Tropical Biomedicine 36(3): 664–676 (2019)

The health burden of malaria and household choices regarding treatment and prevention in Pakistan

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Received 21 March 2018; received in revised form 19 February 2019; accepted 4 March 2019

Abstract. The extent of the economic burden of malaria and its imposed mechanisms are both relevant to public policy. This paper investigates the economic burden of malaria and household behaviour in relation to the treatment and prevention of the illness in Pakistan. In this regard, data were collected from a randomly selected sample of 360 households using structured questionnaires. The survey results indicate that 23.4% of household members contracted malaria during the three-month reference period. The average per person cost of malaria is estimated at 3116 Pakistani rupees (PKR) (USD 32). The estimated cost of the illness was found to be equivalent to, on average, 6.7% of monthly household income. Although high-income households face a higher financial burden due to better preventive and mitigation measures, the negative consequences hit low-income households harder due to liquidity constraints and poor access to effective treatment. We recommend that malaria control policies be integrated into development and poverty reduction programs.

INTRODUCTION

Malaria is a global public health problem. The World Malaria Report 2018 revealed that 219 million malaria cases and 435 000 confirmed deaths were reported in 2017 (WHO, 2018). Most of these deaths occurred in the African region (92%), followed by South-East Asia (5%) (WHO, 2018). These estimates rank malaria as one of the top three killers among communicable diseases (WHO, 2016). Malaria causes various symptoms, such as weakness, spleen disorders, anaemia, fever and malnutrition. In the global context, the consequences of malaria are profound, and its mortality and morbidity impacts were estimated at 55.76 million disability-adjusted life years (DALY) in 2015 (Kassebaum *et al.*, 2016).

Malaria imposes substantial social and economic costs and impedes economic development through several channels, including quality of life, fertility, population growth, savings and investment, labour productivity, absenteeism, premature mortality, and medical costs (Sachs and Malaney, 2002). Therefore, malaria is not only a public health problem but also an economic development problem (Sachs and Malaney, 2002; Barofskya *et al.*, 2015). Quantifying the epidemiological and economic burdens of malaria is critical to formulating efficient and equitable policy decisions regarding research priorities and prevention programmes. Such data allow for a better understanding of the true financial and time burdens imposed by malaria in the world of competing public health issues, as well as the differential economic impacts of the disease on population subgroups.

Attempts at assessing the economic burden of malaria using cross-country regression analysis have found the disease to be a significant factor in distorting long-term economic growth (0.25 to 1.3%) (McCarthy *et al.*, 2000; Breman *et al.*, 2004). This is indeed a striking result, but even if this is a correct estimation of the economic burden of the disease, the estimation technique cannot be relied on to explain the underlying mechanism, as it does not independently consider the chain of causation and functions. Micro-studies at the household level hold the potential to offer more robust explanations of both the extent of the economic burden of the disease and the mechanisms through which it imposes this burden. They also complement the disease burden data, which can be used to show who bears the economic burden of malaria (Gallup and Sachs, 2001; Jimoh *et al.*, 2006; Barofskya *et al.*, 2015). This information can help to target interventions efficiently and equitably and to justify investment in research and control.

Pakistan is amongst the 109 countries with endemic malaria (Ali *et al.*, 2015; Howard *et al.*, 2017). According to the Pakistani government's 2016 annual malaria report, approximately 97% of the Pakistani population is at risk of contracting malaria, with an estimated nationwide burden of 3.5 million cases per year (Government of Pakistan, 2017). It is the second most prevalent and devastating disease, accounting for 12.5% of the overall disease burden of the nation (DMC Ministry of Health Islamabad, 2007; Khan *et al.*, 2010). Therefore, it is considered to be not only a public health problem but also a strong impediment to the socioeconomic development of the country. Studies of the economic burden of malaria are scant in Pakistan. The only study (Khan, 1966) regarding the cost of the illness in the country was completed five decades ago and used a simple spreadsheet methodology to estimate the economic impacts of malaria on households. In general, spreadsheet methodologies fail to incorporate many of the economic interactions that can be addressed by more sophisticated econometric modelling.

