Does Reducing Malaria Improve Household Living Standards?

Ramanan Laxminarayan

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1616 P Street, NW
Washington, D.C. 20036
Telephone: 202–328–5000
Fax: 202–939–3460
Internet: http://www.rff.org

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Abstract

Living in malaria-endemic regions places an economic burden on households even if they do not actually suffer an episode of malaria. Households living with endemic malaria are less likely to have access to economic opportunities and may have to modify agricultural practices and other household behavior to adapt to their disease environment. Data from Vietnam demonstrate that reductions in malaria incidence through government-financed malaria control programs can contribute to higher household income for all households living in endemic areas. Empirically, a 10% decrease in malaria cases at the national level translates to a roughly US$30 million annual economic benefit in the form of improved living standards.

Key Words: Malaria, Living standards, Disease.

JEL Classification Numbers: D1, O1, I0

Contents

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Introduction

Malaria morbidity and mortality are on the rise worldwide, especially in Africa, which shoulders 90% of malaria deaths (*1, 2*). Nevertheless, governments in malaria-endemic countries have not devoted additional attention or financial resources to fight this disease. One possible reason for this lack of attention is a poor understanding of the economic impact of the disease. Many papers have shown that malaria places significant burdens on households that have a sick family member (*3-11*). These include time lost from work by the sick individual, care-giving time spent by other family members, lost productivity, costs of seeking treatment (including transportation and medical care), and premature mortality (*12*). However, the burden of malaria on households that live in an endemic area but do not actually experience an episode has not been well quantified.

Households are adversely affected by malaria in many ways that are not always apparent or easily measured because of the long history of adaptive coexistence with the disease. For instance, they may have access to fewer economic opportunities than those living in other areas, since malaria-endemic regions tend to benefit less from tourist activity and enjoy less business investment because of higher health care costs for workers. A recent study by Utzinger and colleagues shows that investments in malaria control in Zambia (formerly northern Rhodesia) during the colonial period reduced workers' absenteeism in copper mines, which then led to increased copper production and long-term economic development (*13*). Adapting to living with constant malaria could discourage specialization within the household, since individuals have to be ready to substitute for other family members who may be suffering from malaria. There is evidence that households working in malaria-endemic regions are less likely to grow crops that require labor inputs at critical periods during the growing or harvesting season

than are households living in areas with low malaria transmission (*14*). The cumulative costs of adapting to living in malaria-endemic regions that are borne by all households are at least as important as, and potentially of greater magnitude than, the cumulative costs incurred by those who actually suffer from the disease.

Recognizing the larger context in which malaria imposes an economic burden on society, macroeconomists have estimated that the annual growth rates of economies of countries with severe malaria are 1.3% lower, even after controlling for other factors known to influence economic growth (*15*). They speculate that this effect can be attributed to such economy-wide impacts as lower foreign direct investment, reduced tourist activity, and limitations on internal movement of population in malarial countries, as well as the costs of illness and treatment and the long-term health effects of malaria morbidity for individuals. The objective of this paper is to examine these impacts in the context of household living standards.

Although few would question the strong correlation between poor economic status and malaria, empirically establishing that malaria causes poverty is problematic because the causality between malaria and diminished living standards is bidirectional for both nations and households (*15-17*). That is, although malaria may adversely affect economic activity and lead to poverty, it is also possible that the poor are less able to protect themselves from malaria and less able to seek effective treatment and therefore experience greater morbidity from the disease. Furthermore, certain characteristics of a region, such as administrative capacity, economic potential, or political importance, may be correlated with both the level of malaria in the region and the living standards of its households. These unobserved characteristics pose a significant methodological challenge to empirical estimations of the impact of malaria on household living standards—one that, to date, has not been addressed in the literature.

