

Is malaria a disease of poverty? A review of the literature

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Summary

OBJECTIVE To review the evidence on the link between malaria and poverty.

METHODS Review of the published and grey literature to identify (i) the data available on the socio-economic distribution of malaria incidence and vulnerability, and (ii) the uptake of malaria control interventions.

RESULTS We found mixed evidence on malaria incidence, with a number of studies identifying no relationship between socio-economic status and incidence, although a larger number of studies do find a link. There is strong evidence that uptake of preventive and treatment interventions is closely related to proxies for socio-economic status. More generally, the quality of the literature examining this issue is highly variable, with many different measures of socio-economic status and often inadequate descriptions of methods of data collection and analysis in relation to socio-economic status.

CONCLUSIONS Important socio-economic differentials exist in access to malaria interventions, increasing the vulnerability of the poorest. More information is needed about how other methods of delivering malaria treatment and prevention can redress these inequalities.

keywords malaria, malaria incidence, poverty, socio-economic status, Africa, equity

Introduction

Malaria is commonly recognized as a disease of poverty (Gallup & Sachs 2001; Sachs & Malaney 2002; World Health Organization/UNICEF 2003). At the global level, malaria incidence is concentrated in the world's poorest countries, with 90% of malaria deaths occurring in sub-Saharan Africa (World Health Organization 2002). A growing body of evidence suggests that the causal link runs in both directions, as malaria depresses economic growth (Gallup & Sachs 2001). However, the links between malaria and poverty at the micro or household level remain ill-understood. To elucidate the nature and direction of some of these links, we reviewed the evidence about two separate but related issues: first, the relationship between malaria incidence and/or vulnerability and socio-economic status (SES); and second, the uptake of malaria control measures by SES.

Methods

A literature review was undertaken on published literature using electronic data bases (BIDS, Medline, PubMed) and the following key words: malaria and malaria incidence plus: equity, socio-economic status, poverty, poor, income,

wealth, burden, treatment seeking. The review was limited to articles published after 1990, in English. References identified through electronic databases were cross-referenced and followed-up by hand. Unpublished and grey literature from the UK and USA was identified by following-up references in published and unpublished articles and communicating with colleagues working in the area. Finally, internet search engines were used to find studies from organizations that had not been solicited directly.

The literature on malaria and equity must be seen and interpreted in light of the broader literature on health and equity. Our choice to restrict the analysis to studies which look specifically at malaria treatment is justified by (a) the interest in the equity issues related specifically to malaria arising from global disease initiatives such as the Global Fund and the Roll Back Malaria Partnership, as well as the Millennium Development Goals; and (b) the specific features of malaria interventions, which are not always delivered through health facilities. The latter applies to preventive measures such as ITNs, which are often supplied outside the general health service; but equally to some malaria-specific services (e.g. active case detection through outreach services) which are more common in low transmission contexts. These factors notwithstanding, the issues related to malaria treatment are related to the delivery of general

E. Worrall *et al.* **Is malaria a disease of poverty?**

health services. The results of our review are expected to contribute to better understanding of equity in the distribution of health services in general and with regard to malaria in particular.

Results

Approximately 150 studies were retrieved. However, only approximately one-third of these turned out to be relevant and were included in the review. Most were from African countries, although there were a number from Asia and South America. Many studies did not set out to explore the questions examined in this review directly, or if they did, the study designs were often poor or the methods for calculating or estimating SES weak and inadequately described. Studies which examined the determinants of uptake of preventive interventions, especially ITNs and the choice of health care provider, were more numerous and generally of better quality than those which examined the relationship between poverty and incidence.

Methods and language of poverty measurement

Poverty is a multidimensional construct, embodying a lack of resources, limited ability to meet basic needs, and a range of other dimensions of vulnerability and security. It has both absolute and relative dimensions (Falkingham & Namazie 2002), which makes it difficult to measure. For the purposes of this review, we use the terms 'poverty' and 'low socio-economic status' interchangeably.

Economists tend to use household consumption as a 'gold standard' for measuring poverty. Consumption is frequently proxied by expenditure since it is less subject to fluctuation than income, and avoids some of the difficulty of valuing consumption of own production. However, measuring expenditure is difficult, time consuming and costly, and suffers from a range of potential biases (Deaton 1992; Falkingham & Namazie 2002).

