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Biting Back at Malaria – Self-Medication, Traditional Healers, and the Public Sector

Abstract

Malaria kills about 1,500 children every day. Based on the Demographic and Health Surveys, we examine malaria treatment practices of various health care providers in sub-Saharan Africa, where more than 90 percent of the world's deaths due to malaria occur. To assess the quality of each health care provider (including, among others, public health centers and traditional healers), we estimate the likelihood of providers to administer ineffective antimalarial drugs such as chloroquine in areas of known resistance, and to relieve children of malaria symptoms after having had fever within the last two weeks. Our results indicate that relative to self-medication, seeking treatment at most providers significantly increases the likelihood to take any antimalarial drug and decreases the likelihood to use chloroquine. Traditional healers do not exert any effect.

JEL Classification: I11, I14, O15, O57

Keywords: Quality of care; health care providers; health inequalities; malaria; sub-Saharan Africa; child health

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I. Introduction

Malaria kills about 660,000 people each year. The majority of deaths (86 percent) occur in children below five years of age. Approximately 1,500 children die due to malaria every day. Most of them are located in sub-Saharan Africa, where the highest parasite prevalence rates are reported for children among poorer populations and in rural areas (WHO, 2012).

These figures are generally preceived as unacceptable since malaria is considered an entirely preventable and treatable disease. As a consequence, bilateral donors, the World Bank, and the Global Fund to Fight AIDS, TB and Malaria have substantially increased malaria-control funding and provided technical assistance through the World Health Organisation (WHO) and Roll Back Malaria Partnership for years.[1] Prompt and effective malaria treatment is a key component of their strategy to reduce the burden of malaria (RBM, 2005).

Due to widespread parasite resistance to traditional antimalarial drugs such as chloroquine, immediately changing the predominant medication practices is one of the greatest challenges (Frosch et al., 2011). The reasons for the extremely high utilization rates of ineffective antimalarial drugs in sub-Saharan children are subject to vigorous discussions because knowledge of parasite resitance to antimalarial drugs dates back to the 1980s (Achan et al., 2011).

Several country case studies argue for the importance of the treatment-seeking process to understand ineffective antimalarial drug usage (e.g., Smith, 2010). Many caretakers of febrile children below five years of age abstain from seeking advice from health care providers and from administering any or effective antimalarial drugs (McCombie, 1996). The latter is particularly worrisome because malaria is the most likely cause of fever in sub-Saharan African young children (WHO, 2006) and presumptive antimalarial treatment is recommended by the WHO and national guidelines (WHO, 2012).[2] However, even if caretakers bring their febrile children to health facilities, appropriate treatment is not provided as shown by several regional case studies (e.g., Onwujekwe et al., 2009).

The present paper analyzes differences in febrile children treatment practices among different forms of health care, including self-treatment, traditional healers, private health care providers, and the public sector in Western sub-Saharan Africa. We assess the quality of treatment provided to children below five years who had fever within the last two weeks by comparing utilization patterns of antimalarial drugs and cure rates. We consider presumptive treatment with (effective) antimalarial drugs as good quality since this was best practice according to WHO and national guidelines at the time of the survey interviews.

Our results enable us to discuss primary fields of action for malaria control initiatives. For instance, if we find that self-medication fares badly, policy interventions should target provider choice determinants in countries with very low advice-seeking rates. On the other hand, a finding of minor quality differences would explain low advice-seeking rates and therefore require measures to improve treatment quality in health facilities.

[1] International disbursements for malaria control rose from US$ 100 million in 2000 to US$ 1.71 billion in 2010.

[2] While until 2010 (the data end point of this analysis is 2008), presumptive treatment of febrile children was non-restrictively recommended (e.g., WHO 2006), current guidelines encourage the use of rapid diagnostic tests and designate presumptive treatment only when a parasitological diagnosis is not accessible within less than 2 hours of the patient's presentation at the point of care.

