this piece of work, which was a result of the limited time available for the review, prevented us from searching and reviewing the broader literature on health equity and equity in treatment for diseases/conditions other than malaria. However, since malaria is such a common cause of morbidity in many countries, much of this more general literature will be of relevance and this review should be read with these broader issues in mind.

Literature Review

Approximately 150 studies were included in the review. The majority were from Africa, although there were a number of studies from Asia and South America. Many of the studies did not set out to explore the questions examined in this review directly; however, they often collected information on variables relevant to measuring socio-economic status.

Measurement of SES in developing countries

Measuring SES in developing countries is challenging. The generally accepted “gold standard” approach to estimating household welfare is to use

data on household income or expenditure. It has been argued that household expenditure data are preferable since they are subject to less fluctuation than household income, and therefore a better measure of permanent income. This is because households tend to smooth expenditure in anticipation of "lumpy" income (Deaton, 1997). In developing countries it is also more practical to collect expenditure data because it avoids the difficulties of valuing household consumption of own production. However, both methods are likely to face the difficulties inherent in obtaining accurate financial data from respondents: people may be unwilling to disclose financial data and what they do disclose may be biased. Collecting detailed income or expenditure information may also be prohibitively time consuming and costly, and results may be influenced by seasonality in income flows. Other more feasible approaches to estimating household socio-economic status have therefore been developed.

One approach has been to use wealth as a proxy for income or expenditure, where wealth is measured as household ownership of assets. Single assets have been used, e.g. whether the household owns a radio. More recently, researchers have begun to use indices made up of multiple assets (sometimes including housing materials), where the weights are derived using principal components analysis (Filmer and Pritchett, 2001). Occasionally, the index has been validated against income or expenditure data (Filmer and Pritchett 2001). However, more often, the choice of assets is made simply on the basis of their face validity (see for example (Hanson and Jones, 2000; Hanson and Worrall, 2002). Gwatkin et al. (2000) used asset data collected in DHS surveys to examine socio-economic differences in health, nutrition and population indicators. A potential problem with the asset index approach is differences across surveys in the assets used; and that even those studies which use a common asset index cannot be readily compared, except insofar as they provide a relative measure of poverty. Assets commonly used in the creation of such indices include: in-home electricity, radio, TV, refrigerator, bicycle, motorcycle, car, flush toilet and piped water.

For the purposes of analysis and interpretation, households are frequently divided into equal sized groups (quintiles or quartiles) according to their level of asset ownership (e.g. World Bank series of country reports on health equity using DHS data: see for example Gwatkin et al. (2000) or http://www.worldbank.org/poverty/health/data/index.htm; Hanson and Jones, 2000; Hanson and Worrall, 2002; Schellenberg *et al.*, 2002). The gap between the highest and lowest groups, measured in terms of an absolute difference or a ratio of lowest to highest, is used as a measure of inequality. The actual distribution of the underlying index value is rarely reported, and as a consequence, it is difficult to assess the validity of this division. For example, the distribution may be extremely uneven, with a large portion of the population having very few assets, and a very small proportion having a large number. In this case, it is not clear that the division into four or five equal sized groups is justified.

A second approach has been to use a variety of other proxy measures that are assumed to be correlated with income. These include education, occupation, rural/urban location, and gender.

Studies that use level of education as a proxy for socio-economic status are less common than those that use material assets. Difficulties in accurately measuring levels of education as well as subsequent comparisons of those levels across studies can make education an inconvenient and imprecise measure of SES. Moreover, a lack of understanding of the causal pathways between education, SES and malaria makes it difficult to interpret the results of studies that examine the relationship with education. SES and educational attainment are intricately linked since those who are well educated are likely to achieve higher SES and those of higher SES are likely to be better educated.

Occupation is clearly a determinant of SES, and SES may to some extent determine the employment opportunities available. However, like education, the effects of occupation (on the risk of malaria infection and to a lesser extent utilisation of interventions) are difficult to separate from the effects of SES, and such separation may be artificial and of limited operational importance.

A rural or urban categorisation is sometimes used as a proxy for SES, based on the assumption that people in rural areas tend to be poorer than those in urban areas. A full discussion of this is beyond the scope of the review; however, with notable exceptions such as urban slums and highly fertile rural areas with good access to markets, the assumption seems to be reasonable. Throughout our review, therefore, we have assumed that a rural location is a proxy for poverty when compared with an urban location. In addition, differences in malaria transmission between urban and rural areas may complicate the relationship between malaria and SES. These epidemiological differences were not directly examined in this review and should be kept in mind when assessing the results.

Finally, some studies use gender a proxy for SES, reflecting the social and material disadvantage experienced by women in many parts of the world.

Methods of measuring SES used within the studies

The malaria literature has employed a large range of SES measures. Of those studies that estimated household income, some failed to impute income from own production or only took a single “snap shot” view of income instead of measuring it over a suitable time period. Some of the studies included in this review did not set out to measure SES, but examined incidence or utilisation of interventions by an indicator which is likely to be correlated with SES (e.g. housing type or construction materials). On this basis, these studies have been included.

A frequently encountered problem was that many of the studies do not describe adequately their methods, assumptions or the basis for choosing their particular method of SES measurement. Some studies use arbitrary

categories such as low, medium and high without describing how they were developed. Furthermore, there is sometimes difficulty in interpreting the range of poverty (for example from "poor" to "least poor"), if no information is provided to contextualise the study area within the broader country situation. This problem also makes it virtually impossible to make comparisons across country studies. A clear conclusion from the inconsistent methodology employed is that equity has neither been a focus of the interventions nor of the literature, but rather has often been examined as a secondary variable not requiring the same degree of methodological rigour as the epidemiological variables which form studies' primary focus.

In summary, the standard of SES measurement in the studies reviewed is generally poor or inadequately described. There is a lack of common methodology that makes comparison across studies impossible. These limitations should be borne in mind in drawing insights from the literature. In order to improve the quality and reliability of results and facilitate comparison across studies and countries there is an urgent need for consensus on standards for measuring SES.

Part 1 Evidence of Incidence and Vulnerability by SES

The wide variety of types of data collected on malaria incidence and vulnerability to its effects makes any comparative study difficult. Clinical diagnosis is the most widely used approach to diagnose malaria, and the World Health Organization (WHO), for instance, recommends anti-malarials for treatment of fever in all areas of high malaria endemicity as part of its protocol for IMCI (Gove, 1997). However, the symptoms of malaria are non-specific and overlap with those of other febrile illnesses. On the basis of a literature review, Brinkman and Brinkman (1991) estimated that approximately 40% of fever can be attributed to malaria in Africa, though this figure will vary across transmission zones.

Most studies used in this review, particularly those with large data sets, were based on unconfirmed clinical malaria or fever, for example, Filmer 2001. Smaller-scale studies, or those based in health facilities and hospitals, and those studies that were part of a larger clinical trial, were based on laboratory-confirmed malaria diagnosis e.g. Bondi 1991; Sychareun et al. 2000; Holtz et al. 2002. A potential for bias arises from using clinic or hospital based data because only around 20-40% of malaria cases and deaths are estimated to receive treatment in formal health facilities (McCombie, 1996); most malaria is diagnosed and treated in the home. As a result, data from health facilities reflects any inequity in access to those facilities, though the extent of the inequity cannot be determined without comparisons to population based data.

Finally, there are few sources of reliable information on mortality or severity of illness due to malaria and even fewer that examine the relationship between mortality and SES. Even if the risk of malaria incidence does not increase with poverty, the poor may be at greater risk of mortality due to the obstacles preventing adequate treatment. However, since most malaria-related deaths occur at home and are unrecorded {(Mtango and Neuvians, 1986; AMMP,

1997) both cited in (Korenromp *et al.*, 2001)} there is considerable difficulty in studying the relationship between poverty and risk of malaria mortality.

The literature in this area was divided along the lines of macroeconomic and microeconomic perspectives, and this section discusses each in turn. Within the category of microeconomic studies, we have arranged the studies by the various means of SES measurement. Although some overlap in this categorisation is acknowledged, we found that the following arrangement represented accurately the natural and conceptual divisions in the literature: income or expenditure, assets, education, location and housing type, sex/gender, and other SES proxies.

A global perspective

The burden of malaria is greatest among the world's poorest countries. While only 0.2% of global malaria deaths are found in the world's richest population quintile, 57.9% of global malaria deaths are concentrated among the world's poorest population quintile. Similarly, when the burden is measured as disability-adjusted life years (DALYs), 58% of the total global burden due to malaria is concentrated among the poorest 20% of the global population, while only 0.2% of total global DALYs are lost by the richest global 20% (Gwatkin and Guillot, 2000).

Sachs and Malaney (2002) demonstrate a correlation between the presence of malaria in a country and that country's per capita GDP, arguing that there is an inverse relationship between the two and that malaria causes underdevelopment. Historical evidence is used to argue in support of this causal pathway. Najera (1994) argues that the disappearance of malaria in parts of Europe was associated with economic development related to agricultural expansion rather than vector control or chemoprophylaxis.

It has been argued that because the burden of malaria is concentrated in poor countries there is inequity in allocation of global research funds especially by the pharmaceutical industry, since domestic purchasing power for new malaria products is very limited (especially for anti malarial drugs) (Medicines for Malaria Venture, 2001).

A household and individual perspective

Studies examining malaria incidence by socio-economic status on a smaller (micro) scale have not been able to provide as consistent a picture as those examining macroeconomic data. This may partly be due to the inconsistent way in which SES has been measured. Though a small number of studies used income or expenditure data to classify households by SES, the majority used some sort of proxy measure such as ownership of household assets or an index comprising variables such as asset ownership, housing conditions, and educational attainment .

Income/expenditure

Results from a Nigerian community-based survey suggest a heavier malaria burden on the poor than on the rich. The survey, which took place in four states, demonstrated that individuals with a mean income of below N3000/day

(<US$1/day) were less likely to perceive malaria as a preventable disease, more likely to report having fever presently, and suffered significantly more bouts of malaria per month when compared with individuals earning greater than N3000 per day (CHESTRAD, 2000).