There are also limitations of relying on a narrow measure of poverty based on money alone, which may not fully capture the multidimensional nature of poverty. A more recent methodological development has been the use of wealth indices, which can be constructed from a small number of variables which are more easily observed or asked about in surveys. In some instances, wealth indices have been validated against household expenditure data (Filmer & Pritchett 2001). More often, they are used on the basis of the plausibility of the relationship between the individual indicators (usually asset ownership and housing conditions) and SES. A popular measure is the index constructed in analysis of Demographic and Health Surveys (DHS) (<http://www.measuredhs.com>).

Other indicators are sometimes employed such as education, gender, rural/urban residence, or occupation. While these are often not directly aimed at measuring poverty, they are used to make comparisons between groups with implied differences in access to resources. There are problems with measurement and interpretation of all of these measures. For instance, it may be difficult to measure years of education, and comparisons of educational attainment across contexts may not be valid. They also rest on usually untested assumptions about the link between these indicators and poverty; for example, that rural residence implies greater poverty.

An important problem faced in undertaking this review was that we were restricted by the approaches to poverty measurement that were used by studies in the literature. Many of these did not adequately describe their justification for choice of a particular approach. Some used classifications such as 'low', 'medium', and 'high' without giving definitions. More generally, poverty was not the main focus of most of the studies we analysed, consequently results and their significance as related to poverty were often inadequately discussed and described. The lack of a common method made comparisons across studies difficult; even where a common asset index method has been used, comparability between countries and studies is not possible since the approach produces a relative rather than absolute measure of poverty and wealth. Nonetheless, in the interests of discerning the broad patterns suggested by the evidence, we compiled the studies using whatever measures of poverty were available.

Two further methodological issues may affect the validity of the results presented here. The first is the well-known bias in self-reporting of illness. Better-off groups report higher levels of illness than the poor (Foster 1994). This bias would underestimate the relationship between SES and malaria incidence.

The second issue is the endogeneity of the relationship between malaria and poverty. To the extent that studies fail to address bi-directional causality, this will also lead to bias, but in this case overestimating the strength of the relationship between malaria and SES. Although this issue is typically addressed in macroeconomic studies of the relationship between growth and malaria, it is rarely, if ever, recognized in the micro-level studies of the type reviewed here.

Evidence of incidence by poverty status

Table 1 summarizes the studies which investigated the link between poverty indicators and fever/malaria. Nine used a combination of assets including housing type and ownership but also encompassing other information such as

E. Worrall *et al.* Is malaria a disease of poverty?**Table 1** Malaria incidence and poverty: summary of studies

Poverty measure	Significant relationship in hypothesized direction	Relationship in hypothesized direction but not significant/significance not tested or reported	No significant relationship	Mixed results
Assets and education (may also encompass housing type, education level, sex of HH head, crowding)	Clarke <i>et al.</i> (2001), Koram <i>et al.</i> (1995)		Villamor <i>et al.</i> (2003), Abdulla <i>et al.</i> (2001a), Rashed <i>et al.</i> (2000a,b), Schellenberg <i>et al.</i> (2003a,b)	Filmer (2002), Mensah & Kumaranayake (2004), Mwageni (2002)
Occupation	Rajasekhar & Nandakumar (2000)			
Location and housing type	Tshikuka <i>et al.</i> (1996), Holtz <i>et al.</i> (2002)	Rashed <i>et al.</i> (2000a,b)		
Sex/gender			Schellenberg <i>et al.</i> (2003a)	
Hospital location/facility type		Olowu <i>et al.</i> (2000)		
Nutrition level	Olumese <i>et al.</i> (1997)			
Livestock ownership and receipt of food subsidy, electricity	Klinkenberg <i>et al.</i> (2004)			
Income education and/or occupation		Sychareun <i>et al.</i> (2000), Kitvatanachai <i>et al.</i> (2003)	Biritwum <i>et al.</i> (2000), Sharma <i>et al.</i> (2001)	

housing type, education level, sex of household head and indicators of crowding. Some constructed an index whereas others used logistic regression to identify correlated variables. Of these studies, two found a significant relationship between poverty and malaria and four found no significant relationship. Three studies provided mixed results.