Moreover, detailed knowledge of quality differences across health care providers makes it possible to assess observed socioeconomic gradients in the patients' likelihood to seek advice at certain health facilities (Filmer, 2005).[3] Although a few studies (e.g., Onwujekwe et al., 2009; Smith et al., 2010; Ebong et al., 2012) exist on antimalarial drug provision of different health care providers, the evidence is restricted to single countries and, due to a regional focus within these countries, usually are not representative. We use the nationally-representative Demographic and Health (DHS) surveys for eight West African countries (Burkina Faso, Benin, Ghana, Guinea, Liberia, Mali, Nigeria, and Niger), which allow us to assess heterogeneity in febrile children treatment practices across countries. Moreover, we are the first who aim to extensively control for confounding factors such as the educational background of the guardians.[4] Thus, we run a much lower risk of presenting spurious correlations compared to previous (country-case) studies, which abstain from employing multivariate regressions. This study also adds to the current literature by examining the development of treatment provision for two West African countries (Ghana and Nigeria). This is highly relevant because it addresses the question about the effectiveness of nationally- and internationally-funded malaria control efforts.

This paper contributes to an emergent development economics debate on the quality of medical care in two ways. First, it presents a further approach to measure the quality of medical care, which has been predominantly assessed based on employed input factors, such as the physical infrastructure and the stock of medical supplies (e.g., Collier et al., 2003). More recently, clinical vignettes in combination with item response are used to judge treatment quality (Das and Hammer, 2005; 2007).[5] Based on the conviction that availability of effective antimalaria drugs is part of the provider production function and building up on the work of Das and Hammer, we suggest *actual* compliance with current treatment guidelines as a method to measure health care quality. Second, it presents further empirical evidence on the quality of health care in the developing world. Generally, more evidence is needed to detect areas where health systems fail and, hence, to take the right measures to strengthening the health system (Berman and Bitran, 2011).

II. Data & Study Population

The data for the analysis comes from the Demographic and Health Surveys (DHS) conducted for eight selected West sub-Saharan African countries, namely Burkina Faso, Benin, Ghana, Guinea, Liberia, Mali, Nigeria, and Niger.[6] The DHS are nationally representative consisting of three core questionnaires: the women's, the men's, and the household questionnaire. Sociodemographic characteristics are collected for purposes

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[3] The author finds that sixty percent of fever cases in sub-Saharan Africa result in a visit to a modern medical provider (thirty percent to a public and twenty percent to a private facility). Richer families are much more likely to seek advice although, conditional on seeking advice, they have no pronounced provider preferences. Poorer families, in contrast, primarily seek care from public entities (government health center, government health post, mobile clinic, community health worker).

[4] The guardian's education is likely to be related to both health care provider choice and knowledge of effective malaria treatments, and, thus, causing biased estimates if not taken into account in the econometric analysis.

[5] The authors presented medical doctors in urban Delhi (India) with five health-related "vignettes", which contained images of hypothetical patients arriving with symptoms of specific diseases. The doctors' proposed diagnostic proecedure and derived treatment was subsequently compared to the recommended medical practice, forming an index of each doctor's competence.

[6] Further details about the DHS are available from the Measure DHS website at http://measuredhs.com.

of, among others, assisting policymakers in these countries to implement instruments to improve public health.

We have one wave for Burkina Faso (2003), Benin (2006), Guinea (2005), Liberia (2006/2007), Mali (2006), and Niger (2006); we use two waves for Ghana (2003 and 2008) and Nigeria (2003 and 2008). Since the focus of the paper is on the effectiveness of the provider on the treatment of malaria, we restrict the sample only to those children who had fever within the last two weeks according to the mother. Note that malaria is the most likely cause of the young childrens' illness in these countries (WHO, 2006). The final pooled estimation sample consists of child-level data for 19,267 children, of which 18,069 lie within the common support (described in Sec. III).

Our primary outcome variables are the (1) probability of receiving antimalarial drugs, (2) the probability of receiving "good" antimalarial drugs, (3) the probability of receiving only chloroquine, and (4) the probability of having fever at the time of the interview. Good antimalarial drugs are the recommended first-line treatment for uncomplicated malaria according to national guidelines in place at the time of the interview. These drugs have been shown to be effective treatments for malaria in the presence of chloroquine resistance, which is the case in the eight countries examined in this paper (Figure 1).