Similar results were obtained in Lao PDR, where investigators used questionnaires to obtain income information from pregnant women in a remote district hospital and found a difference in malaria prevalence between socio-economic groups (Sychareun *et al.*, 2000). 87.5% of women with positive slide parasitaemia were classified as having low income (<50,00 kip), while only 12.5% were classified as having high income (> 90,000 kip). However, with only 16 women testing positive for malaria and the majority of women sampled - regardless of malaria diagnosis - falling into the low-income category, the results were not statistically significant.

Not all income-based studies have been consistent in their results. A study in Ghana compared malaria incidence in two communities, one with relatively low average income (73,824 cedis/year), and one with relatively higher average income (138,167 cedis/year) (Biritwum *et al.*, 2000). Despite lower formal education levels among caregivers and fewer children in nursery, malaria incidence in the poorer community was not significantly different from that in the richer community, though incidence of ill-health in general was higher among the poor than the rich.

Assets and education

In a multi-country study using DHS data (Filmer, 2001) investigated the relationship between SES (measured as an asset index) and incidence of fever (as a proxy for clinical malaria). While there was no statistically significant relationship at the household level, there was a more pronounced relationship at the district level. Epidemiological differences in malaria transmission patterns between the large number of countries included in the study, however, may play a role in obscuring the relationship between lower SES and incidence of fever. Data from a demographic surveillance site (DSS) in rural Tanzania, also using an asset index to measure SES, support Filmer's finding, revealing that fever seems to affect the poor and less poor approximately equally (Abdulla et al. 2001). However, recent evidence from another Tanzanian DSS site (de Savigny *et al.*, 2002) indicates that the poorest infants and children under five-years of age had higher risks of death than those in the least-poor socio-economic quintiles. One reason for these conflicting results may be that there is insufficient variation in socio-economic status in some areas to allow significant differences to be detected.

A study in Benin used the results of a malaria KAP survey to analyse the relationship between a number of demographic and social variables (including income and expenditure) and incidence of febrile episodes in children (Rashed *et al.*, 2000). Only ITN use and the age of the child were found to be significantly related to fever incidence.

Other evidence from Tanzania examines the relationship between SES and treatment seeking for fever (Abdulla *et al.*, 2001). The rate of treatment

seeking was compared between the lowest and highest SES quintiles (measured as an asset index), and found a poor/least poor ratio of 0.5 - 0.6. This result suggests that the poor may experience greater vulnerability to the consequences of malaria, arising from less treatment seeking.

Another asset-based study investigated the role of a large number of potential socio-economic risk factors for malaria in a matched case control study in the Gambia (Koram *et al.*, 1995). The socio-economic variables examined included occupation and education of parents, household crowding (defined as >3 sleeping per room), ownership of selected items (refrigerator, radio etc), state of compound (cleanliness) and structure of house. The study found that the use of mud for wall construction, absence of ceiling in child's room and poor cleanliness of the house were associated with the occurrence of malaria, but after multivariate analysis only cleanliness was statistically significant. In addition, possession of a refrigerator – certainly not a sign of being among the poorest – was significantly associated with protection against malaria. Approximately twice as many children with malaria slept in crowded rooms when compared to controls (also significant). There is some potential bias arising from the selection of malaria cases from health facilities, which may have biased the sample in favour of higher SES groups who are more likely to use health facilities, and attenuated the relationship between SES and malaria incidence.

Another Gambian study used an index including assets and housing construction materials to measure SES and examined the prevalence of parasitaemia in children from families of different SES. The study found that prevalence of parasitaemia declined significantly with increasing SES (Clarke *et al.*, 2001). In rural Kenya Shulman et al. (2001) used a similar measure of assets to approximate SES in pregnant women, together with ethnic group and literacy as proxies for SES. The study found an increased presence of placental malaria among one particular ethnic group, as well as in women of lower socio-economic status and low body mass index (BMI).

Clear evidence on the impact of educational levels is scant, but data from the Malawi 2000 DHS reveal that women with lower levels of education were more likely to have fever than women with higher levels of education (Ndawala *et al.*, 2000).

Occupation

Certain occupations place individuals at greater risk for malaria infection than others. Agricultural labourers, for instance, may not only place themselves at risk through increased contact with the malaria vector but also, through their migration, place others at greater risk by contributing to the spread of the disease (Service, 1991; Martens and Hall, 2000). Consequently, occupation may reflect both socio-economic status and differential risk of exposure through occupational attributes.

Ijumba and Lindsay (2001) reviewed the relationships between irrigation (for rice, wheat, cotton, sugar cane, dams) and malaria in a variety of African countries, finding that rice irrigation does not increase malaria in local

communities and may actually reduce it. The authors cite evidence from other studies to suggest this may be due to wealth creation in local communities that allows farmers to use disposable income to protect themselves from the mosquito vector (Audibert *et al.*, 1990; Boudin *et al.*, 1992). However, as the better off are more likely to benefit from this process of wealth creation, the exacerbation of existing inequities is a concern. Also, in areas of unstable malaria, irrigation may have devastating consequences by causing increased infection among non-immunes.

In Ethiopia, highland migrant labourers have been shown to be vulnerable to malaria while migrating to find lowland agricultural work (Ghebreyesus *et al.*, 2000). While migration puts the labourers at greater risk, it also limits access to treatment as the agricultural work sites to which labourers migrate are located an average of over two hours' walk from health facilities. Furthermore, the workers must sleep in the fields in which they work, which may increase significantly the risk of malaria infection in this group. Workers in other occupations, such as gem miners (Yapabandara and Curtis, 2002) and rice farmers (Mutero *et al.*, 2000) have also been shown to be at greater risk, both while they work and sleep. In Sri Lanka, for example, gem miners' housing gives no protection from the mosquito vector and cannot be sprayed with insecticide (Yapabandara *et al.*, 2001).

Further evidence of the relationships between occupation and malaria infection can be found from a study in Zaire where researchers found a significantly higher prevalence of the plasmodium parasite in a low SES occupational category (consisting of generally low paid, industrial or unskilled workers or the unemployed with shared toilet facilities) than in a high SES category (consisting of workers living in government or company housing with a good job and private toilet facilities). Similar relationships in clinical malaria were also observed, though the results did not always reach statistical significance (Tshikuka *et al.*, 1996). In addition, data from the Andhra Pradesh province of India reveal consistently higher incidence of malaria and lower use of preventive measures among hospital workers and students of lower SES (non-physicians, nursing students) than among those of higher SES (surgeons, physicians, medical students) (Rajasekhar and Nandakumar, 2000).

Location and housing type

Though rural locations appear to experience higher rates of transmission, the relationship between the two is not fully understood. Rural locations can be associated with increased malaria risk for both epidemiological and socio-economic reasons. Similarly, urban residence can be accompanied by potentially protective socio-economic factors against malaria risk such as education and income (Rashed *et al.*, 2000).

A number of recent studies have used urban and rural variables in their analyses of risk factors and transmission rates. In Malawi, for example, Holtz et al. (2002) examined urban location, among other potentially socio-economically relevant variables such as the education of caregivers and housing construction materials, to examine determinants of ITN use, anaemia

and parasitaemia. The results revealed rural residence as the highest risk factor for parasitaemia in children under five years of age, even after controlling for bednet use.

Similar results were found in Benin, where rural children had significantly more annual febrile episodes (1.93 vs. 0.34) and illness episodes (2.05 vs. 0.40) than urban children (Rashed *et al.*, 2000). The importance of bednet use and determinants of expenditure on treatment from this study are reported in the second part of this review. In addition, evidence from Malawi reveals that rural children, as well as women with lower levels of education, are more likely to suffer from fever compared to urban children and better educated women (Ndawala *et al.*, 2000).

Certain types of housing may influence malaria transmission. Greater exposure to the outdoors (lack of windows or screens, for example), may increase contact between an individual and the mosquito vector. Similarly, the presence of particular structural features that limit contact with the mosquito vector are likely to reduce infection. This phenomenon is commonly cited in discussions of the elimination of malaria from parts of the Southern United States in the mid-twentieth century, when the spread of screened windows and air-conditioning (and the accompanying economic development, of course) limited individual contact with mosquitoes (Shell, 1997). Housing that places individuals at increased risk of malaria infection is used more frequently by those in lower socio-economic strata than those in higher socio-economic strata. Some have attempted to distinguish the independent effect of housing itself from SES. In Sri Lanka for example, Gamage-Mendis et al. (1991) argued that the housing type is a more important determinant of variability in malaria risk than the socio-economic differences that accompany it.

Sex and gender

While women are frequently disadvantaged in socio-economic terms, the evidence of this translating into an increased risk for malaria infection is mixed. An additional factor is the ability of women to seek and receive prompt and proper care once infected. Tanner and Vlassoff (1998) argue that: "[T]he combination of epidemiological, social and economic risk differentials means that children and women in areas of high transmission are inevitably the most disadvantaged population sector". In addition, pregnancy is an important risk factor for malaria infection, due to depressed immune status.*

The recent empirical evidence, however, is less conclusive. In Dar es Salaam, Tanzania, for example, malaria-related mortality was shown to be proportionally equal (1:1 ratio) between men and women, though anaemia was an important cause of death only in women. Among children, no consistent sex difference was detected in either malaria-related mortality or

* For further evidence, readers are referred to the review by Tanner M. and Vlassoff C. (1998) Treatment-seeking behaviour for malaria: a typology based on endemicity and gender. *Social Science and Medicine* **46**: 523-532. which presents an argument and literature review highlighting the importance of a gender-focused approach to malaria control.

anaemia-related mortality {(AMMP, 1997) cited in (Korenromp *et al.*, 2001)}. A study in Myanmar (Tin-Oo *et al.*, 2001) provides further evidence of an insignificant sex difference in malaria incidence. Qualitative data were obtained to assess differentials between men and women in their exposure to mosquitoes given their respective night-time activities. Results yielded an equal chance of contracting malaria, during peak biting time, for men and women.