Goodman *et al.* (2003) argued that studies must be designed to inform policy action and not merely to document the total burden. They further stressed that studies of the microeconomic impact must be rooted in a sound understanding of the nature of economic activities and must confront the possible pervasive effects of malaria on the productive environment and the production possibilities of households. This requires greater attention to the economic burden per socioeconomic group, and an emphasis on documenting households' choices between types and quantities of products, and types of treatment. However, relatively little is known about these determinants in the context of the cost of malaria in developing countries. Therefore, a rigorous study that concentrates on analysing the magnitude of the malarial burden by socioeconomic group and its interaction with households' economic decisions is needed. This kind of analysis would help to identify interventions that would make the most significant contribution to reducing these economic burdens. The present study is such an endeavour. It aims to provide this information by observing the financial and time burdens of episodes of illness on households. It also emphasises the determinants of treatment-seeking and treatment-averting behaviours of households in the rural areas of Sheikhupura District and the slums of urban Lahore.

MATERIALS AND METHODS

Conceptual and Analytical Framework

The most common approach to evaluating the economic burden of malaria has been the 'human capital method' (HCM), which categorises costs into direct, indirect and intangible costs. Direct costs include both private and non-private medical care. Expenses such as doctors' fees, costs incurred in purchasing medicine, transportation, diagnosis and treatment are included in private medical care. Indirect costs are normally tied to lost productivity due to morbidity and mortality. Usually, indirect cost is measured using HCM, which monetises the loss of productivity caused by illness and premature mortality. This approach is based on the neoclassical principles of market orientation, which are applied in the context of the opportunity cost framework – a key concept in market economics (Harwood, 1994). Intangible cost captures the suffering, pain and anxiety caused by illness. The economic cost of a disease can be measured using the HCM approach with the following standard formula.

COI = Private and Non-Private Medical Costs + Foregone Income + Pain and Suffering

While the formula includes the cost of pain and suffering, this is naturally difficult to impute in economic terms. Therefore, studies that use this approach ignore it, despite its being a critical component of real cost.

This study used a modified version of the health production function model described in Freeman (2014), originally formulated by Grossman (1972), and extended by Harrington and Portney (1987) to analyse the impact of malaria infection. In this regard, the household health production function and the demand function for avoidance and mitigation activities have been embedded in the individual's behaviour aimed at utility maximisation. The utility function, health production function and budget constraints are given below:

The individual's utility function can be specified as:

$$U = U(X, L, H)$$

where X is the consumption goods, L is leisure time available per period to an individual, and H is the number of work days lost per reference period due to sickness. The individual derives utility from X and L, while H results in disutility.

The health production function is defined as:

$$H = H(A, M, Z)$$

where A is avoidance activities, M is mitigation activities and Z is the vector of personal characteristics of the individual. The budget constraint can be expressed as:

$$Y + w\,(T - L - H) = X + Pa.\,A + Pm.\,M$$

where Y is non-wage income, T is total available time, Pa is the cost of avoidance activities, Pm = the cost of mitigation activities, and the cost of X is normalised as one. The individual selects A and M, X and L to maximise his or her utility subject to budget constraints. The demand functions for avoidance activities (A) and mitigation activities (M) can be specified as:

$$A = A(w, Y, Pa, Pm, H, Z)$$
$$M = M(w, Y, Pa, Pm, H, Z)$$

The demand function gives the optimal quantities of A and M as functions of income, prices and household characteristics (Freeman, 2014).

Data Collection

The primary data were collected from 360 households in October 2015 through a structured questionnaire. Respondents were randomly sampled. Out of the 360 households, 192 (53%) were selected from five villages within the district of Sheikhupura. A further 168 (47%) households were situated in three of Lahore's slum areas. The number of respondents selected from each location is proportional to the size of the population residing in the target locality. In each study area, households were randomly selected, and face-to-face interviews were conducted with the head of the household (or other adult male member of the household, if the head of the household was unavailable). The respondents were asked to provide information about the family member who had suffered from malarial illness during the reference period, which was specified as the last 3 months of the monsoon season.