In this paper, we confront the challenge in the context of a natural experiment from Vietnam. The 1990s witnessed dramatic declines in malaria in Vietnam, largely as a result of increased central government expenditure on malaria control and treatment (*18*). Although malaria declined in most provinces, the decline was not uniform across all provinces, in part because of differences in the ecological characteristics of the disease vector and the parasite in different parts of Vietnam. The declines in malaria incidence were largely attributable to increased central government investment in insecticide retreatment of bed nets and antimalarial treatments; therefore, the intervention may be considered exogenous and uncorrelated with living standards in each province. One would expect that households living in provinces where malaria incidence declined to a

relatively greater extent would be more likely to experience improvements in living standards. To test this hypothesis, we estimate the impact of *changes* in malaria incidence on *changes* in household living standards over a six-year period after controlling for other household characteristics. By measuring differences in dependent and independent variables between two time periods, we eliminate unobserved variables that are correlated with both malaria prevalence and living standards. The panel data approach permits an unbiased and efficient estimation of the impact of malaria on living standards.

Data

Household living standards were measured using data on log consumption expenditures in 1992–93 and 1997–98. Consumption expenditures are more likely to be accurately measured than income data because many households receive wages in kind or are self-employed. Furthermore, households tend to transfer income between periods by saving or borrowing, in order to smooth consumption; therefore, a household's consumption reflects its standard of living more accurately than its income, which may fluctuate from one year to the next. Socioeconomic, demographic, and expenditure data on households were extracted from the results of two rounds of the Vietnam Living Standards Survey (VLSS) in 1992–93 and 1997–98. Both surveys were conducted by Vietnam's General Statistical Office with financial assistance from the United Nations Development Programme and the Swedish International Development Agency, and with technical assistance from the World Bank.

The first round of the VLSS was administered from October 1992 to October 1993 with a sample size of 4,800 households and 23,839 individuals. A second round was undertaken from December 1997 to December 1998, with some changes in questionnaire design and a slightly larger sample, 6,000 households and 28,518 individuals. Both surveys were nationally representative. Roughly 4,300 of the households and 17,780 of the individuals interviewed in 1997–98 were the same households and individuals interviewed in 1992–93. These data were matched with province-level data on malaria cases, deaths, and population obtained from Vietnam's National Malaria Control Program (NMCP).

Total expenditures were calculated from specific questions on household consumption of various food, nonfood, and durable goods for each household in both 1992–93 and 1997–98. Health care costs were calculated as the cost of medical care and drugs obtained from traditional, private western, and public providers and from

pharmacies. To calculate real expenditures, nominal expenditure data were deflated by monthly and regional price deflators, which were obtained from the consumer price index unit of Vietnam's General Statistical Office. Separate regional price deflators were applied to food and nonfood expenditures. Monthly deflators were used to adjust expenditure variables to January 1998 prices. All measurements were in 1998 Vietnamese dongs. Data on malaria deaths were excluded from the analysis for two reasons. First, there was strong contemporaneous correlation between changes in malaria cases and malaria deaths ($p<0.001$). Second, malaria was eradicated in a few provinces; therefore, the data on deaths in 1998 were truncated at zero, which would have led to biased estimates using an ordinary least squares regression.

Table 1 contains summary statistics on malaria case rates and malaria death rates recorded in 1993 and 1998 for seven geographical regions of Vietnam. Malaria cases declined by an average of 68% across the entire country, with the greatest percentage decrease occurring in the Southeast. Case rates in 1992 were highest in the Central Highlands. Deaths declined by an average of 91% across the country between 1992–93 and 1997–98.

Table 2 contains summary statistics for the 4,258 households that were followed between 1992–93 and 1997–98. The mean size of a household decreased slightly between the two surveys, and household expenditures increased by roughly 40% in real terms.

Results

The log-linearized household consumption Euler equation was estimated. Household-level time-invariant fixed effects, which are expected to be correlated both with income and with exposure to malaria, cancel out between 1993 and 1998. Time-variant fixed effects were reduced to the constant term in the regression. Log change in household expenditure between 1993 and 1998 was regressed on log change in malaria cases at the provincial level and a set of household characteristics, including household size, education of household head, and urban versus rural location (Table 3). Unlike for malaria cases and household expenditures, levels of other household characteristics (rather than changes) were included, on the assumption that these levels mediate the relationship between malaria prevalence and living standards. A separate analysis in which the independent variables were changes in household characteristics (rather than levels) yielded similar coefficients on the log change in malaria cases.