Other SES proxies

A number of studies measured SES in ways that do not fall into the categorisation used above and are considered here. In addition, some studies which do not address malaria *per se* are included because they use certain proxies of socio-economic inequalities that could be explored in future research.

Data have shown that ethnicity might be an important marker of socio-economic inequalities even among the poor (Brokerhoff and Hewett, 2000). The authors report that ethnicity may influence norms and attitudes toward health and education, resulting in disparate immunisation rates, child mortality, and number of antenatal care visits in some countries. The better health and care-seeking of some ethnic groups over others may also derive from household level economic conditions that differ between ethnic groups and it is suggested that these economic differences between ethnic groups be reduced in order to influence the health inequities that lead to increased mortality.

Evidence of the influence of ethnicity on malaria incidence can be found in a qualitative study on the Thai-Myanmar border that described differences in the health situation of communities divided along ethnic and class lines (Panvisavas, 2001). In the study, the incidence rate among non-Thais, most of whom were socio-economically disadvantaged immigrants, was twice that of the Thais, who were generally less poor and not socially marginalised. Reasons for the higher rate among non-Thais may be centred around a lifestyle compromised by poverty. Their work (and searching for work) and housing, for instance, produces increased vector exposure, while their lack of financial means prevents access to bednets - most of which are sold at high prices by travelling vendors - and health insurance.

Data from Burkina Faso (Okrah *et al.*, 2002) highlight further the importance of understanding community perceptions of the links between malaria and poverty. Focus groups consisting of participants from rural and urban households revealed links between poverty and malaria at the community level. All discussions saw poverty as the principal cause of malaria, in particular, the inability of the poor to prevent disease or purchase treatment.

Studies in Nigeria have examined the type of hospital facility attended, and severity of presented symptoms to determine differences by socio-economic status. Olowu et al. (2000) examined socio-economic differences in birth weight and parasitaemia by studying women who sought care in two different hospitals – a university hospital, used as a proxy for middle and high SES and

a maternity hospital, used as a proxy for low SES. Babies born in the low SES hospital had lower birth weights, and both mothers and infants in the low SES hospital had higher levels of parasitaemia. Bondi (1991) found that paediatric coma admissions in a central Nigerian hospital, 55% of which were cerebral malaria-related, consisted primarily of people with a low socio-economic background. Finally, also in Nigeria, Olumese et al. (1997) found that cerebral malaria was less common among well-nourished children. In addition, in comparing well-nourished and malnourished children with cerebral malaria, the authors determined the prognosis to be significantly worse for the malnourished children than for the well-nourished children.

Part 2 Utilisation of interventions

This section of the paper comprises a review of the utilisation of malaria interventions by SES. The literature has been classified into two broad categories: malaria prevention and treatment. The prevention section examines preventive expenditure as a proportion of household expenditure and the determinants of preventive expenditure. A special section is devoted to utilisation of ITNs and mosquito nets by SES, reflecting the relatively large number of studies on this subject. The section on treatment expenditure addresses the literature on treatment expenditure by SES and as a proportion of household income. The determinants of treatment expenditure are also examined. A relatively large number of studies were found which examine the determinants of treatment choice and utilisation. This section has been divided according to the types of determinants revealed by the studies; however the categorisation is not definitive and some studies could have been placed under more than one heading. A special section is devoted to utilisation of interventions for malaria in pregnancy. The section concludes with a short summary of the main findings.

Malaria prevention by SES

Generally we would expect use of and expenditure on malaria prevention methods to be higher among those of higher SES since they are likely to have more disposable income to spend on items which are often considered luxuries. Much of the evidence on use of and expenditure on malaria prevention is focused around ITNs, though there is some limited evidence relating to other interventions and to preventive expenditure in general. The evidence suggests that the poor are less likely to use preventive measures, especially the most effective ones. They are also less likely to use preventive methods in the most effective or appropriate manner. Generally, the level of expenditure on prevention methods is positively correlated with income, wealth or other proxy measures of SES such as education and occupation; however the relationships are not always clear. It seems that when the poor do choose to invest in malaria prevention, they suffer a greater relative burden of this expenditure (in terms of the share of total household expenditure) and its opportunity cost.

Preventive expenditure as a proportion of household income

A study in Malawi by Ettling (1994) found that expenditure on malaria prevention was positively correlated with income. Ten percent of all

households and only 4% of very low income households (average annual income=$68.11) reported expenditure on malaria prevention in the previous month. Estimated annual expenditure on prevention in all households was $2.55, ranging from $0.59, or 0.9% of annual income in very low income households (VLYH) to $4.70, or 0.5% of annual income in low to high income households (LHYH)[1]. In contrast, in Benin Rashed et al. (2000) estimated that prevention expenditure accounted for 1.6% of rural (poorer) and 2.1% of urban (less poor) annual household income. Examining preventive expenditure in this way may be flawed since, in reality, expenditure may be intended for the prevention of nuisance biting rather than malaria prevention. The extent to which households invest in prevention may therefore be dependent on the amount of nuisance biting they face. However, it is clear that expenditure on a relatively expensive item such as a mosquito net or ITN will constitute a greater share of the disposable income of a resource-poor household.

Determinants of preventive expenditure

Within households there is some evidence that the seasonality of availability of financial resources does not influence spending for preventive measures such as chemoprophylaxis, coils or insecticides. These may be driven more by the seasonality of transmission (or of mosquito nuisance), suggesting that households are able to mobilise credit for malaria prevention (Rashed *et al.*, 2000). However, this evidence contradicts qualitative findings from an ITN social marketing project in Tanzania (SMITN, Phase 1), where people reported that they could mobilise credit for malaria treatment, but not for prevention, and that they were obliged to wait until harvest season when cash was available to purchase nets (Hanson and Jones, 2000). When asked about the type of assistance needed to enable them to buy nets, 37% of participants in a focus group discussion in Burkina Faso preferred free nets , 45% preferred reduced prices and 10% preferred nets to be available on credit (Okrah *et al.*, 2002). These results may indicate that credit is a feasible and desirable way of obtaining malaria prevention for some but not all, though the underlying reasons for this are not clear.

The evidence suggests that use of preventive measures is generally higher among those of a higher SES. For example, in Malawi, (Ettling, 1994) found that all preventive measures were used by a greater percentage of LHYH than by VLYH including coils (67% and 16% respectively), aerosol sprays (46% and 8% respectively), bednets (31% and 10% respectively) and repellents (11% and 1% respectively). Similarly, a novel study from India examined the various malaria prevention methods used by different cadres of hospital staff and revealed that lower levels of staff such as nurses and domestic staff were far less likely to use methods such as repellents, anti-malarials and mosquito mesh in rooms than medical students and doctors. The exposure to malaria risk because of working practices (e.g. working through the night) was also higher for low level workers. These factors resulted in a higher incidence of malaria in these cadres and zero incidence in doctors (Rajasekhar and

[1] Low and high income households were grouped together to make group sizes similar in this study

Nandakumar, 2000). Two studies suggest that a threshold level of wealth exists where it becomes possible to invest in prevention to save on treatment (Mwabu, 1991; Wang'ombe and Mwabu, 1993).

A close examination of the determinants of expenditure on chloroquine chemoprophylaxis for children was carried out using logistic regression on data from Benin (Rashed *et al.*, 2000). The authors found that the key determinants of expenditure were women's income, "material wealth" indicators (not described further), age of household head and religion of male adults (with Christian possibly being an indicator of membership of a favoured class). Factors such as accessibility or distance to the nearest hospital (it is not clear whether this is the source of supply of drugs or a proxy for general accessibility of services) and being less educated were found to be associated with lower expenditure on chemoprophylaxis. These results concur with those from a study in Malawi by Ziba et al. (1994) which found that an increase in household income and men's level of education was strongly correlated with the use of malaria prevention methods; and also with those from a study in Uganda which found that non-users of nets (likely to be poorer) were more likely to use traditional medicine for malaria prevention and treatment of episodes, and less likely to undergo blood slide examination than net users (Nuwaha, 2001).

Zone of residence (rural or urban) also seems to be an important determinant or proxy for use and appropriate use of preventive methods. For example, (Rashed *et al.*, 2000) also found that chemoprophylaxis was used less regularly in rural compared to urban areas and rural children were on a chemoprophylaxis regimen less frequently than adults, but children were favoured for chemoprophylaxis in urban areas. The data also showed that rural residents were significantly more likely to use medicinal plants rather than chloroquine chemoprophylaxis as a preventive measure (40% in rural compared to 10% in urban) and were more likely to burn leaves rather than use coils or sprays..

A study in Burkina Faso (Guiguemde, 1994) examined expenditure on prevention and treatment combined[2] in three zones, central, intermediate and outlying, of the same district. More than US$80 per family was spent during the six month malaria season by 60% of families in the town centre, by 45% of those in the intermediate zone, and 39% of outlying zone families. The increased expenditure with proximity to the town occurred in spite of increasing incidence in the outer zones, leading the authors to conclude that nuisance biting may have been an important factor in preventive expenditure. Unfortunately, although the study gathered information on monthly household income, the main outcomes are not reported by income level. Moreover, the aggregation of prevention and treatment expenditure makes it impossible to understand the extent to which the individual categories of expenditure vary across the different zones.