Table 1. Number of respondents per location

District							
Lahore			Sheikhupura				
Location 1	Location 2	Location 3	Village 1	Village 2	Village 3	Village 4	Village 5
60	74	34	45	46	36	35	30
	n = 168				n = 192		

RESULTS

Demographic and Socioeconomic Information

The 360 sample households contained a total of 2506 household members. The average household contained 6.96 individuals. Half of the surveyed household heads were illiterate. Most households lived in two- (32%) or three-room dwellings (26%), while about 18% lived in one-room dwellings. A further 22% occupied homes with four or more rooms. About 99% of households confirmed having a separate washroom in the house; 94% of households had separate kitchens, and 92% confirmed having open drainage. Of the respondents, 38% confirmed their dominant occupation as agriculture. The average household income was approximately PKR 18 500.

Burden of Disease and Preventive Measures

The data highlight that, of the 360 households surveyed, 338 (94%) reported that at least one member of the family suffered from malaria in the reference period of 3 months, while 6% of households reported no malaria cases. It was observed that, overall, 588 individuals from the 338 affected households suffered from malaria. Therefore, the overall prevalence of malaria

Table 2. Household characteristics

Household characteristics	n	%
Education of head of household		
Illiterate	180	50.00
Educated for up to 5 years	63	17.50
Educated for 5–10 years	71	19.78
Educated for 12 years and above	46	12.78
Dominant occupation		
Agriculture	113	38.03
Non-agriculture	247	61.97
Living conditions		
One-room dwelling	69	17.9
Two-room dwelling	115	32.1
Three-room dwelling	94	26.2
Four or more rooms	82	22.8
Separate washroom in the home	356	.99
Separate kitchen in the home	338	.94
Open drainage	331	.92
Household income (PKR)		
Monthly household income	6 661 008	18 502.80
Family size		
Total number of family members in all households	2 506	6.96

was 23.4%. Table 3 exclaims that, on average, a malaria episode persists for 3.47 days, and the mean number of work days lost by adult patients was 2.94 days, which on average inflicted a loss of wages/income of PKR 689 on each affected household. Regarding households' methods of protection against malarial attacks, the results reveal that all of the households used some sort of mosquito coil or insecticide spray. The use of bed nets was less common (with only 60% of households using these), and the majority of such nets were found in rural areas. Regarding the use of healthcare facilities, the study found that households consulted a wide range of healthcare facilities. The data show that about 34% of households consulted nearby pharmacists, 13% used traditional medicine from herbalists, locally known as *hakeem*, 35% visited hospitals for treatment and 8% obtained medicine from homeopathic practitioners, while 11% self-medicated.

Direct Cost of Malaria to the Household

The direct costs of malaria fall into two groups: mitigation and avoidance expenditures. Mitigation expenditures are those expenses incurred with the aim of eliminating, reducing or treating the disease. These may include medication costs, medical consultation fees, diagnostic test fees, travel expenses to visit medical facilities, and so forth. As shown in Table 3, the total mitigation costs incurred in the treatment of the 588 malaria cases amounted to PKR 502 165 (approximately USD 5200), or PKR 854 (USD 8.50) per case. The average treatment cost per case, however, varies depending on the type of treatment sought and the severity of the case. Drugs and treatment accounted for a significant proportion of total treatment costs. It is important to mention that the average treatment cost is PKR 811 and the average travel cost per case per episode of malaria is PKR 43 (see Table 3).

Table 3. Malaria and households' mitigation and avoidance behaviours

Items	Actual number/ value	Total no. of households	Average/ Percentage
Malaria and associated impacts			
No. of people who contracted malaria in the sample households	588	2 506	23%
No. of households where at least one family member contracted malaria	338	360	94%
Malaria-related sickness days	2 041	588	3.47
Adult work days lost due to malaria	329	112	2.94
Wage loss of affected persons (PKR)	77 205	112	689.33
Avoidance activities and associated costs			
Use of bed nets	216	360	60%
Use of mosquito coils or insecticide sprays	360	360	100%
Expenditure on bed nets	186 127	216	861.7
Expenditure on mosquito coils or insecticide sprays	96 120	360	267
Total avoidance expenditures (bed nets + coils)	282 334	360	784
Type of doctor consulted			
Qualified doctor or formal hospital	125	360	35%
Pharmacist	122	360	34%
Homeopath	28	360	8%
Herbalist (*hakeem*)	46	360	13%
Other/self	39	360	11%
Mitigation costs (treatment and travel costs) (PKR)			
Treatment cost	25 284	360	811
Travel cost	476 868	360	43
Total mitigation expenditure	502 165.0	360	854