For the sample of all households, a 10% decrease in malaria cases at the provincial level resulted in a 0.3% increase in household consumption (p<0.001). Household size was negatively correlated with changes in household expenditure, but the education of the household head was positively correlated with changes in expenditure. Households living in urban areas were more likely to experience increases in living standards between 1993 and 1998. There was evidence of a convergence effect in living standards, with relatively poorer households likely to experience greater improvements in living standards.

The impact of change in province-level malaria cases on household living standards decreased slightly when the sample was restricted to households below the median expenditure level in 1993 (p<0.10); it increased when the sample was restricted to households above the median expenditure level in 1993 (p<0.001). Neither of these deviations from the estimate for the complete sample was statistically significant. However, it is plausible that wealthier households could potentially gain more from increased economic activity resulting from malaria control in the province.

Next we regressed log changes in household health expenditures on log change in malaria cases between 1993 and 1998, log change in expenditures over this period, and a set of household characteristics in 1993 (Table 4). For the full sample, a 10% decrease in malaria cases was associated with a 0.63% decrease in health expenditures. Since health expenditures in 1993 were roughly US$25 (accounting for 5% of overall household expenditures), this is equivalent to a $0.16 benefit to each household for every 10% reduction in malaria at the provincial level. Changes in province-level malaria were not significantly associated with changes in health expenditures of relatively poorer households. This may be because poorer households do not seek treatment for malaria as frequently as wealthier households—an explanation supported by evidence from our 1993 sample, which included a question for self-reported malaria. In the case of households with expenditures above the median in 1993, however, a 10% decrease in malaria was significantly associated with a decrease in health expenditures of roughly 1%.

Discussion

We have assumed that changes in malaria prevalence between 1993 and 1998 were uncorrelated with other factors, such as efficiency of the provincial government, which may have influenced household living standards. Other changes in Vietnam

between 1993 and 1998 led to rapid increases in living standards, including greater private ownership of agricultural land, reductions in government spending, and greater agricultural production. To the extent that these changes are not correlated with province-level changes in malaria, our results should be unaltered. However, further analysis is required to examine the impact of regional economic changes on the effectiveness of malaria control efforts in each province and the extent of bias this might have introduced in our results. Although other factors may have played a role, the rapid declines in malaria in Vietnam during the 1990s are largely attributed to the sustained efforts of the National Malaria Control Program. The program promoted the use of nets treated with the insecticide permethrin, invested in training and supervision of district and commune health staff, and conducted intensive community education about the use of treated nets. Consequently, the number of people protected by treated nets increased from 300,000 in 1991 to almost 10.8 million in 1998. With respect to treatment, artemisinin-based combination drugs were deployed to replace antimalarials such as chloroquine and sulfadoxine-pyrimethamine, which had been rendered ineffective by parasite resistance.

It is estimated that between 1991 and 1997, national and local governments invested a total of US$28 million in malaria control and prevention. The current budget of NMCP is estimated at roughly US$5 million. Were these investments worth the cost? There were approximately 850,000 fewer cases of malaria in 1997–98 than in 1992–93. Based on 1998 data, we estimate that the mean cost of service and drugs associated with a visit to a health care provider cost was roughly $11. Therefore, the dramatic reductions in malaria translate to an annual economic benefit of approximately $10 million. Even this limited assessment of the benefits of malaria control exceeds the annual cost of malaria control expenditures by NMCP.

Next we examine the broader impact of malaria control on household health expenditures, using parameters estimated in our regression analysis. The roughly 60% average reduction in malaria nationwide in Vietnam would have translated to approximately US$14 million in reduced out-of-pocket health care expenditures by households. This estimate, too, exceeds the annual cost of malaria control efforts in Vietnam.