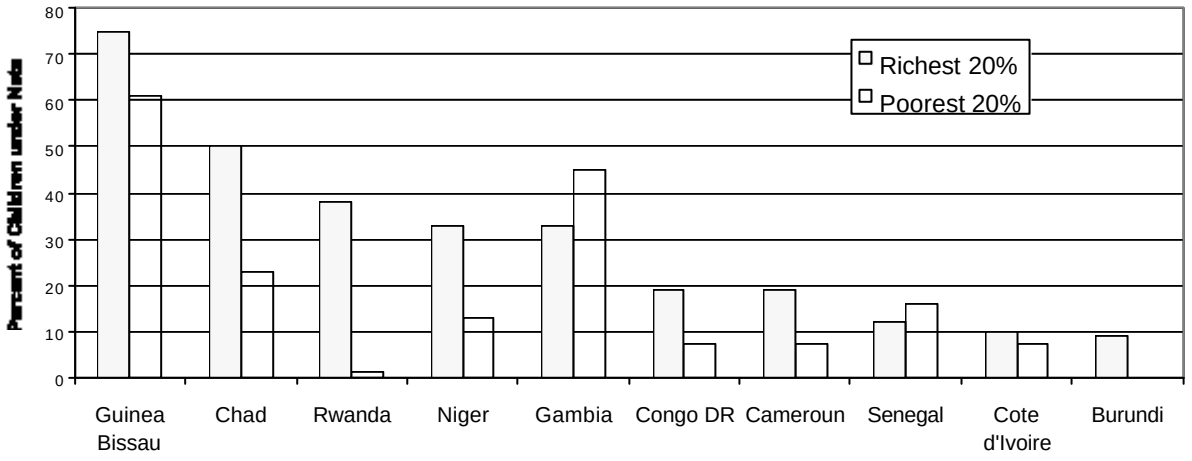
[2] Combination of prevention and treatment expenditure in this study makes it impossible to report results separately.

Mosquito nets and ITNs: Determinants of net ownership and net use

The evidence regarding mosquito net and ITN ownership points firmly to the conclusion that net ownership is strongly determined by SES with large differences between rural and urban net ownership. For example, recent evidence from a Tanzanian DSS site indicates that eight percent of the poorest socio-economic quintile owned nets compared to 51 % of the least poor quintile (de Savigny *et al.*, 2002). Using UNICEF Multiple Indicator Cluster Survey (MICS) data collected between 1999 and 2001 in 10 countries in sub-Saharan Africa, (Wardlaw, 2003) found differences by asset index (comparing the richest and poorest 20%) in the proportion of children under five who slept under a net the night before the survey. The greatest differences were found in Burundi, Rwanda, Cameroon, DRC, and Niger where equity ratios (poorest 20%: richest 20%) ranged from 0 in Burundi to 0.4 in Niger. Interestingly, in both the Gambia and Senegal, a higher share of children in the poorest 20% slept under a net than those in the richest 20% (Figure 1). Though the reasons for this are unclear, one explanation is that prior interventions may have encouraged net use among the poor, consequently affecting the survey results.

Analysis of DHS data from Malawi (Ndawala *et al.*, 2000) showed that treated nets are twice as common in urban (56%) as rural (28%) areas and that households with higher SES (as proxied by household ownership of a radio) are more likely to possess at least one bednet. Further evidence from social marketing activities in Malawi (Holtz *et al.*, 2002) revealed that overall net ownership was around 20%, but urban net ownership was much higher (28.8%) than rural net ownership (6.4%). Holtz also found that only 3.3% of rural children and 24% of urban under-five's slept under a net on the night before the survey.

Figure 1 Mosquito net use by wealth index in sub-Saharan African children under 5, MICS2 adapted from Wardlaw (2003)



A study in Mbarara, Uganda examined predictors of net ownership using logistic regression on a number of potential SES indicators such as occupation, education, asset ownership and certain malaria knowledge variables (Nuwaha, 2001). The strongest predictors of mosquito net use were found to be living in a permanent house (an indicator of relatively high SES) and the belief that mosquito nets are worth the cost, although a number of other variables such as being under thirty years old and owning a TV or radio were also positively associated with net use.

The gender difference between hypothetical demand for preventive malaria interventions (hypothetical vaccine and bednets) was examined by Lampietti et al. (1999). They found a significant difference between men and women (husbands and wives) in the demand for vaccines but not for bednets (although this may have been due to a small sample size for the bednets). Hanson and Worrall (2002) found that in Tanzania net ownership was more common among households where women had a source of cash income. After controlling for the possibility that these households were more wealthy the results were less clear, but they still gave some support to the argument that households where women have a cash income are more likely to own nets. Women's control of their cash income, however, did not seem to be related to the likelihood of owning a net.

Net ownership has also been related to the educational levels of household members. This is a complicated relationship since educational attainment can be a proxy for SES and is also likely to have an independent bearing on an individual's ability to understand and access information regarding malaria prevention methods. In Malawi it was found that net ownership was less common in households where the head/caretaker had not completed primary school and in homes where the house had mud walls or a grass roof (a proxy for low SES) (Holtz *et al.*, 2002). There is some evidence to show that educational attainment is related to the acquisition of malaria specific knowledge. For example in Zambia, knowledge of malaria was found to be positively associated with level of education (Kaona *et al.*, 2000). In Nigeria, Fawole and Onadeko (2001) found a statistically significant difference in the malaria "knowledge score" (based on a series of questions related to the cause, transmission, symptoms and prevention of malaria) of mothers of different ages, education attainment and occupation. Knowledge was higher among those who were skilled or professional than among the unemployed or unskilled category.

The *level* of education attained may also be a factor. In a study on ITN use in Benin (Rashed *et al.*, 1999) suggest that there may be a threshold effect, with ITN acquisition increasing among those men who have completed secondary, but not primary, education. In Zambia, knowledge of malaria was found to be positively associated with level of education but no significant relationship was found between education and the use of mosquito nets (Kaona *et al.*, 2000) indicating that education is sometimes, but not always, an important determinant of net ownership.

Specific knowledge on the cause, prevention and treatment of malaria was found to be positively related to net ownership in Uganda, however, the study found no difference between users of treated versus untreated nets in SES, age, and health beliefs (Nuwaha, 2001). A similar picture regarding the relationship between SES and malaria-specific knowledge emerged from Malawi, where knowledge and appropriate use of ITNs was found to be lower in rural (poorer) compared to urban (less poor) households (Holtz *et al.*, 2002).

Notwithstanding the complex yet important role played by people's general and malaria-specific knowledge, poverty appears still to be the most important barrier to net use with more than 80% of households without a net in one Malawian study reporting "lack of money" and 13% reporting "can't afford them" as the reason (Holtz *et al.*, 2002). The authors of this study conclude that "[P]ervasive poverty and the expense of the nets were the chief reasons for the lack of nets in these [rural] households". An ITN social marketing project in Tanzania found similar results, with the most common constraint on net ownership reported as affordability (Hanson and Worrall, 2002). FGD in Myanmar regarding ownership of bednets revealed that the majority of families used them but they mostly shared nets, and the most common reason for not owning was lack of money to buy them. FGD in Burkina Faso (Okrah *et al.*, 2002) revealed that net ownership was higher in urban (55%) than in rural areas (34%) and that the high cost was the most frequently stated reason for not owning nets.

Malaria prevention tools do not always remain out of reach to all of the poorest households. In rural Tanzania, data have suggested that a combination of social marketing with active private sector participation was able to achieve net ownership in two-thirds of the poorest households. The ratio of net ownership in the poor to least poor households (equity ratio) was 0.54-0.69 at baseline before 3 years of social marketing and 0.60-0.73 after 3 years of activity. It is important to note, though, that the study took place in a small area, inviting the possibility that the population studied was relatively homogeneous, and that net treatment and re-treatment rates, among the poor and least poor, remained quite low (Abdulla *et al.*, 2001). A similar picture was seen in Tanzania for the larger SMITN social marketing project, with the equity ratio improving over time as coverage increased (Jamu *et al.*, 2002). These results suggest that prolonged efforts in the social marketing of ITNS can improve equity of ownership; however there are also conceptual problems of examining a ratio of coverage rates, which by definition will converge to one as average coverage increases, even if the absolute difference is constant.

Net retreatment rates in Malawi were found to be lower in rural (16%) than urban (35%) households (Holtz *et al.*, 2002). In Tanzania net retreatment rates were lower for those of lower SES and those of higher SES were less likely to have never treated their nets. However, the socio-economic gradient in net treatment was less marked than for net ownership. The authors suggest that this may be due to the considerably lower cost of insecticide compared to a net, and because those who buy nets may be more sensitive

to health issues and therefore are more likely to invest in insecticide, even in the lower SES quartiles (Hanson and Worrall, 2002).

There is some evidence to suggest that children, who are especially vulnerable to malaria, are not given priority access to malaria prevention. Evidence from Malawi revealed that bednets used by adults are often newer and more recently treated with insecticide than those used by children (Ndawala *et al.*, 2000). These problems may be compounded in poor households where use of preventive methods is even more limited or constrained. However, data from Tanzania showed that children were given priority for sleeping under a net with the proportion of children under a net being constantly higher than that of adults in net owning households (Hanson and Worrall, 2002). Smith et al. (2002) draw attention to the reduction in burden of disease which could be achieved by giving nets to the elderly in Papua New Guinea. While the article does not make its case from an equity perspective, arguments in support of providing nets for vulnerable groups frequently fail to identify the elderly.

One of the problems of examining simple outcomes such as "net ownership" or "net use" is that they fail to control for the physical condition of the net, which may differ systematically between socio-economic groups. A study from the Gambia found that the use of untreated nets in good condition was strongly associated with SES of households (measured using an index of assets and house structure) and children's net use increased from 64% in the poorest households to 86% in the wealthiest households (Clarke et al. (2001)). However, importantly the proportion of nets in good condition also increased with socio-economic status, from 50% to 69% in the poorest and wealthiest households respectively. Interestingly, the effect of untreated net use on prevention of malaria (compared to no net) was found to be significant only in the poorest households where malaria prevalence with a net was 40% compared with 63% without a net. In the middle and high income households, malaria prevalence without a net was 44% and 35%, and prevalence with a net was 41% and 31% respectively. These results led the authors to conclude that the poorest have most to gain from using untreated nets.