Table 4. Regression results of household health production function

Independent variables	Dependent variable: Work days lost		
	Coefficients	*SE*	*p*
Avoidance activities (A)			
Bed net use	-.6134416	.1780334	-3.45 (0.001)
Mitigation activities (M)			
Treatment by qualified doctor	-.2061471	.2541324	-0.81 (0.418)
Household characteristics (Z)			
Age	-.0019242	.0106315	-0.18 (0.856)
Education	-.1336165	.056796	-2.35 (0.019)
Household expenditure	-.0000239	.0000131	-1.82 (0.070)
Urban area dummy	.2383518	.1887722	1.26 (0.208)
Constant	3.809304	.5141981	7.41 (0.000)
Observation	358		
Pseudo R^2	0.0428		

The other component of direct cost is avoidance activity cost. Avoidance activity cost is the expenditure incurred by the household in the attempt to avoid the disease. These costs include the use of insecticide sprays, mosquito coils or bed nets, activities undertaken to eliminate potential mosquito breeding sites within or outside the house, and the use of long-sleeved shirts. Data about these avoidance activities and their associated costs were collected. The survey revealed that households spent on average PKR 784.20 (USD 7.80) on preventive measures (see Table 3). The total expenditure on preventive measures was estimated at PKR 282 334 (about USD 2800). The disease also incurs indirect costs, which can be estimated by quantifying in monetary terms the opportunity cost of the time spent by households in seeking treatment from the various treatment centres. In addition, during days of complete incapacitation and convalescence, the productive time lost by malaria patients and their caretakers, as well as any substitute labourers, should also be valued. However, due to limited data, the indirect costs were not measured in the present study.

Statistical Analysis

Estimating household health production function

A Poisson regression model was used to estimate the households' health production function, as the dependent variable is a count of the number of work days lost by an individual due to malaria infection, where there are several zero observations. In this case, the application of the Poisson regression model is appropriate as it accounts for the preponderance of zeros and the discrete nature of the dependent variable. The empirical specification is given below:

***H* (work days lost):** Avoidance activities, mitigation activities, age, household expenditure, area dummy, family size, education.

'Avoidance activities' is operationalised as the use of bed nets to protect from mosquito bites and defined as follows: bed net used = 1; no bed net used = 0. 'Mitigation activities' is defined as follows: treatment by a qualified doctor = 1; no such treatment = 0. The age of the household head is defined in years, while household expenditure is given in PKR. Area is expressed as urban = 1, rural = 0. The education variable is expressed in years of education completed. Family size is defined as the number of household members living together in a single dwelling. The household health production function described in equation 7 is estimated using the Poisson regression model and the results are presented in Table 4.

The use of bed nets is negatively correlated with work days lost ($p<0.01$), indicating an increased probability of work days being lost for households who do not use bed nets to avoid mosquito bites. Treatment by a qualified doctor is negatively correlated with work days lost, indicating that such treatment reduces the number of work days lost. This result, however, is not significant. Education and household expenditure (a proxy for household income) are the only significant household characteristics ($p<0.01$). The household expenditure variable exhibits a negative relationship with work days lost, indicating a lower probability of work days being lost for higher income households ($p<0.10$). Similarly, the results indicate that more educated individuals are less likely to lose work days.

Demand for mitigation activities (treatment by qualified doctor)

With reference to equation 6, we estimated the relationship between the decision to obtain treatment from a qualified doctor for malaria infection and income, prices and household characteristics. In this model, the dependent variable is defined as a binary variable, where treatment obtained from a proper hospital or qualified doctor during the reference period is expressed as $Pr = 1$, otherwise $Pr = 0$. The dependent variable takes the form of a binary response variable; hence, a probit model is used for the analysis. The empirical specification of the model is given below:

Treatment choice = *f* (household income, cost of mitigation activities, cost of avoidance activities, child under 5, education, distance to hospital or qualified doctor, waiting time at healthcare facility, family size, age of household head)