The study by Filmer (2002) is notable in that it compiled DHS data from 29 surveys in 22 countries. The analysis was carried out for West and Central Africa (W & C) and East and Southern Africa (E & S) on an aggregate (regional), individual child and country-by-country basis. At the regional level a positive but insignificant relationship was found between fever and household poverty in W & C Africa; the relationship was significant at the 10% level for E & S Africa (and at the 5% level when Madagascar was excluded from the analysis); however, further analysis showed maternal education to be far more strongly correlated with fever. At the individual child level the relationship between fever and wealth was negative and not significant in W & C Africa, and significantly negative at the 10% level in E & S Africa. Neither of these results was significant when controlling for the level of fever in the cluster (approximately 20 households). The relationship between fever and wealth of other households in the cluster was

significant and negative in E & S Africa but not significant in W & C Africa. Importantly, fever in an individual child was significantly (5% level) positively correlated with level of fever in other households in the cluster in both E & S and W & C Africa.

These results are similar to those of Khan *et al.* (2003) who found that differences in health status among populations are not due solely to the poverty of individual households, and argued that the concentration of poverty at community level appears to play a role. Similar results were produced by Filmer in the country by country (as opposed to regional) analysis with most countries demonstrating a significant relationship between fever in an individual child within a household and fever and wealth in other households in the cluster.

The studies using occupation, nutritional level and one using a combination of livestock ownership, electricity and receipt of food subsidy as proxies for poverty all found relationships in the hypothesized direction. Studies using income, education and/or occupation found either insignificant or no relationship between fever/malaria and poverty.

Assessing the relationship between poverty and malaria incidence raises the problem of defining malaria incidence. In most studies, reported clinical diagnosis (either malaria or fever) was used. A number of smaller scale

E. Worrall *et al.* **Is malaria a disease of poverty?**

(e.g. Bondi 1991; Sychareun *et al.* 2000) or facility-based studies (e.g. Holtz *et al.* 2002) provided laboratory confirmed malaria diagnosis. There is an intrinsic bias in facility-based studies, due to high levels of self-treatment. McCombie (1996) estimated that only 20–40% of malaria cases and deaths are treated in the formal health sector and use of formal health facilities is likely to be higher amongst those of higher SES (see for example Schellenberg *et al.* 2003a,b).

There are few sources of reliable information on mortality from malaria, as most deaths occur in the home (Mtango & Neuvians 1986; AMMP 1997); however, evidence from Tanzania suggests inequity in malaria mortality. A study in a demographic surveillance site (DSS) in Tanzania constructed an asset index measure of poverty and used verbal autopsy to establish cause of death. The results showed 44% higher crude mortality, 46% higher infant mortality, 53% higher under-five mortality and 66% more malaria mortality in lowest compared with highest SES households (Mwageni 2002), suggesting that the distribution of malaria mortality is more inequitable than all-cause mortality. These results are in contrast to some studies which find a stronger relationship between all cause mortality and SES than between malaria and SES (e.g. Filmer 2002).

Malaria is a common cause of anaemia in children living in malaria endemic areas and malaria control with ITNs and chemoprophylaxis reduces the level of anaemia. Two studies (Kahigwa *et al.* 2002; Schellenberg *et al.* 2003a,b) found that anaemia in children was significantly negatively associated with SES using an asset index.

There are a number of general problems with the studies described above. First, population homogeneity, especially in rural areas, may reduce the level of variation in poverty and obscure relationships (e.g. Abdulla *et al.* 2001a,b). Some studies drew their samples from health facilities (e.g. Koram *et al.* 1995 and Villamor *et al.* 2003) which may have biased samples in favour of higher SES groups more likely to access health facilities. Issues around occupation and risk are complex. For example, occupation may be correlated with SES but also with malaria. While involvement in certain occupations such as irrigated agriculture may increase the risk of malaria, the wealth created by those economic activities may allow farmers to use their income to protect themselves from the mosquito vector (Audibert *et al.* 1990; Boudin *et al.* 1992; Klinkenberg *et al.* 2004). Certain patterns of economic activity may both increase risk of infection and reduce access to health services in the case of illness, as has been argued for highland migrant farm labourers in Ethiopia (Ghebreyesus *et al.* 2000). De Plaen *et al.* (2003, 2004) conducted a detailed study which examined how a

shift to double rice cropping affected the complex interactions between factors which influence SES, such as wealth, gender roles, agricultural practices and exposure to malaria risk. They concluded that the change in agricultural practice reduced the capacity of women to manage malaria in children and increased vulnerability to the disease without increasing wealth or food security.