While most studies look at the socio-economic determinants of intervention use, a recent study from Tanzania reversed this relationship and looked at the extent to which mosquito net use can be used as a predictor of household economic well-being. Analysis of household budget survey data revealed mosquito nets to be one of the strongest predictors of household expenditure (Trudy Owens, personal communication, ,2002).

Treatment expenditure by SES

In Malawi, (Ettling, 1994) found little difference in expenditure on treatment of malaria by treatment source between children in VLYH compared to LHYH, although the mean expenditure per case using a traditional healer was $0.88 for VLYH compared to $1.67 for LHYH, possibly suggesting that traditional healers have more flexible services or pricing which can be adapted to their perception of their clients' ability to pay (Figure 2). A similar pattern emerged for adult treatment expenditure with very little difference in median

expenditure between VLYH and LHYH; however, in this case hospital admissions stood out as being more expensive in VLYH where mean expenditure was $7.68 compared to $3.89 in LHYH (Figure 3).

Figure 2 Household expenditure on treatment of malaria in children under 10, Malawi adapted from (Ettling, 1994)

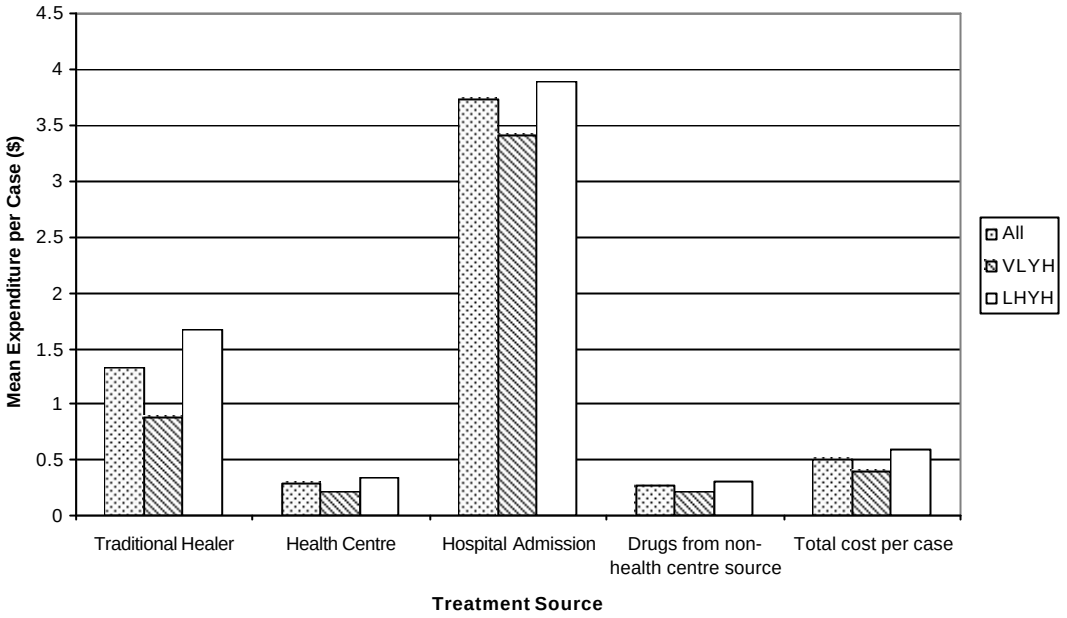
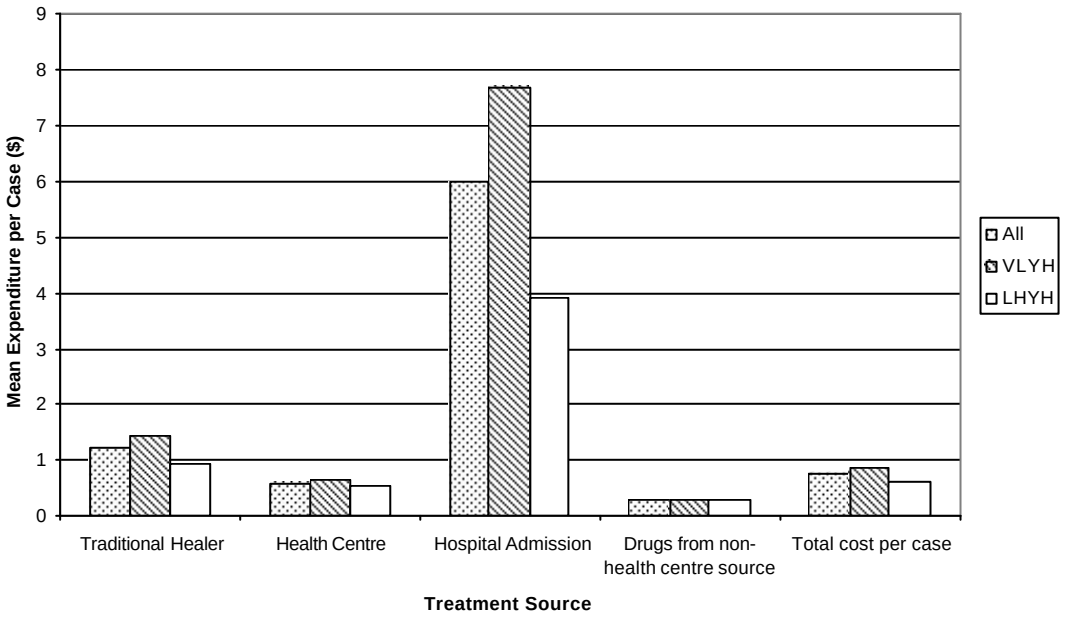


Figure 3 Household expenditure on treatment of malaria in adults, Malawi adapted from (Ettling, 1994)



Treatment expenditure as a proportion of income

(Ettling, 1994) calculated that total annual household expenditure for malaria treatment for VLYH (very low income households) was $19.13, or 28% of mean annual household income for VLYH and $19.94 or 2% of LHYH total annual income. Similarly in Benin, Rashed et al. (2000) found that total treatment expenditure accounted for a slightly higher proportion of annual household income in rural (3.3%) compared to urban (2.4%) households, illustrating that the relative burden of malaria treatment expenditure is likely to be greater for poorer than less poor households.

Determinants of treatment expenditure

The literature highlights a large number of possible determinants for the level of treatment expenditure for a malaria episode. In Benin, mean expenditure for treatment of febrile episodes was found to be negatively correlated with inaccurate knowledge about malaria (the belief that malaria is transmitted by things other than mosquitoes) and positively correlated with women's income which was associated with an increase in treatment expenditure on children in rural areas (Rashed *et al.*, 2000). The authors also pointed out that more variables influenced prevention practices than influenced average treatment expenditure for febrile illness because the nature of illness is the principal determinant of expenditure on a particular illness episode.

Further analysis of the Benin data by the same authors (Rashed *et al.*, 2000) found no significant difference in treatment costs for episodes in adults compared with children; however, the average cost of treatment was significantly higher in urban areas (less poor) than rural areas (poor). Expenses were found to vary with number of febrile episodes rather than availability of financial resources. However, it is possible that households which anticipate that they are likely to experience a greater number of episodes of illness in a year will adjust downwards their expenditure per episode when faced with a budget constraint.

Nyamongo (2002) investigated malaria treatment seeking behaviour in a rural Kenyan community. This study found evidence that people seek to minimise expenditure incurred as a result of malaria by starting with self-treatment at home and observing progress before making a decision to seek care elsewhere. This illustrates that the type and source of treatment received will be an important determinant of the cost of treatment, and is discussed further below in the section on treatment choice.

Determinants of treatment choice and utilisation

Individuals with malaria or their carers can choose from a large number of treatment options. These range from no treatment, self treatment, or traditional treatment through to treatment at a range of formal and informal, public and private pharmacies, clinics and hospitals. Generally, treatment seeking behaviour and choice of treatment options differ between individuals of different SES, age, sex and zone of residence and those of lower SES may be more likely to receive cheaper (possibly inferior) treatment or no treatment at all. Treatment choice may also be unrelated to SES and may simply reflect

the quality or perceived quality of care offered at various facilities. Treatment practices may also differ according to the nature of the illness or symptoms (e.g. for uncomplicated versus complicated malaria).

Income, wealth and cost

In Mali, Kelley et al. (2001) found that those in the poorest economic quintile were significantly more likely to seek care from traditional providers than other quintiles and to use hospitals less frequently than other quintiles. Individuals in the richest income quintile were almost twice as likely to seek treatment for fever as those in the poorest quintile. However, in the sample studied, the majority (60%) of respondents sought no care at all with 33% citing "lack of money" as the reason for not doing so. Of those who sought no care at all, 89% self-medicated. In Uganda, non-users of nets (likely to be poorer) were more likely to use traditional medicine for malaria prevention and treatment of episodes, and were less likely to undergo blood slide examination than net users (Nuwaha, 2001).

In Burkina Faso, Mugisha et al. (2002) found that people in urban areas and those with high incomes were more likely to seek care (for any illness) from health facilities (compared with self-treatment or a traditional healer) as a result of ease of geographical and monetary access. For malaria, treatment at health facilities was found to incur the greatest out of pocket expenditure, followed by self treatment and traditional healer; however most people chose self treatment for malaria because they were familiar with the disease and felt confident in their ability to treat themselves.