In equation 8, the 'child under 5' variable is defined as binary (i.e., yes = 1, no = 0), while the distance to a qualified doctor is given in kilometres (km) and the waiting time at the healthcare facility in minutes. The cost of mitigation activities is operationalised as the consultation fee, which is defined in PKR. The price of avoidance activities is expressed as the cost of coils or bed nets and is also defined in PKR. The results of the probit regression are reported in the first column of Table 5. Column 1 in Table 5 indicates that, of the 11 variables, five emerged as significant. These are monthly household expenditure, level of education of the household head, waiting time at the healthcare facility, doctor's consultation fee, and a dummy for urban area. The coefficients of all of these variables have the expected signs. The estimates show that households with higher income are more likely ($p<0.01$) to obtain treatment from qualified doctors. The results also show that the probability of visiting a qualified doctor for malaria treatment significantly increases with more years of education. The probability of visiting a qualified doctor is also higher for those living in urban areas than for household members living in rural areas. However, this result is significant only at 10%. Similarly, waiting time at the healthcare facility significantly reduces the probability of obtaining treatment from a qualified doctor. The consultation fee and waiting time at the healthcare facility are the most important results, which indicate that lack of access to qualified doctors and higher consultation fees deter poor households from obtaining standard treatment.

Estimating avoidance activity function

It is generally advised that preventive measures be taken to avoid mosquito bites. Households normally make use of certain products, use such as aerosol sprays, mosquito coils and bed nets, to protect themselves from mosquito bites. The use of mosquito coils was nearly universal amongst the households, albeit with varying degrees of intensity; however, relatively little is known about the determinants of bed net use in the context of malaria. Therefore, we also estimated the relationship between the use of bed nets by individuals and income, prices and household characteristics. In this model, the dependent variable is defined as binary, where the use of bed nets is expressed as 1 and non-use is defined as 0. Therefore, the probit model is used for the analysis. The empirical specification of the model is given below:

Table 5. Regression analysis of demand for mitigation and avoidance activities

Independent variable	Dependent variables	
	Demand for qualified treatment	Demand for bed nets
	Coefficients	Coefficients
Income (y)		
Household expenditure	.0001 (.0001)***	.0002 (.0001)***
Price of mitigation activities (pm)		
Consultation fee	0004 (.0001)***	–
Price of avoidance activities (pa)		
Cost of coil/bed nets	.0004 (.0002)	-.0046 (.005)***
Health production characteristics (H)		
Work days lost	.0549 (.0624)	-.1475 (.050)*
Household characteristics (Z)		
Area (urban)	.3991 (.2365)*	-.08684 (.1797)
Age	-.0080 (.0118)	-.0002 (.0101)
Family size	.0160 (.0333)	-.0275 (.0282)
Education	.3913 (.0596)***	.0608 (.0523)
Child under 5	.1155 (.2503)	.15123 (.2217)
Distance to qualified doctor	-.0389 (.0365)	–
Waiting time at healthcare facility	-.0314 (.0089)***	–
Constant	-3.567 (.6772)***	2.193 (.501)***
Observations	358	359
R/Pseudo R squared	0.3685	0.2001

*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Use of bed nets = *f* (household income, cost of mitigation activities, cost of avoidance activities, child under 5, education, family size, age of household head).

The results of the probit regression model are given in column 2 of Table 5. The relationship between the price of bed nets and their use is negative and significant ($p<0.05$). This finding is in line with the economic theory of demand, which states that, the higher the price of a commodity, the lower will be the demand for the product. Another important result is the relationship between the use of bed nets and household economic status, which is positive, indicating that higher levels of household income significantly increase the use of bed nets in the house ($p<0.01$). The cost of mitigation activities and work days lost were negatively and significantly related ($p<0.05$), indicating that individuals who faced higher treatment cost and more lost work days were likely not to make use of bed nets. In summary, the results clearly illustrate that access to and the use of bed nets is tied to the socioeconomic status of the household.