In general, the papers reviewed give a somewhat mixed picture, and the results seem to depend on how poverty is measured. The Filmer study highlights this problem with relationships between fever and wealth/poverty that appear to be initially significant altering and becoming insignificant when controlling for/considering factors such as clustering and maternal education. The complex pathways between poverty, economic activity, health care seeking, and malaria are not well understood and as demonstrated by the De Plaen *et al.* studies, elucidating them requires long-term careful observation and monitoring of a whole host of interrelated factors. This makes it difficult to demonstrate a direct link between malaria and poverty at an individual or household level even though it is intuitively plausible.

Evidence of use of interventions by SES

In contrast to the studies of malaria incidence described above, the picture regarding the uptake of malaria interventions is more consistent, with most studies finding an association with various poverty measures.

Prevention

One set of studies investigates the uptake of a variety of preventive measures, and finds a consistent picture of higher uptake and use of more effective (i.e. appropriate drugs and modern mosquito avoidance measures) among those of higher SES, measured in a variety of ways (Table 2). This has implications for the proportion of total income spent on malaria prevention, which may be greater for wealthier households which tend to use more expensive preventive measures such as insecticide sprays and insecticide treated nets (ITNs) than their poorer counterparts. In Benin, for example Rashed *et al.* (2000a,b) estimated that prevention expenditure accounted for 1.6% of rural (poorer) and 2.1% urban (less poor) annual household income.

A similarly consistent pattern is seen when looking at the factors associated with mosquito net ownership, use and treatment (Table 3), where most studies found a significant relationship, using a variety of different measures of poverty. When examining the relationship between gender and demand, Hanson and Worrall (2002) found some

E. Worrall *et al.* Is malaria a disease of poverty?**Table 2** Studies investigating use of preventive measures by SES

Country and study	Poverty measure	Outcome	Finding
Malawi (Ertling <i>et al.</i> 1994)	Income	Expenditure on prevention. Use of coils, sprays, bednets, repellents	Inverse relationship with lower absolute amount of expenditure but higher proportion of income
India (Rajasekhar & Nandakumar 2000)	Low level (nurses, domestic staff) <i>vs.</i> high level health workers (doctors, medical students)	Use of repellents, anti- malarials, mosquito mesh, night time exposure	Use lower in lower level employees
Benin (Rashed <i>et al.</i> 2000a,b)	Women's income Material wealth indicators Distance to nearest hospital Education Rural residence	Expenditure on CQ prophylaxis for children in rural areas	Positively related to women's income, material wealth indicators, age of head of household. Negatively related with use of other preventive measures, status of women in household and distance to health facility
Benin (Rashed <i>et al.</i> 2000a)	Rural <i>vs.</i> urban	Frequency of use of chemoprophylaxis in under 5's and adults Use of traditional prevention methods	Higher in urban than rural Higher in rural than urban
Malawi (Ziba <i>et al.</i> 1994)	Household (HH) income Men's education	Use of malaria prevention methods	Increasing HH income and education level of HH head strongly correlated with use of commercial (as opposed to traditional) methods to prevent malaria
Uganda (Nuwaha 2001)	Users and non-users of mosquito nets	Use of traditional medicine for malaria prevention and treatment Blood slide diagnosis	More likely among non-users Less likely among non-users
Burkina Faso (Guiguemde <i>et al.</i> 1994)	Zone of residence (central/intermediate/ outlying)	Expenditure on prevention and treatment combined	Significantly greater in centre than outlying zones
Kenya (Macintyre <i>et al.</i> 2002)	Assets and education	Adoption of multiple mosquito avoidance practices	Significantly positively associated with wealth and education

support for the proposition that net ownership is higher in households where women have a source of cash income, even controlling for the level of income. One study examined the condition of nets and found that poor physical condition (i.e. many holes) was associated with lower levels of SES (Clarke *et al.* 2001).