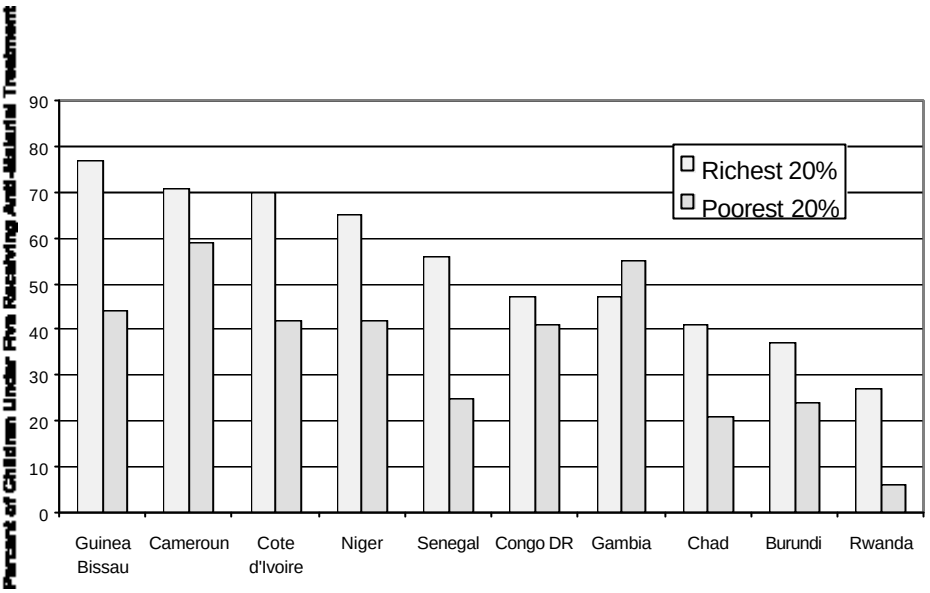
In Kenya, Nyamongo (2002) found that the cost of accessing treatment options was the main reason why some options were not utilised. Negotiable prices and payment according to level of treatment received, together with drug shortages at public facilities, were the main reasons for choosing private sector clinics over public ones.

Biritwum et al. (2000) gathered data on management practices for (unconfirmed) malaria illness from two communities in Ghana, one of low and one of relatively higher SES. Very few caregivers did nothing, but left-over drugs were used to treat more (82%) episodes in the poor compared to the less poor community (53%) and the purchase of drugs without prescription was more common (29%) in the poor than in the less poor (19%) cases. The poor were also less likely to go to a clinic than the less poor (19% and 31% respectively). The authors argue that the use of left-over drugs is indicative of a household facing a cash constraint.

These differences in antimalarial treatment by socio-economic status are supported by recent MICS data in ten countries in sub-Saharan Africa (Wardlaw, 2003). The data indicate that a lower percentage of children under five-years of age in the poorest wealth quintile (as determined by household assets) are receive any antimalarials compared to children in the highest quintile (Figure 4) in nine of the ten countries surveyed. Only in the Gambia were those in the lowest quintile more likely to receive treatment more than those in the highest. This finding could be due in part to previous efforts to

increase treatment, which is supported by a relatively high percentage treated in both quintiles.

Figure 4 Antimalarial drug treatment by wealth index in sub-Saharan African children under five-years, MICS2 adapted from (Wardlaw 2003)



De Bartolome and Vosti (1995) used an econometric choice model to examine the household choice between public and private health care for malaria in Brazil. They assumed that a typical household with an infected member obtains utility from the household consumption and health of the infected member and that the health of the infected person depends on treatment, severity of attack, innate resistance and time to treatment. Individuals choose between public and private treatment in order to maximise utility with a further assumption that private treatment is better, and that the health gain from private treatment is larger the more severe the episode. Data on malaria episodes, household assets (adjusted for household size), price of treatment, distance from home to clinic/urban centre (proxy for travel cost) were collected and analysed using the model. The model results showed that price and wealth are significant determinants of choice of treatment source. Holding household assets constant, households with many members are significantly less likely to choose private treatment. A rural location (no facilities are available in the rural areas so patients had to travel to the centre), short distance to centre, and high literacy all significantly increase the probability of private treatment, whereas the number of recent infections, age and sex of individual are insignificant factors of choice. Transport costs were found to be an important deterrent to treatment, providing support to the argument for mobile clinics in the area.

Filmer (in press) examined the linkage between fever and its treatment in Sub-Saharan Africa using a subset of data from DHS surveys. Data from six Western and Central African countries and six Eastern and Southern African

countries were examined to analyse where treatment or advice was sought in response to reported fever in children under three. Treatment options were categorised as "no modern sector" which included no treatment, advice from friends, and treatment from a traditional healer; "public higher level facilities" or government hospitals; "public lower level hospitals" e.g. government health centre, government health post, mobile clinic, CHW; and "private medical or commercial facilities" which included medical facilities such as private hospitals/clinic, private doctor, private mobile clinic or a commercial facility such as a pharmacy or a shop.

He found a substantial difference between the two regions in the overall percentage who seek care in the modern sector, with 43% of fever cases resulting in a visit to the modern health sector in West and Central Africa (WCA) compared to 63% in East and Southern Africa (ESA). In both regions substantial inequity was found with the percent seeking care in the modern sector substantially larger in the richest than the poorest quintile, (SES was measured using an asset index).

The results of the study are shown in Figures 5 and 6 below. In WCA, private, medical or commercial seems to be the most equitably distributed treatment source although those in quintiles 1 and 2 (Q1, Q2) still use services less than those in Q3, Q4 and Q5. Use of private services declines in Q5 compared to Q4 and it seems as if at this level public higher level is substituted for private medical or commercial. In ESA use of private medical or commercial is fairly similar for Q1 and Q2, but increases with a step between Q2 and Q3 and then continues to increase steadily up to Q5.

Use of no modern sector shows a clear decline from Q1 to Q5 in ESA and WCA although the decline is much steeper in the latter. This illustrates the inferior[3] nature of care involving no modern sector. In WCA care involving no modern sector has a very steep upward gradient with only 25% of those in Q1 compared to 66% in Q5 obtaining treatment from this source. The situation in ESA is still inequitable but much less so with 54% of those in Q1 and 75% of those in Q5 obtaining care from this source. In WCA public lower level and public higher level show a similar pattern (gradient) of inequity between quintiles although utilisation of public lower is around 10% higher for all quintiles. In ESA utilisation of public lower level facilities is higher for all quintiles than public lower level. Public lower level utilisation is fairly similar among quintiles with a mean of approximately 30% and a range of 6.3%, utilisation is slightly lower in Q5 than Q1. Public higher level facilities show more inequity with Q1 utilisation around 8% compared to 25% in Q5. Overall, Filmer's results show a substantial difference in the types of care sought by the wealthy and the poor, with the poor more frequently opting for care involving no modern sector and the wealthy more frequently opting for care involving some modern sector. Overall the picture in ESA looks less inequitable than in WCA.

[3] Inferior in the economic sense of the word, meaning that as incomes rise consumption of the good falls more than proportionately.

Figure 5 Choice of treatment options by socio-economic quintile (West and Central Africa) adapted from (Filmer, In press)

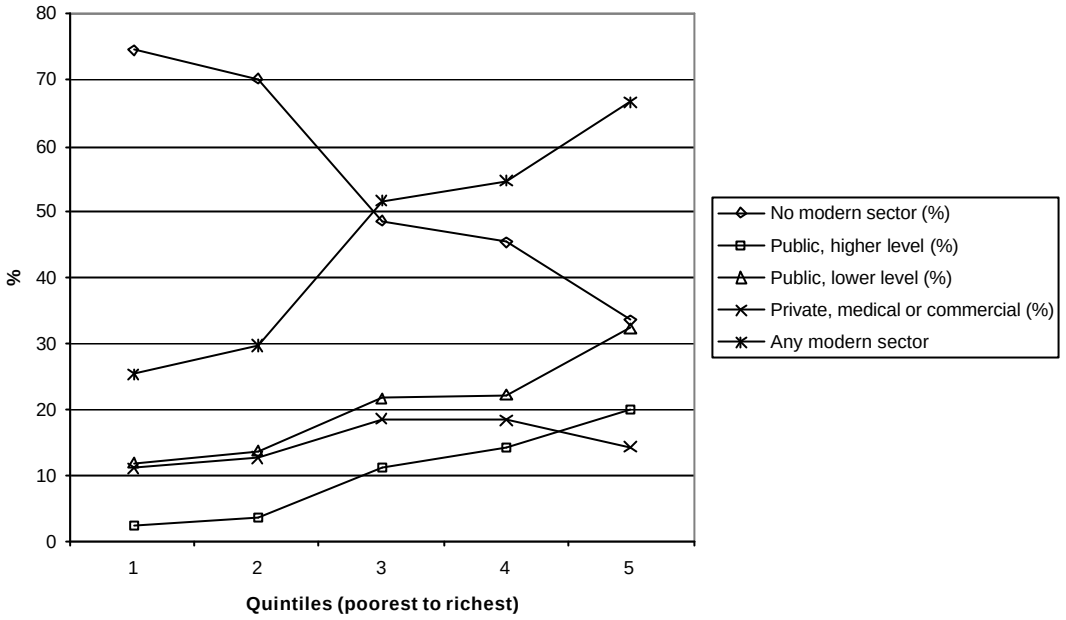
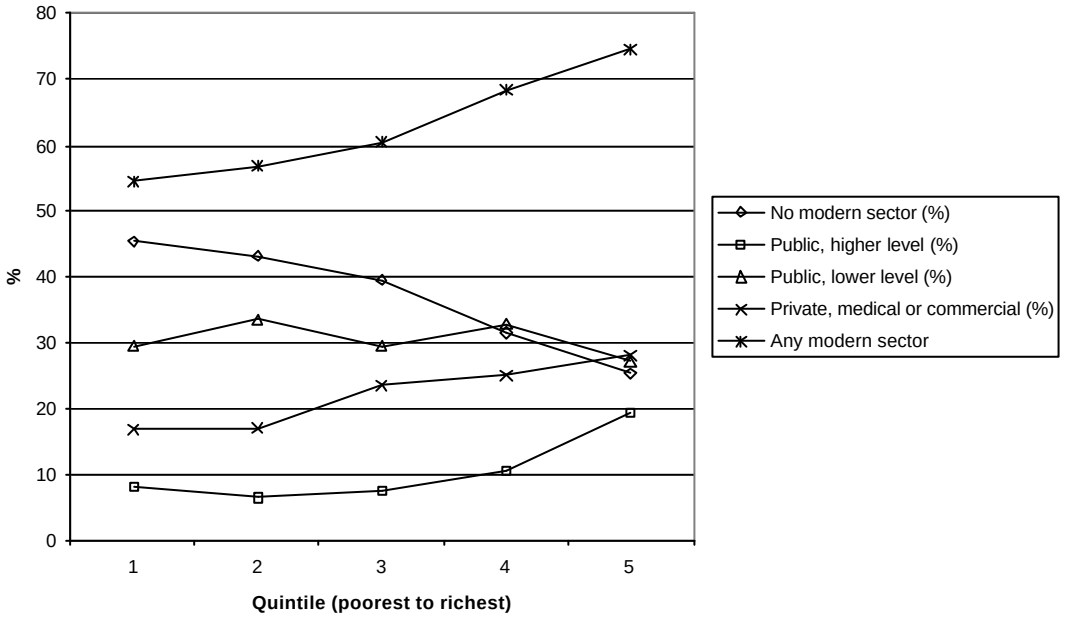