DISCUSSION

Though malaria is prevalent at a large scale in developing countries, including Pakistan, policymakers face a challenging environment in which reliable information on the precise economic burden of malaria and its interactions is missing. These types of constraints prevent policymakers from designing an appropriate policy framework which takes account of the abovementioned indicators. This study estimates the economic cost of malaria as borne by Pakistani households. The estimates reveal that, on average, participants spent approximately PKR 854 (USD 8.50) on the treatment of malaria during the reference period of three months. The total mitigation expenditure incurred on the 588 malaria cases reported in the household survey amounted to PKR 502 165 (approximately USD 5200). However, in rural contexts where people have limited financial resources and earning opportunities, this amount is substantial. Other studies have had similar findings (Ewing *et al.*, 2011; Hennessee *et al.*, 2017). Many have concluded that treatment costs constitute only a fraction of the indirect costs of the disease due to the inability of ill breadwinners to work (Ettling *et al.*, 1994; Gallup and Sachs, 2001; Sachs and Malaney, 2002; Asante and Okyere, 2003; Shretta *et al.*, 2016; Hennessee *et al.*, 2017).

A study by Hennessee *et al.* (2017) estimated that the burden of malaria cost disproportionately affects the poor and consumes a significant proportion of households' annual income through prevention, treatment and lost productivity. Moreover, the information on the extent to which the burden falls more heavily on lower socioeconomic groups is reasonably consistent (WHO, 2003; Castillo *et al.*, 2008). Our findings are supported by other studies that have found that, despite equal exposure and incidence of the disease across socioeconomic groups, the treatment cost varies significantly with socioeconomic status (Grossman, 1972; Johannesson and Jonsson, 1991; Hennessee *et al.*, 2017). These costs are considerably higher in poor households and can be catastrophic to the inhabitants of rural areas (Johannesson *et al.*, 1991; Castillo *et al.*, 2008; Hennessee *et al.*, 2017). Studies examining socioeconomic groups in terms of their assets, education and occupation have consistently reported data that suggest an inverse relationship between the impact of malaria and socioeconomic status (Johannesson and Jonsson, 1991; Gallup *et al.*, 2001; WHO, 2003).

The research maintains that, although the burden of cost disproportionately affects poor households, the same is not true of the prevalence of disease in the study area. Therefore, it cannot be argued that malaria is a simple consequence of poverty. Being well off is not sufficient to escape the risk of infection in malarious areas. These findings have been vindicated by household surveys in different countries in Africa, where no correlation exists between the relative wealth of households and the incidence of childhood fever (Breman *et al.*, 2004; Goodman *et al.*, 2000). The wealth of the household, however, does play a pivotal role in determining whether a patient receives treatment for fever and also influences the kind of treatment sought (Njau *et al.*, 2006). Furthermore, the study describes that low-income households consult inferior healthcare facilities or depend on self-medication. The data suggest that non-standard and substandard medication are the most prevalent forms of treatment among the respondents studied. This is most likely informed by the relative affordability of these treatment types ($p < .01$). There is evidence that low-income groups are more vulnerable to the consequences of malarial infection, partly because of poorer access to effective treatment (Goodman *et al.*, 2003; Castillo *et al.*, 2008; Tinuade *et al.*, 2010). Malaney (2003) described that poor families very often lack the resources to obtain proper treatment of the disease, even in complicated and life-threatening cases. Asenso *et al.* (1996), however, found the opposite, reporting that, as household income rises, individuals become more likely to self-medicate when they contract malaria. These findings are, however, not supported by any other research.

One important side effect of non-standard treatment is the higher number of work days lost by these households. The negative relationship between the use of proper healthcare facilities and work days lost succinctly indicates that the likelihood of losing work days increases significantly for individuals who either depend on self-medication or use traditional sources of treatment. This result implies that high-income groups face higher direct costs in terms of better treatment and avoidance activities, while low-income groups experience higher indirect cost in terms of work days lost and caregiving. The use of qualified doctors also varies by education. Educated households show a significantly higher demand for qualified doctors than less educated households. The results are an obvious confirmation of earlier evidence that those with lower socioeconomic status are more vulnerable to the consequences of malarial infection, possibly because of poorer access to proper healthcare facilities (Cropper *et al.*, 2001; Tinuade *et al.*, 2010).