The studies of education and uptake of preventive measures raise important issues around the specific causal pathway at work, and whether education is serving as a proxy for SES or whether it is an independent argument in the demand for preventive measures. There is some evidence to show that educational attainment is associated with malaria-specific

knowledge. For example, in Zambia knowledge of malaria was found to be positively associated with level of education, however this knowledge did not translate into increased mosquito net use (Kaona *et al.* 2000). And in Uganda malaria knowledge was found to be related to net ownership (Nuwaha 2001). In Nigeria, Fawole and Onadeko (2001) found a statistically significant difference in the malaria 'knowledge score' (based on a series of questions about the cause, transmission, symptoms and prevention of malaria) of mothers of different ages, educational attainment and occupation. Knowledge was higher among those who were skilled or professionals than among the unemployed or unskilled category. In

E. Worrall *et al.* **Is malaria a disease of poverty?****Table 3** Studies examining determinants of net ownership and use

Country and study	Poverty measure	Outcome
Malawi (Holtz <i>et al.</i> 2002)	Urban <i>vs.</i> rural residence Completed primary education Housing material	Net ownership Brand awareness and understanding of insecticide and net products
Uganda (Nuwaha 2001)	Education, occupation, assets (TV, radio), literacy, living in permanent house, age	Mosquito net use Treated <i>vs.</i> untreated net use (not related to SES)
Tanzania (Hanson & Worrall 2002)	Asset index, women's income and control of income	Net ownership Net re-treatment rates
Benin (Rashed <i>et al.</i> 2000a)	Completion of secondary school	ITN ownership
Malawi (Holtz <i>et al.</i> 2002)	Urban <i>vs.</i> rural residence	Knowledge and appropriate use of ITNs Net re-treatment rates
Tanzania (Abdulla <i>et al.</i> 2001a)	Asset index	Changes in net ownership over time
Tanzania (Jamu <i>et al.</i> 2002)	Asset index	Changes in net ownership over time
Tanzania (Abdulla <i>et al.</i> 2001a)	Asset index	Determinants of net ownership
Kenya (Macintyre <i>et al.</i> 2002)	Assets and education	Everyone (in household) sleeps under a net
Burkina Faso (Okrah <i>et al.</i> 2002)	Urban <i>vs.</i> rural residence	Net ownership
Afghanistan (Howard <i>et al.</i> 2003)	Assets/SES index	ITN purchase by wealth quintile Net ownership
Gambia (D'Alessandro <i>et al.</i> 1994)	Type of bed and ownership of radio	Ownership of nets
Nigeria (Onwujekwe <i>et al.</i> 2003)	Assets and occupation	Stated and observed WTP for ITNS
Tanzania (Marchant <i>et al.</i> 2002)	Age, gravidae, marital status, access to cash	ITN use in pregnancy
Uganda (Nuwaha 2001)	Occupation, education, assets, malaria KAP	Net use
Tanzania (Mushi <i>et al.</i> 2003)	Assets/SES index	Use of voucher to obtain a subsidy on ITNs
Congo (Carme <i>et al.</i> 1992)	Language (French) comprehension	Use of mosquito net

Benin, Rashed *et al.* (1999) found ITN acquisition increasing among those men who completed secondary education, but completion of education up to primary level did not increase ITN acquisition. This suggests that a threshold level of education may be required to impact upon take up of interventions.

Although all of the evidence points to an important direct relationship between higher SES and higher net/ITN ownership and use, these important tools do not always remain out of reach of all the poorest households. In rural Tanzania, data suggest that a combination of social marketing with active private sector participation was able to achieve net ownership rate of two-thirds even among the poorest group of households. The ratio of net ownership in the most to least poor households (equity ratio) was 0.54–0.69 (95% CI) at baseline, and after 3 years of social marketing was 0.60–0.73 ($P < 0.05$) (Abdulla *et al.* 2001a,b). However, it is important to note that the population in the study area was relatively homogeneous, and that net treatment and re-treatment rates among all groups remained quite low. 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). In Afghanistan social

marketing of ITNs achieved higher coverage among the top two SES quintiles; however 39% of net owning households were from the bottom 2 quintiles (Howard *et al.* 2003). If ownership were perfectly equitable we would expect 40% from bottom 2 quintiles suggesting, on average, good ownership rates even among the poorest households. A study on uptake of a voucher subsidy scheme for ITNs operating within a social marketing project found that women from the least poor households commonly used it while none of the women in the poorest households did (Mushi *et al.* 2003).