Figure 6 Choice of treatment options by socio-economic quintile (East and Southern Africa) adapted from (Filmer, In press)



In contrast to the results reported above, Ettling (1994) found that in Malawi treatment source patterns (for adults and children) were very similar for VLYH and LHYH respectively with approximately equal proportions of VLYH and LHYH using traditional healers, hospitals and drugs from non-health centre sources. Interestingly, a study in the Bla district in rural Mali revealed that use of services for fever treatment differed significantly according to income quintile for women but not for men. According to the data, 31% of women in the lowest income quintile sought treatment for fever compared to 47% in other quintiles (Kelley *et al.*, 2001).

Zone of residence (rural/urban)

In coastal Kenya Molyneux et al. (2002) found that the types of therapy used (defined as biomedical only (BM), biomedical then traditional (BM+T), traditional then biomedical (T+BM) and traditional only (T)) for uncomplicated fever were very similar in rural and urban settings. For convulsions however, rural women were much more likely to visit BM only compared to urban women. Urban women were more likely to visit T+BM and traditional only, compared to rural women (36%). Urban mothers were almost twice as likely as rural mothers to contact a private facility, and half as likely to contact a government facility. For all mothers direct contact with any health facility was more common with children under five years of age.

In Benin, annual expenditure on self-medication with chloroquine was significantly higher in rural (US$0.44) compared to urban areas (US$0.08), as was expenditure on traditional treatment. Expenses for private consultation, on the other hand, were significantly higher in urban areas and the proportion of total treatment costs accounted for by private consultation were 11% of rural and 48% of urban total treatment expenditure (Rashed *et al.*, 2000).

Education

In Nigeria, Fawole and Onadeko (2001) examined the treatment seeking behaviour of urban poor mothers or carers of children with fever. The level of education was a statistically significant predictor of the type of help first sought in a childhood fever episode. Of those with no formal education 28.8% went to a health facility first compared to those mothers/carers with secondary education where 40.2% visited the health facility first. Uneducated mothers constituted the majority (52.6%) of those who went to the traditional healer whereas “patent medicine sellers” were more frequently patronised by educated mothers (41%) than illiterate mothers (25%). In Zambia, the use of chloroquine (compared with traditional or no medicine) was positively correlated with age and level of education but no relationship was found between education and knowledge of correct dose (Kaona *et al.*, 2000).

Gender and age

In rural Thailand Ettling (1989) and (1991) investigated attendance patterns at three types of clinic: central, peripheral and periodic (a weekly mobile clinic). The results showed a greater number of men attend all clinics than women and children, although they have comparable levels of exposure. The periodic clinics had the highest (and more equal compared with coverage of

men) coverage for women and children because the distance required to reach the periodic clinic was walkable and therefore imposed no direct cost.

Espino and Manderson (2000) examined treatment choices for febrile episodes in a community of high malaria risk migrant families in the Philippines. No significant difference was found in the mean number of therapeutic options resorted to by ill individuals or their caretakers according to age of ill person. However, individuals in the under-fifteen age group were significantly more likely (21/35 =60%) than those in older age group (21/62=33.9%) to seek treatment at health facilities (compared to home remedies, self-treatment (traditional and western), traditional healer, nothing) for febrile episodes perceived to be malaria. Adults in the observed households tended to self-medicate rather than seek treatment at a clinic and men were more likely than women to self-treat rather than go to a clinic, but the difference was not significant. Only three individuals in the study stated that lack of financial resources affected their decision, although the authors suggest that irregular income, and the cost of fares and drugs must have been disincentives to clinic use. Other reasons, such as expectations of correct diagnosis at the health facilities and availability of medicines, encouraged people to use clinics. Past experience and advice from neighbours or relatives played a role in encouraging home treatment for those who chose this option; however, when this failed or illness worsened, formal treatment was often sought.

An evaluation of a CHW intervention in an epidemic prone area of Ethiopia found that CHW were utilised far more by those over 15 years, with children under 15 years being treated far less than would be expected given their proportion in the population (Ghebreyesus et al. 2000). Children under 10 years were treated only about 45% as often as would be expected; however there was no difference between treatment of female and male children. Adult females were treated less frequently than expected given their proportion in the population: consistently less than 40% of CHW patients were women and they attended only 70% as often as expected. The highest treatment rate was in the adult male group and males in the area have been shown to have higher infection rates compared to females. FGD revealed that women's workload left them with little spare time to attend to their own or their children's health needs. In response to these barriers, female traditional birth attendants were trained to provide malaria treatment, and a pilot programme was undertaken comparing the utilisation of these female CHW to that of existing male CHW. The results showed that more women and children were treated by the female CHW; however the differences declined after 2 years, possibly as a result of a home treatment initiative which had begun in the area.

Evidence from both rural and urban Mali (Kelley *et al.*, 2001) indicates that utilisation of services for fever treatment by age is fairly uniform (43%-44%) and varies substantially only between older age groups, with 25-39 year olds using services more when ill (47%) compared to the older group (55 and older) who used services the less (36%).

Accessibility

Distance was also found to be an influential factor in treatment seeking patterns for fever and convulsions in Zambia (Baume *et al.*, 2000). They found that children living within 1 hour travel time were more likely (79%) to be taken to health centres compared to those living more than 1 hour away (58%). For a follow up visit for continued symptoms 16% of those living near and only 3% of those living far away made the trip. They also found that financial constraints deterred caregivers from seeking help at clinics where user fees were charged. Caregivers living near these clinics most frequently cited lack of money as the reason for not taking child to clinic.

Drugs and drug resistance

The results from a Nigerian community-based survey showed that those earning greater than N3000/day were twice as likely to use "appropriate" drugs (defined as drugs to which resistance had not developed – Fansidar mainly) compared to those earning less than N3000/day who were more likely to use CQ, despite resistance (CHESTRAD, 2000). In the Solomon Islands Hess et al. (1997) defined a number of occupations as being proxies for low SES (farmer, fisherman, labourer or unemployed) to examine the risk of drug resistance in children from different SES groups. They found a smaller proportion of low SES children in the chloroquine sensitive group compared to the proportion of low SES children in the insensitive group, but the difference was not significant. Malnutrition was not found to be an indicator of risk of resistance in the low SES group, but was a strong risk factor for resistance in children in high SES group. There was weak and insignificant evidence of a protective effect of low SES against treatment failure as long as children were well-nourished. Antibodies against blood-stage antigens (a measure of exposure rather than immunity) were more prevalent in the low SES group, but the authors suggest that lower SES group children may have a higher level of immunity to malaria than children in higher SES group.

Malaria in Pregnancy

Pregnancy compromises women's immune systems making them more vulnerable to malaria and therefore increasing their need for adequate malaria prevention and treatment. In addition to the problems of poverty, lack of access to and knowledge of malaria prevention and treatment that face other individuals at risk of malaria, pregnant women face additional barriers such as the belief that fever is a normal sign of pregnancy (Winch *et al.*, 1996) or that bitter tasting substances such as chloroquine can provoke abortion. Such perceptions can prevent them obtaining the preventive or curative treatments required. In addition, economic factors within the household such as male control of spending decisions (Hartigan, 1999) and women's lack of cash may compound this problem and make it an issue even in households of relatively high SES.

Ndyomugyenyi et al. (1998) examined the choice of antenatal care (ANC) options in a rural subsistence farming community in Uganda. They found that the level of education, religion and marital status of women did not influence ANC attendance, but that health seeking behaviour was influenced by the perceived high cost of ANC services, delivery and treatment and the

inadequacy of the formal health system. In the study 66.4% of women reported suffering from malaria during current pregnancy, and only 49% of these had obtained treatment from the formal delivery system; the rest had used self-treatment with drugs purchased from shops, attended private clinics, or been treated by neighbours, using herbs or not at all. The main reasons for not using formal health systems were "economic" and the lack of drugs in formal clinics, distance and cost of travel to clinics and waiting times.

Data that measure utilisation of intermittent presumptive treatment (IPT) by SES are scarce, and few countries in Africa currently provide IPT as part of regular antenatal care. However, antenatal contacts provide a potential opportunity for delivering a range of malaria control interventions (IPT, provision of ITNs, vouchers for ITN/retreatment). It is therefore of interest to determine the degree to which poor women currently access antenatal care. A recent World Bank cross-country analysis provides important insight into the utilisation of antenatal care by socio-economic status in a wide range of African countries (http://www.worldbank.org/poverty/health/data/index.htm).

In the DHS data analysed, antenatal care was measured as percent of births in the five years before the survey for which a woman received at least one antenatal care consultation from a medically trained person. Poor/rich (equity) ratios in antenatal care use were calculated comparing the rate of use prevailing in the poorest population quintile with that in the richest quintile[4] (defined on the basis of an asset index). These ratios ranged from 0.239 in Mali to 0.946 in Zimbabwe and reveal that in many countries there is a long way to go to improve access of the poorest.