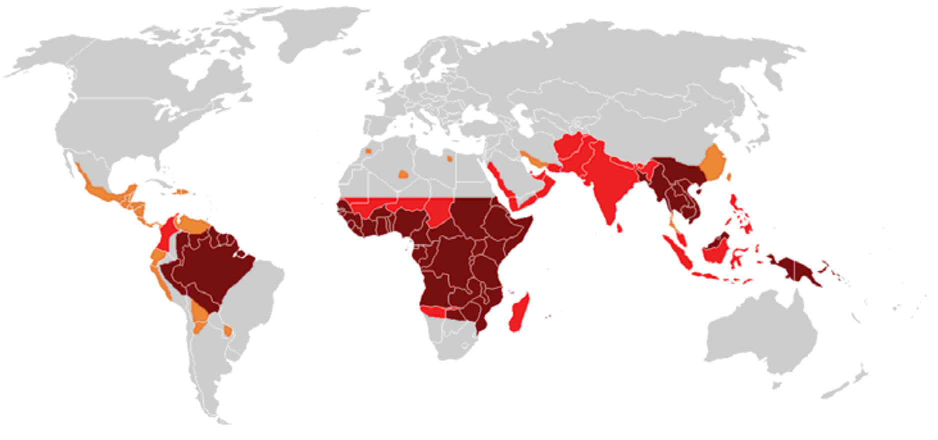

FIGURE 1

MAP SHOWING THE DISTRIBUTION OF MALARIA IN THE WORLD

NOTE: ♦ Elevated occurrence of chloroquine- or multi-resistant malaria, ♦ Occurrence of chloroquine-resistant malaria, ♦ No *Plasmodium falciparum* or chloroquine-resistance, ♦ No malaria. SOURCE: Wikipedia (http://en.wikipedia.org/wiki/Malaria; accessed on April 01, 2013).

Following the definition of Filmer (2005), our treatment variables are (1) going to a public hospital, (2) going to a public health facility which is not a hospital, (3) going to a private hospital, (4) going to a private health facility which is not a hospital, (5) going to a pharmacy or a shop, (6) going to a traditional healer, or (7) self-medicating. We remove observations where the child was in contact with more than one treatment provider (about 2 percent of the sample). More detailed information on the variables used in this paper is provided in the appendix.

The means of the outcome and treatment variables by country are presented in Table 1.[7] Liberia and Ghana are clearly ahead of the other West African countries in terms of both

[7] The means of the other relevant variables are available in Table A1 in the appendix.

TABLE 1
MEANS OF OUTCOME AND TREATMENT VARIABLES BY COUNTRY

	Burkina Faso	Benin	Ghana	Guinea	Liberia	Mali	Nigeria	Niger
Outcome								
Antimalarial	0.5345	0.5734	0.5765	0.4361	0.5731	0.3588	0.3868	0.3638
Good antimalarial	—	0.0080	0.4811	—	0.1468	—	0.0755	—
Chloroquine only	0.4881	0.1854	0.1982	0.2303	0.1343	0.3756	0.3398	0.4513
Has fever now	0.2672	0.2430	0.3041	0.3219	0.2801	0.3461	0.3500	0.1929
Provider								
Public hospital	0.0187	0.0290	0.2199	0.0299	0.1169	0.0139	0.1091	0.0215
Other public facility	0.3051	0.2316	0.1778	0.2695	0.2801	0.2579	0.1448	0.2950
Private hospital	0.0041	0.0420	0.0593	0.0087	0.1219	0.0111	0.0587	0.0128
Other private facility	0.0108	0.0572	0.0155	0.0225	0.0634	0.0227	0.1649	0.1344
Pharmacy/shop	0.0823	0.1123	0.2053	0.1703	0.1361	0.0377	0.2228	0.1503
Traditional healer	0.0575	0.1728	0.0455	0.0892	0.0727	0.2085	0.0308	0.0282
Self-medication	0.5214	0.3550	0.2766	0.4099	0.2088	0.4481	0.2689	0.3576
Observations	3147	3687	1164	1603	1403	1803	4511	1949