Experiments in some African countries have shown that insecticide-treated bed nets reduce the incidence of vector-borne illness and mortality among infants and children (Asante and Okyere, 2003; Monasch *et al.*, 2004). Our focus in this study was on the use of bed nets by the sample population groups. Socioeconomic variables have been identified as prime determinants of the use of bed nets. Studies consistently show that the poor have less access to insecticide-treated nets (Goodman *et al.*, 2000; Abdulla *et al.*, 2001; Chima *et al.*, 2003). The use of bed nets evidently varied between income groups. Here, the important result is the relationship between the use of bed nets and household economic status. The coefficient of household income level shows that the probability of bed net use increases significantly with higher household income.

Among the other variables whose coefficients significantly diverge from zero are the cost of bed nets, the presence of a child under the age of 5 in the house, and individuals living in rural areas. The relationship between the cost and use of bed nets is negative, indicating the likelihood that the poor have fewer financial resources with which to purchase bed nets. This relationship is straightforward and in line with the economic theory of demand. Furthermore, analogous findings have been reported in the literature. Asenso *et al.* (1996) found that the choice of preventive care is influenced by the cost of the product, which has an inverse relationship with the use of such products. There is a positive relationship between the presence of a child under the age of 5 in the house and the use of bed nets, indicating that the presence of young children in the house encourages the use of such nets. This finding seems logical but is nonetheless contrary to Goodman *et al.* (2000), who reported that the demand for bed nets was lower, the larger the number of children under the age of 5 in the household. It is important to mention that the variable 'child under 5' in the house was marginally significant.

The area dummy demonstrates that the use of bed nets is notably higher among households located in rural areas than urban areas. This is likely due to the higher levels of transmission and malaria parasite prevalence in rural areas compared to urban localities. According to Asenso *et al.* (2009), agricultural activities have been recognised as one of the reasons for the increased intensity of malaria around the world, because it supports the breeding of mosquitoes that carry the malaria parasite. Breman *et al.* (2004) however, argued that, although urban malaria transmission is substantially less intense than in rural settings, the danger of epidemics can be higher due to the presence of non-immune populations. People of all ages are often at comparable levels of risk in urban settings (Breman *et al.*, 2004). Meanwhile, according to Snow *et al.* (1999), pregnant women and children are particularly likely to be infected because of their lower immunity.

Another component of the malarial economic burden is the productive work days lost by adult household members. Almost 19% of adult individuals fell ill with malaria during the reference period. Even though the data do not include information on the severity of the illness, it is estimated that a high percentage of patients lost a large number of labour days. On average, 2.94 productive work days were lost by economically active patients. When an adult is ill within the household, there is a significant amount of labour substitution, with other adults or children taking on parts of their labour burden. Of course, labour substitution generally comes at the cost of labour or leisure time for other members of the family. Implicit in labour substitution practices is often a gender implication, as the burden of labour substitution tends to fall disproportionately upon women. A study in rural Colombia found that, while men bear the greatest disease burden, women bear a greater share of the economic burden imposed by malaria (Lopez, 2012). Mothers of large numbers of children are less able to participate in the labour force, thereby also reducing the household income. However, the current study did not help elucidate these findings.

One major limitation of the study is that, although this investigation provides useful information on the extent of the economic burden at the household level, it is based on a quantitative survey conducted on a three-months recall basis. This static approach does not capture costs that spread beyond the recall period or costs that unfold slowly over time, negative externalities associated with the disease, and seasonal variations in the burdens. The final consideration is particularly critical for a disease like malaria, whose transmission levels vary over time. Thus, longitudinal studies are recommended in malarial endemic countries, including Pakistan.

CONCLUSION

This study found that malaria inflicts significant cost on households through several channels and puts forth that these costs are external to the household as a unit. Therefore, government should take the necessary steps to make appropriate changes that would make public sources of treatment more attractive and accessible to poor families. The government must subsidise pesticide-treated bed nets and collaborate with private healthcare providers to supply effective and low-cost methods of treatment. In the face of the increasing disease burden and associated cost, there is a need for strong collaboration among major stakeholders, including the government, international organisations and – more importantly – the private healthcare sector, to develop efficient and cost-effective methods of treatment. Poverty alleviation strategies should also recognise the importance of effective anti-malaria interventions, since low-income groups by themselves are unable to escape the burdens imposed by the disease.

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