The above two estimates of benefits fail to include the larger impact of malaria control on household living standards through effects on economic activity and household adaptive behavior. Based on our estimates, the roughly 60% average reduction in malaria nationwide in Vietnam was associated with a 1.8% increase in annual household consumption. Extrapolating from these results to the entire country, this

translates to a mean $12.60 benefit to all households in Vietnam.[1] [2]. Aggregating nationwide, the benefits of the malaria reduction program would be estimated at US$183 million each year. This benefit estimate is substantially greater than estimates obtained from looking solely at health expenditures. It is evident that economic analyses confined to the impact of malaria on health alone may seriously underestimate the true benefit of reducing malaria, as measured by the impact on household living standards.

More than a third of the world's population (about 2 billion people) lives in malaria-endemic areas. Our finding that households in provinces that experienced large decreases in malaria incidence were more likely to experience improvements in living standards is potentially important for directing health policy and investment for this population. Malaria control in the long term necessarily requires sizable annual investments by local and national governments in effective malaria control and treatment (*19, 20*). Without clear evidence that household living standards will be improved by a measure greater than the cost of investing in malaria control, malaria is unlikely to attract the sustained attention of policymakers in malaria-endemic countries.

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[1] The exchange rate in 1998 was US$1 = 15,000 VND

[2] Vietnam's population in 2001 was 78.7 million with a per capita income of $420.

References

1.   T.C. Nchinda, *Emerging Infectious Diseases*,4: 398–403 (1998).

2.   B. Greenwood, T. Mutabingwa, *Nature* 415: 670–72 (February 7, 2002).

3.   M. Gomes, *Social Science and Medicine* 37: 1093–108 (1993).

4.   A. Mills, *Tropical Medicine and Parasitology* 44: 9–13 (1993).

5.   R. Sauerborn et al., *Tropical Medicine and Parasitology* 42: 219–23 (1991).

6.   D.S. Shepard, M.B. Ettling, U. Brinkmann, R. Sauerborn, *Tropical Medicine and Parasitology* 42: 199–203 (September 1991).

7.   W.K. Asenso-Okyere, J.A. Dzator, *Social Science and Medicine* 45: 659–67 (1997).

8.   M.B. Ettling, D.S. Shepard, *Tropical Medicine and Parasitology* 42: 214–18 (September 1991).

9.   M. Ettling, D.A. McFarland, L.J. Schultz, L. Chitsulo, *Tropical Medicine and Parasitology* 45: 74–79 (1994).

10.   F. Konradsen, W. van der Hoek, P.H. Amerasinghe, F.P. Amerasinghe, K.T. Fonseka, *Transactions of the Royal Society of Tropical Medicine and Hygiene* 91: 127–30 (1997).

11.   A. Mills, *Health Policy* 29: 209–27 (1994).

12.   R.I. Chima, C.A. Goodman, A. Mills, *Health Policy* 63: 17–36 (January 2003).

13.   J. Utzinger, Y. Tozan, F. Doumani, B.H. Singer, *Tropical Medicine & International Health : Tm & Ih* 7: 657–77 (August 2002).

14.   G.N. Conly, *The impact of malaria on economic development : A case study* (Pan American Health Organization, Pan American Sanitary Bureau Regional Office of the World Health Organization, Washington, 1975).

15.   J.L. Gallup, J.D. Sachs, *American Journal of Tropical Medicine and Hygiene* 64: 85–96 (2001).

16.   J. Sachs, P. Malaney, *Nature* 415: 680-5 (2002).

17.   F.D. McCarthy, H. Wolf, Y. Wu, The growth costs of malaria, *Technical Report No. 7521* (NBER 2000).

18.   Q. Hung le et al., *Bulletin of the World Health Organization* 80: 660–66 (2002).

19.   P.A. Kager, P.J. de Vries, *Ned Tijdschr Geneeskd* 144: 357–61 (February 19, 2000).

20.   N.J. White et al., *Lancet* 353: 1965–67 (1999).

Table 1. Comparison of malaria case rates and malaria death rates by region*

Geographical region	Case rate (1992)	Case rate (1998)	Percentage change in case rate	Death rate (1992)	Death rate (1998)	Percentage change in death rate
Northern Mountains	0.039	0.014	–64%	3.3E-05	6.5E-07	–98%
Red River Delta	0.012	0.003	–74%	6.9E-06	6.8E-08	–99%
North Central Coast	0.046	0.012	–74%	6.4E-05	4.8E-06	–92%
South Central Coast	0.023	0.013	–45%	8.2E-05	6.3E-06	–92%
Central Highlands	0.158	0.047	–70%	5.1E-04	4.9E-05	–90%
Southeast	0.027	0.005	–83%	5.8E-05	4.1E-06	–93%
Mekong Delta	0.030	0.008	–73%	1.1E-05	4.8E-07	–96%

Case rates are cases divided by population in each survey year.