Treatment

A number of studies have looked at the relationship between expenditure on treatment and household SES. Ertling *et al.* (1994) found no difference in the absolute level of expenditure between income groups, but large differences in the value of that expenditure when expressed as a share of total annual expenditure. In contrast, Rashed *et al.* (2000a,b) found little difference between rural and urban areas in the share of total household income accounted for by treatment. Laxminarayan (2004) estimated that in Vietnam a 10% reduction in province-level

E. Worrall *et al.* **Is malaria a disease of poverty?**

malaria reduced average household health expenditure in the whole population by 0.63%. However, reductions in malaria were not significantly associated with reduced expenditure in the poorest households, possibly because the poorest households seek malaria treatment less frequently.

These results are somewhat difficult to interpret, however, because the welfare consequences of differences among socio-economic groups are not unambiguous. To the extent that limits on expenditure lead to rationing of either quantity or quality of care received, differences in absolute levels of expenditure across groups or similar levels of expenditure if quality differs may result in significant inequities. However, a given absolute level of expenditure will have different consequences for poorer and richer households, with catastrophic expenditures such as those associated with hospitalisation for severe or complicated malaria having the potential to drive a household into (or further into) poverty.

Another dimension of treatment seeking is choice of provider. Malaria treatment options range from no treatment, self-treatment with drugs stored at home or purchased from a chemist or drug seller, traditional healers, to the more formal service providers including health centres and hospitals. Patterns of treatment choice may be related to perceived illness and severity, perceptions of service quality, or to resource constraints.

Most studies show socio-economic differentials in treatment seeking (see Table 4). There is some difficulty in comparing across studies because of different classifications of providers, together with lack of information about the relative quality levels of care provided by different providers. Some clear pictures emerge from the literature.

In general, richer groups are more likely to seek care than poorer groups, compared with self-treatment. Private sector use generally increases with SES, as does use of higher level public facilities (hospitals). Generally, traditional healers are used more by the poorest (Rashed *et al.* 2000a,b; Fawole and Onadeko 2001; Kelley *et al.* 2001; Nuwaha 2001; Mugisha *et al.* 2002). However, for treatment of convulsions, Molyneux *et al.* (2002) find greater use of traditional healers, together with multiple treatment seeking and use of private facilities, among urban than rural women.

Distance from a health facility, which may be associated with SES, was found to be significantly associated with care seeking in a study by Baume *et al.* (2000). Another study found that rural residents had to travel 0.7–5 km further to reach government health facilities in Kenya than their urban counterparts (Noor *et al.* 2003).

Some studies find no difference in patterns of care-seeking between households of different SES for fever (Ettling *et al.* 1994), and for malaria with a fatal outcome (de Savigny

et al. 2004). One study found socio-economic differentials in treatment seeking for women but not for men (Kelley *et al.* 2001).

Contrary to most studies, Kofoed *et al.* (2004) found that indicators of lower SES (no electricity and increased crowding) lead to higher levels of treatment seeking at the health facility. However, they also found that those not attending health facilities were more likely to have chloroquine at home which was in turn positively associated with mothers' education and being connected to electricity (indicators of higher SES). Home treatment with chloroquine is also related to lower SES where left over drugs are used to treat in the home (Biritwum *et al.* 2000). The apparent contradiction between these studies highlights the difficulties of disaggregating the effects of individual variables in the complex causal pathway that underlies treatment seeking behaviour. Appropriate use of drugs is critical particularly when considering home treatment, but the evidence on the relationship between SES indicators and appropriate drug use is limited to a single study by Kaona *et al.* (2000) who found no correlation between educational attainment and knowledge of correct dosage.

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. Malaria is also an under recognized cause of severe anaemia in pregnancy where its transmission is endemic (Shulman 1999). In addition to the problems of poverty, lack of access to and knowledge of malaria prevention and treatment that face other groups, 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 can provoke abortion. Such perceptions can prevent them from obtaining preventive or curative treatment. 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. Few studies examine the impact of these issues; but Shulman found that low birth weight (to which malaria and anaemia contribute) was more common in younger women and women of lower SES (Shulman *et al.* 2001). Marchant *et al.* (2002) found that younger (15–19 years), unmarried, primagravidae women without access to cash had the lowest ITN use among pregnant women.