NOTES: In calculating the share of children who took good antimalarial drugs and chloroquine, the observations are restricted to those who have taken any antimalarial drug. Hence, the numbers of observations above do not apply for the rows “Good antimalarial” and “Chloroquine only”. We have no information available on whether good antimalarial drugs were provided in Burkina Faso, Guinea, Mali, and Niger. For Ghana and Nigeria, good antimalarial drug refers to the year 2008 only. SOURCE: Authors’ calculations based on the DHS.

providing antimalarial drugs (57.3 and 57.7 percent, respectively) as well as providing effective antimalarial drugs (48.1 and 14.7 percent, respectively) conditional on providing any antimalarial drug. Benin also ranks high in terms of providing antimalarial drugs, although it is among the worst performers in the provision of good antimalarial drugs.[8] No information is available on receiving good antimalarial drugs for a large set of countries.[9]

Only 35.9 percent of Mali’s children with a fever episode within the last two weeks receive any antimalarial drug. Worryingly, even though the region is widely acknowledged to have chloroquine-resistant malaria-causing parasites, nontrivial shares of febrile children still receive the ineffective treatment.

In terms of provider choice, apart from Mali and Benin, going to a traditional healer seems to be a marginal phenomenon. Typically, a large share of the febrile children in this region goes to some public health facility which is not a hospital for treatment, with the only exception being Ghana, where most are taken to either a public hospital or a pharmaceutical shop. However, larger shares are in fact being self-medicated (or not receiving treatment at all) with the sole exception of Liberia. This is troubling in a region where chloroquine-resistant malaria prevalence is exceptionally high, since good antimalarial drugs are tipically not available at home.

III. Estimation & Results

To assess differences in febrile children treatment practices between health care providers, we estimate linear probability models (LPM) for four different binary outcome variables, using a set of five health care provider indicators (with self-treatment as the reference category) and further (control) variables as regressors. The estimated coefficients of the provider dummy variables yield the difference in the

[8] These differences may partly be due to the year of information on good antimalarial treatment (Benin 2006, Liberia 2006, Ghana 2008, and Nigeria 2008). All four countries introduced artemisinin-based combination therapies as first-line treatment in 2004. However, large-scale policy implementation requires some time.

[9] Information on usage of first-line antimalarial drug is available for Benin, Ghana (2008), Liberia, and Nigeria (2008).

outcomes between the respective health care provider and self-treatment (denoted self-medication) conditional on the covariates. Quality differences between two health care providers are calculated by subtracting the respective coefficients. Wald tests are used to assess whether both coefficients significantly differ from each other.

The central problem for our econometric analysis is to accurately determine the expected counterfactual outcome for each febrile child in treatment at a certain health care provider. LPM allows us to base the estimation of the counterfactual state on a large range of individual characteristics, environmental factors, region, and time of the interview. However, by employing many covariates, we run the risk of projecting into regions where there are no data points. To circumvent this, we restrict our analysis to the common support, i.e., we ensure that for each treated febrile child there is a comparable child in the self-medication category. To determine the common support, we first calculate the minimum and maximum predicted probabilities of being in the self-medication category for each health care provider category (including the self-medication group).[10] We then trim the sample by dropping observations that have predicted probabilities that are either higher than the maximum predicted probability of any of the categories or lower than the minimum predicted probability of any of the categories.[11]

Regression results for all outcomes and three different model specifications are displayed in Table 2. In the basic model specification (Column 1), we control for child-related variables, mother-related variables, household size, region and time. The latter variables partly capture the effects of antimalarial drug availability and health care costs since institutional factors vary considerably across regions and time (Table A7 in the appendix). The extended model specification (Column 2) additionally considers proxy variables for wealth and income at the household level, and is supplemented by variables on environmental factors in the full model specification (Column 3). By gradually including income and environmental factors such as access to safe water and bed net usage at night time, we aim to establish the robustness of our results with respect to accounting for the ability to pay for health services and antimalarial drugs as well as for the likelihood that the child's fever episode is due to malaria.[12]