Table 2. Summary statistics for household variables (unweighted)

Variable	1992–93	1997–98
Age of household head (years)	45.53 (14.58)*	48.35 (13.82)*
Education of household head (years)	6.20 (4.14)	6.87 (4.29)
Household size	5.03 (2.17)	4.77 (1.97)
Annual household expenditure (1,000 VND (1998))	7,844 (6,075)	10,976 (9,338)
Urban residence (% of households)	0.19 (0.39)	0.21 (0.40)

* Standard deviation in parentheses.

Table 3. Results of regression model predicting log change in household expenditure between 1993 and 1998 in Vietnam[†]

	All households	Expenditure below median in 1993	Expenditure at or above median in 1993
Log change in malaria cases between 1993 and 1998	–0.03*** (–0.045,–0.015)	–0.018* (–0.039,0.002)	–0.039*** (–0.059,–0.019)
Household size (1993)	0.055*** (0.046,0.065)	0.068*** (0.052,0.084)	0.049*** (0.037,0.061)
Education of household head (1993)	0.024*** (0.021,0.027)	0.020*** (0.015,0.024)	0.026*** (0.021,0.031)
Urban residence (1993)	0.238*** (0.203,0.274)	0.231*** (0.175,0.288)	0.238*** (0.192,0.284)
Log expenditure (1993)	–0.335*** (–0.363,–0.308)	–0.326*** (–0.377,–0.275)	–0.347*** (–0.401,–0.293)
Constant	2.750*** (2.534,2.967)	2.650*** (2.257,3.042)	2.873 (2.399,3.347)
R-square	0.20	0.17	0.18
Number of observations	4,244	2,116	2,128

* $p<0.1$; **$p<0.05$; ***$p<0.001$.

[†] Reported standard errors are corrected for a general, unknown form of heteroscedasticity using the Huber-White method.

[††] 95% confidence intervals in parentheses.

Table 4. Results of regression model predicting log change in annual household health expenditure between 1993 and 1998 in Vietnam[†]

	All households	Expenditure below median in 1993	Expenditure at or above median in 1993
Log change in malaria cases between 1993 and 1998	0.063** (0.004,0.122)	0.030 (−0.060,0.120)	0.096** (0.019,0.172)
Household size (1993)	0.050*** (0.026,0.073)	0.002 (−0.033,0.038)	0.036** (0.004,0.068)
Education of household head (1993)	−0.011* (−0.024,0.002)	−0.030** (−0.048,−0.012)	−0.008 (−0.026,0.010)
Urban residence (1993)	0.138* (−0.004,0.281)	0.001 (−0.216,0.219)	0.106 (−0.068,0.280)
Log change in expenditure	0.437*** (0.319,0.555)	0.633*** (0.436,0.810)	0.512*** (0.353,0.671)
Insurance (1998)	−0.066 (−0.283,0.151)	−0.059 (−0.362,0.245)	−0.165 (−0.452,0.122)
Log health expenditure (1993)	−0.740*** (−0.782,−0.698)	−0.771*** (−0.832,−0.709)	−0.771*** (−0.829,−0.713)
Constant	2.571*** (2.299,2.842)	2.770** (2.395,3.145)	2.981*** (−0.829,−0.713)
R-square	0.39	0.37	0.40
Number of observations	2974	1416	1558

* $p<0.1$; **$p<0.05$; ***$p<0.001$

† Reported standard errors are corrected for a general, unknown form of heteroscedasticity using the Huber-White method.

†† 95% confidence intervals in parentheses.