Although few countries in Africa currently provide intermittent presumptive treatment in pregnancy (IPTp) as part of regular antenatal care, antenatal contacts provide

E. Worrall *et al.* **Is malaria a disease of poverty?****Table 4** Poverty and choice of health care provider

Country and study	Poverty measure	Main results
Mali (Kelley <i>et al.</i> 2001)	Household consumption	Poorest quintile more likely to use traditional providers, less likely to use hospital Most (60%) used no care, with one-third of these citing 'lack of money'
Uganda (Nuwaha 2001)	Net ownership	Non-users more likely to use traditional medicine for prevention and treatment, less likely to have laboratory diagnosis
Burkina Faso (Mugisha <i>et al.</i> 2002)	Urban residence Income	Higher income, urban residents more likely to seek care for any illness; Most people chose self-treatment for malaria
Ghana (Biritwum <i>et al.</i> 2000)	Income, occupation, education	Left-over drugs more commonly used in poor community; purchase of drugs without prescription more common in poor community; Poor less likely to use clinic than less poor
Brazil (de Bartolome & Vosti 1995)	Household assets & modelling	Price and wealth are key determinants of choice between public and private treatment
Sub-Saharan Africa (Filmer 2002)	Asset index	Richer groups more likely to seek modern care; West and Central Africa: use of private sector, public lower level, and public higher level care all increase in wealth; East and Southern Africa: Use of private sector and public higher level positively related to wealth, but no relationship between wealth and use of public lower level facilities
Kenya (Molyneux <i>et al.</i> 2002)	Urban/rural residence	No difference in pattern of treatment seeking for uncomplicated malaria; For convulsions urban mothers more likely to consult private facility than government facility
Tanzania (Schellenberg <i>et al.</i> 2003a)	Assets and education	Hospital admissions for all cause fever in lowest SES group half those in highest; children in lowest SES group half as likely to have been given anti-malarials than those in highest SES group
Kenya (Noor <i>et al.</i> 2003)	Rural Urban	Greater proportion of rural residents are >5 km away from HF; rural populations travel on average 0.7–5.1 km further to get to government health facility than urban counterparts
Mali (Kelley <i>et al.</i> 2001)	Income (household consumption) Sex	Treatment sources differ significantly by income quartile for women but not for men
Malawi (Ettling <i>et al.</i> 1994)	Income	Treatment source patterns similar for low and high income households
Guinea Bissau (Kofoed <i>et al.</i> 2004)	Housing quality, ownership, education	Those not attending health facility are more likely to have chloroquine at home, chloroquine at home is positively associated with mothers education and connected to electricity. Increased crowding and no electricity related to increased treatment seeking at health facility
Tanzania (Abdulla <i>et al.</i> 2001a)	Asset index	Correlation between increased mortality, reduced treatment seeking for fever and lower SES
Tanzania (de Savigny <i>et al.</i> 2004)	SES/asset index	No significant difference in treatment seeking for malaria with fatal outcome between SES groups
Benin (Rashed <i>et al.</i> 2000a)	Rural Urban	Expenditure on self medication with chloroquine and traditional treatment higher in rural and private consultation more common in urban
Nigeria (Fawole & Onadeko 2001)	Education	Uneducated mothers more likely than educated mothers to use traditional healers, less likely to visit health facility first and use patent medicine sellers

E. Worrall *et al.* Is malaria a disease of poverty?**Table 4** (Continued)

Country and study	Poverty measure	Main results
Zambia (Kaona <i>et al.</i> 2000)	Education, age	Use of chloroquine (compared to traditional or no medicine) positively correlated with age and education. No correlation between education and knowledge of correct dose
Thailand (Ettling 1989; Ettling <i>et al.</i> 1991)	Gender age	Greater number of men attend than women although levels of exposure are comparable. Periodic/mobile clinics reach women and children more than central or peripheral
Malawi (Slutsker <i>et al.</i> 1994)	Household income, education of head of household	Household heads with primary or secondary attendance significantly more likely to attend clinic.
Congo (Carme <i>et al.</i> 1992)	Language (French) comprehension	Significantly related to chemoprophylaxis in children (+), preference for injections (-) and purchasing drugs at market (-).
Tanzania (AMMP 1997) cited in (Korenromp <i>et al.</i> 2001)	Gender	M:F ratio in mortality 1.3–1.6 times higher in hospitals than in the community