[4]No information about the middle three quintiles is provided when using this approach, see original for these data.

Table 1 Equity ratios for ante-natal care visits from (Gwatkin et al. 2000)

Country	Equity ratio for ante-natal care visits and range of utilisation (poorest-richest socio-economic quintile, in %)
Benin	0.599 (59.1-98.7)
Burkina Faso	0.463 (42.9-92.7)
Cameroon	0.535 (52.7-98.5)
Central African Republic	0.436 (40.0-91.8)
Ghana	0.779 (75.8-97.3)
Kenya	0.915 (87.9-96.1)
Madagascar	0.702 (67.1-95.6)
Malawi	0.869 (84.0-96.7)
Mali	0.239 (20.2-84.5)
Mozambique	0.474 (46.6-98.3)
Namibia	0.922 (82.8-89.8)
Níger	0.292 (24.6-84.3)
Nigeria	0.341 (30.9-90.7)
Senegal	0.694 (66.8-96.3)
Tanzania	0.858 (82.4-96.0)
Togo	0.705 (68.2-96.8)
Uganda	0.905 (86.6-95.7)
Zambia	0.917 (91.3-99.6)
Zimbabwe	0.946 (91.0-96.2)

Discussion

Although there are strong *a priori* reasons for believing that the burden of malaria is greatest on the poor, the evidence in the literature to support this is mixed. One important consideration is whether this burden is measured in terms of malaria incidence, or vulnerability to more serious consequences of malaria arising from, for example, delayed treatment seeking. There do appear to be inequalities in the uptake of interventions, including treatment seeking patterns. However, the inconsistency and questionable reliability of the various ways in which socio-economic status is measured limit the strength of conclusions.

Is there a relationship between malaria incidence or vulnerability to malaria's effects and SES?

Though there is evidence that malaria is a disease that primarily affects poorer countries, the evidence regarding the distribution of malaria incidence between poor and less poor population groups is mixed and often contradictory. Most studies that use material assets as a proxy for SES have failed to establish a positive relationship between asset ownership and reduced incidence of febrile episodes (as a proxy for malaria) at the household level. The most consistent data come from Filmer's (2001) large sample study in which no difference at the household level was observed in fever incidence between the poor and less poor, but significant differences were seen at more aggregate levels. These findings have been questioned by malaria epidemiologists, as differences in transmission patterns across the large number of countries examined may be confounding the consistency of the SES-incidence relationship, or lack thereof (Lawrence Barat, personal communication, 2002).

Evidence of malaria incidence by occupation is also mixed, though stronger than that obtained from using asset-based indicators. Migration of labourers in agricultural work as well as unemployment have been shown to be risk factors for malaria infection. However, there exists some evidence that in the case of agricultural labourers, the relationship between occupation and incidence are dampened – if not reversed – by the generation of community-level wealth. This evidence, taken with that from (Filmer and Pritchett, 2001), implies that community-level data might provide stronger indicators of the link between malaria and poverty than household data. Similarly, although only limited work has been done exploring the relationships between malaria and ethnicity, aggregate-level data have suggested that ethnic group might have a significant relationship with malaria incidence.

The evidence with regard to vulnerability to the consequences of malaria by groups of lower SES is more consistent. Studies examining SES using assets, education, and occupation all yield data that suggest an inverse relationship between the severity of malaria's effects and SES (Bondi, 1991; Olumese *et al.*, 1997; Olowu *et al.*, 2000; Rajasekhar and Nandakumar, 2000; Abdulla *et al.*, 2001; Okrah *et al.*, 2002). Though poorer populations may be at similar risk for contracting malaria, it seems that they have less access to effective means of treatment once infected.

The lack of consistent socio-economic differentials in malaria incidence is not necessarily counterintuitive. Given the epidemiology of malaria transmission, particularly its environmental aspects, it should not be surprising that variables such as "housing type" had an impact on incidence, given the importance of housing in limiting vector/human contact. That most of the other variables yielded, at best, conflicting data on their impact on malaria incidence could be a testament to the high degree of exposure to the mosquito vector regardless of SES, particularly in areas and periods of high transmission. Vulnerability to the consequences of infection, on the other hand, has much less to do with non-discriminatory environmental factors, and more to do with inequities in access to prevention and treatment.

Although some studies indicated differences in malaria incidence by various socio-economic proxies, many of these differences did not survive multivariate statistical analyses. The conflicting data are likely to be at least partly the result of flawed methodologies and the inherent difficulties involved in measuring SES in developing countries. Furthermore, although we found a great deal of literature on equity and health more generally, limited research has been undertaken which looks at these relationships specifically for malaria. Where studies contained variables that allowed the relationship between SES and malaria to be investigated, this was rarely the main topic of the research, a factor that helps to explain the weaknesses in measurement of SES. In contrast, the body of qualitative work examining inequities other than those related to SES has provided more consistent evidence of a greater malaria burden, but not necessarily incidence, on the poor and marginalized in society. Given the extremely limited evidence-base, however, we hesitate to draw any conclusions but encourage more work to be done in this important area.

Are there differences in utilisation by socio-economic status?

Expenditure on prevention is more strongly correlated with income and SES than expenditure on treatment. This leads to two forms of inequity: first, the poor are less likely to benefit from preventive measures due to their inability to afford them; and second, the burden of any given level of expenditure on treatment will be greater for those on low incomes. In addition, the cost of treatment was mentioned frequently as a barrier to access. The role and importance of women's income in malaria treatment was inconclusive.

Evidence of utilisation of interventions other than ITNs – such as IPT and indoor residual spraying (IRS) - is scarce. However, higher levels of mosquito net ownership and use have both been correlated with higher socio-economic status. A number of studies determined that the most common reason for lack of ownership remains affordability. Very few studies examine differences in the quality of care received or in the physical condition of nets. Perhaps most importantly, there is little information on whether or not prevention or treatment is being directed at the members of the household who are usually most at risk – young children. Future studies of inequities in malaria control must address the degree to which children are benefiting from malaria control.

The relationship between education and malaria knowledge remains unclear as does the relationship between these two variables and the use of malaria prevention tools. The uncertainty regarding the role of education may be due to the multiplicity and accuracy of variables used to measure education. For example, studies are often unclear in defining whose education is being measured – mother or household head. In addition, the level of education acquired, and its measurement, vary greatly by study and location, as does the relationship between education and relevant skills such as literacy or ability to read. The attainment of malaria-specific knowledge, for instance through social marketing, has demonstrated some impact on preventive actions and increases in equity, however, the evidence-base remains quite limited.

There is even less evidence of the relationships between ethnicity and gender and utilisation of prevention and treatment. The effects of social marginalisation along a range of dimensions have been documented for a variety of health outcomes. However, the role that social status may play in causing or exacerbating inequalities which may lead to lower utilisation of proper effective malaria control were beyond the scope of this review.

Finally and perhaps most importantly, there were very few studies which examined the effect of interventions to improve equity, with appropriate controls. Potential service delivery mechanisms for malaria interventions, such as the provision of IPT in antenatal clinics need to consider equity levels when monitoring impact. Though few antenatal clinics in Africa currently provide IPT, there is considerable range with regard to utilisation of antenatal clinics by the poor; this point merits further discussion given the interest in using antenatal clinics to deliver malaria services and products.

Conclusions

Studies need to adopt a more common methodology to permit comparisons.

Survey data are most useful when a consistent methodology is employed in its collection and analysis. Problems of data comparison plagued this review and limited the conclusions that could be drawn from the literature. Furthermore, the lack of geographical diversity and the homogeneity within many of the study sites were also of concern. The systematic reanalysis of DHS data examining the relationship between socio-economic inequalities and health outcomes (e.g. (Gwatkin D.R., 2000)) constitutes an important step. There are many existing data sources that could contribute to the understanding of service utilisation and disease burden that have yet to be fully analysed.

Qualitative research should be encouraged to obtain more in depth, locally-relevant, and descriptive data on malaria control inequities and care-seeking behaviour.

In interpreting the data presented in this review, we are faced with results that do not consistently agree with what we empirically know to be true at a more

global level – that malaria is a disease of the poor. This, however, may arise from the limitations of the primarily quantitative methods used to measure socio-economic status, or the failure to capture sufficient variation in socio-economic status within a study population. There is evidence of inequalities along a number of dimensions that can be taken to be proxies for poverty – low income, ethnic group, and lack of knowledge of malaria, to name a few. However, the independent effects of these variables are difficult to ascertain without qualitative data to elucidate causal pathways and the roles of different inequalities in them. Descriptive, locally-specific data on the care-seeking process for malaria are required to inform programmatic changes that target the poor. A better understanding of inequalities in malaria incidence and control might result from pursuing complementary quantitative and qualitative studies that examine locally relevant inequalities and measure malaria incidence and intervention uptake at the community level.

A greater focus on inequity is needed in studies from inception to inform programmes that seek to reach the poor.

Much more work, both new field studies and the analysis of existing data, needs to be done to address specifically the questions asked in this review. Many of the studies examined included an equity component or some measure of SES that was used *ex post* to examine equity, as part of larger epidemiological or biomedical studies. A number of these studies introduced potential bias by recruiting the sample from health centres, the users of which tend to be better off. The fact that relatively few studies have focused on equity reflects a gross neglect in malaria research that needs immediate attention if the burden of malaria among the poor is to be reduced.

There is a need for evidence about the effectiveness of interventions aimed at reducing inequities in access to effective prevention and treatment.

Since relatively few interventions have been carried out specifically aiming to reach the poorest, the opportunities to review successes and failures of attempts to target the poor are limited. It is hoped that a better understanding of the causal pathways leading to inequities will lead to interventions specifically designed to reduce these inequities, helping to build a foundation on which even the poorest of the poor might be able to benefit from malaria control efforts.

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