The four outcome variables are utilization indicators for any, effective, and ineffective antimalarial drugs, respectively, and an indicator variable for currently having a fever. We restrict the estimations for the effective and ineffective antimalarial drug variables on children who have taken any antimalarial drug. This completes the quality assessment based on drug usage because antimalarial drug intake alone does not necessarily indicate better quality. Besides the risk of being entirely ineffective, antimalarial treatment may be inappropriate if the child's illness is, in fact, not due to malaria. In order to prevent parasite resistance to antimalarial drugs, their usage should

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[10] To estimate the likelihoods to fall into each of the categories (self-medication, traditional healer, pharmacy/shop, other private, private hospital, other public, public hospital) based on control variables (without the region and year indicators), we use a multinomial logit model. The parameter estimates are then used to calculate the predicted probability of being in the self-medication categroy for each observation. Figure A1 in the appendix illustrates the distribution of the predicted probability of being in the self-medication category for each category.

[11] At maximum, we exclude 1,198 observations. None of the results depend on restricting the sample to the common support. Regression results based on all observations are available upon request.

[12] Since malaria is carried by mosquitoes, which lay their larvae in still water, we assume that a lack of safe water and sanitation is positively associated with the likelihood of malaria. Bed net usage approximates exposure to mosquito bites.

be restricted to assumed and actual malaria cases.[13] This holds, in particular, for providers that use diagnostic tests for malaria.[14] In cases where a provider advises antimalarial drug usage (because a diagnostic test was not available or the test came back positive for malaria), the first choice must be an effective antimalarial drug; there is no reason to administer chloroquine due to its ineffectiveness. While the first quality indicators measure the appropriateness of the treatment, the fever indicator is result-oriented, i.e., the fever regressions are informative about the effectiveness of the proposed malaria control measures.

Concerning the probability of any antimalarial medication, we observe for all three model specifications significantly positive coefficients for public and private hospitals, other public and private facilities, and (pharmaceutical) shops.[15] The effect is largest for other public facilities (41.9 percentage points), followed by public and private hospitals with an increased likelihood to prescribe antimalarial treatment of around 35 percentage points compared to the self-medication category. While other private facilities and (pharmaceutical) shops are also positively and significantly associated with antimalarial drug usage, we find no difference in antimalarial drug utilization rates between children who were brought to a traditional healer and children who were self-medicated. Accordingly, pair wise comparisons between the traditional healer and other health care providers yield that traditional healers are significantly less likely to advice antimalarial drug intake.

Regarding the difference between the public and private sector, we find no significant differential between seeking advice at a public or a private hospital. However, compared to seeking advice at other public facilities, visits to other private facilities significantly decrease the likelihood to receive antimalarial medication by almost 14 percentage points (p-value 0.000). On the other hand, patients of other private facilities are 11.7 percentage points more likely to receive antimalarial medicine than febrile children whose parents sought advice at (pharmaceutical) shops.

With respect to receiving good antimalarial treatment (conditional on having received any antimalarial drug), we only observe significant effects for public hospitals and other public facilities. Children advised by public hospitals have the greatest chance of receiving effective antimalarial drugs. Compared to self-medication, seeking advice at a public hospital (other public facility) increases the probability of taking an effective antimalarial drug by 4.9 (3.4) percentage points. At the 10-percent level of significance, the coefficients of public hospitals and other public facilities are significantly larger than the coefficients of the other health care providers. A possible explanation is that in most countries good antimalarial drugs are free of charge in the public sector (Table A7 in the appendix), while in the private sector they are not.[16] There is no significant difference between the two public providers.

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[13] Note that the presumptive treatment recommendation implies that the first assumption for febrile children is malaria.

[14] We neither observe whether a child has malaria nor whether it was tested for malaria by the provider. However, in seven out of eight countries (not in Liberia) the proportion of reported suspected cases in the public sector receiving a parasitological test was low (WHO 2012). There are no data for other sectors.