Table 5 Rich/poor ratio and antenatal care visits to a medically trained person

Country	Ratio of antenatal care coverage in highest to lowest quintiles (equity ratio) (per cent coverage in lowest and highest quintiles)
Benin	1.670 (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)
Niger	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)

Source: http://siteresources.worldbank.org/INTPAH/Resources/Publications/Tables-and-Figures/acv_medical.pdf

an opportunity to deliver a range of malaria control interventions (e.g. IPTp, ITNs). There is little data directly examining uptake of malaria interventions in pregnancy. However, a World Bank cross-country analysis provides important insight into the use of antenatal care by SES in a

wide range of African countries (http://www.worldbank.org/poverty/health/data/indicators/acv_medical.pdf). In the DHS data analysed, antenatal care was measured as the per cent of births in the 5 years before the survey for which a woman received at least one antenatal care consultation from a medically trained person. Socio-economic differentials in antenatal care use were calculated comparing the rate of use in the poorest population quintile with that in the richest quintile, defined on the basis of an asset index. These ratios ranged from 0.239 in Mali to 0.946 in Zimbabwe (see Table 5).

Discussion

The overall findings of this review must be interpreted in light of the two methodological difficulties identified earlier: the failure to adequately address the endogeneity of the relationship between malaria and poverty, and the difficulties of relying on self-reported morbidity when there may be systematic differences among socio-economic groups in the propensity to report ill-health. While these biases are likely to work in opposite directions, it is by no means clear that they are of similar magnitudes and will therefore cancel each other out.

These limitations notwithstanding, the evidence that within poor countries malaria incidence disproportionately affects poor people is mixed. Using income, expenditure or asset ownership to measure poverty directly, a number of studies failed to show significant differences between poorer and less poor groups especially at the individual or household level. The evidence is more consistent for other measures of SES, such as occupation, housing type, and rural location, but these

E. Worrall *et al.* **Is malaria a disease of poverty?**

indicators are, in turn, more distal from the underlying construct of poverty and may be more directly related to exposure and risk of disease.

The evidence on uptake of interventions is more consistent. Available studies show a clear link between poverty measured using a range of different indicators, and use of preventive measures such as ITNs and expenditure on chemoprophylaxis. A further finding is the strong link between poverty and treatment seeking, with poorer groups more likely to self-treat and less likely to access private and high level public providers. Even if incidence is unrelated to SES, the ability of individuals to access treatment promptly is an important determinant of health outcomes. To the degree that poorer households have less access to treatment, they are more vulnerable to the deleterious consequences of malaria, including progression to severe disease and death. It is more difficult to interpret the implications of greater use of private care by the better off without more disaggregated information about use of different types of private provider, and about the quality of care provided. It is possible that even within the private sector, poor people are more likely to use the more informal providers who provide lower quality care. Better evidence is needed about socio-economic differentials in use and quality of care received.

Although there was little evidence about socio-economic differences in access to interventions to prevent malaria in pregnancy, DHS data depict a highly heterogeneous picture in terms of access to antenatal care. Many countries have highly equitable access to antenatal care, with poor:rich ratios exceeding 90%. However, there are a number of countries where use of antenatal care by poor women is very low. In such contexts, use of this channel to deliver preventive interventions such as ITNs and IPT needs to be reviewed carefully.

This literature review did not extend to the general issues of health equity and equity in treatment for 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 relevant.

Conclusions

Few studies set out to examine directly the link between poverty and malaria, although many studies contain information which allows the relationship to be explored indirectly. As a result, the quality of reporting of methods and results is frequently low, with gaps as to the justification for the choice of particular measures and details about how analysis was undertaken, such as the rationale for specific cut-off points for groupings. Publication bias and under-reporting of insignificant relationships may also

affect the results of this literature review. Work in this area is made more complex by the lack of comparability between alternative measures of poverty and SES. However, easy to use techniques to rapidly estimate household wealth have been shown to be adequate (Morris *et al.* 2000), and increasing the application of such techniques to the questions addressed in this review will improve the quantity and quality of evidence.

Finally, it is not sufficient to simply document existing inequalities in risk of disease and access to interventions. Many questions remain about how different delivery mechanisms reach different population groups, and how best to reach the poor with effective interventions. Addressing these inequalities should be a priority for future research and implementation.

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