[15] For the other outcome variables, the results are also robust across model specifications (Table 2). Therefore, we focus on the results from the full model specification. Table A2 in the appendix presents results for the covariates.

[16] Note that in some countries (e.g., Ghana), certain health services are free of charge for people that have a health insurance.

TABLE 2

LINEAR PROBABILITY MODEL ESTIMATION RESULTS FOR DIFFERENCES IN THE TREATMENT PRACTICE ACROSS HEALTH CARE PROVIDERS

	Basic Model	Extended Model	Full Model
Any antimalarial			
Public hospital	0.3573***	0.3505***	0.3499***
	(0.0156)	(0.0157)	(0.0157)
Other public facility	0.4273***	0.4200***	0.4191***
	(0.0088)	(0.0089)	(0.0089)
Private hospital	0.3541***	0.3483***	0.3474***
	(0.0186)	(0.0187)	(0.0187)
Other private facility	0.2866***	0.2820***	0.2817***
	(0.0145)	(0.0145)	(0.0145)
Pharmacy/shop	0.1679***	0.1654***	0.1645***
	(0.0114)	(0.0114)	(0.0114)
Traditional healer	–0.0095	–0.0081	–0.0079
	(0.0128)	(0.0128)	(0.0127)
Observations	18069	18069	18069
Good antimalarial			
Public hospital	0.0499**	0.0485**	0.0489**
	(0.0185)	(0.0185)	(0.0185)
Other public facility	0.0335***	0.0335***	0.0336***
	(0.0092)	(0.0092)	(0.0092)
Private hospital	0.0062	0.0043	0.0054
	(0.0161)	(0.0160)	(0.0160)
Other private facility	–0.0046	–0.0043	–0.0038
	(0.0109)	(0.0109)	(0.0109)
Pharmacy/shop	–0.0072	–0.0079	–0.0083
	(0.0138)	(0.0139)	(0.0139)
Traditional healer	0.0060	0.0063	0.0059
	(0.0118)	(0.0114)	(0.0115)
Observations	4305	4305	4305
Chloroquine only			
Public hospital	–0.0934***	–0.0851***	–0.0812***
	(0.0190)	(0.0190)	(0.0189)
Other public facility	–0.0751***	–0.0716***	–0.0691***
	(0.0133)	(0.0133)	(0.0133)
Private hospital	–0.0959***	–0.0833***	–0.0804***
	(0.0208)	(0.0209)	(0.0208)
Other private facility	–0.0067	–0.0036	–0.0013
	(0.0206)	(0.0205)	(0.0205)
Pharmacy/shop	–0.0676***	–0.0677***	–0.0639***
	(0.0175)	(0.0175)	(0.0174)
Traditional healer	–0.0106	–0.0121	–0.0098
	(0.0221)	(0.0221)	(0.0221)
Observations	8593	8593	8593
Has fever now			
Public hospital	–0.0616***	–0.0582***	–0.0570***
	(0.0151)	(0.0152)	(0.0152)
Other public facility	–0.0349***	–0.0337***	–0.0326***
	(0.0091)	(0.0091)	(0.0091)
Private hospital	–0.0535**	–0.0480**	–0.0470*
	(0.0184)	(0.0185)	(0.0185)
Other private facility	–0.0907***	–0.0895***	–0.0887***
	(0.0140)	(0.0140)	(0.0140)
Pharmacy/shop	–0.0481***	–0.0470***	–0.0462***
	(0.0110)	(0.0110)	(0.0110)
Traditional healer	–0.0216	–0.0220	–0.0218
	(0.0129)	(0.0129)	(0.0129)
Observations	18069	18069	18069

NOTES: * significant at 5%, ** significant at 1%, *** significant at 0.1%. Robust standard errors in parentheses.

As to the probability of taking chloroquine, we find significant effects for public and private hospitals, other public facilities, and (pharmaceutical) shops. The likelihood of taking chloroquine falls by 8.1, 8.0, 6.9, and 6.4 percentage points, respectively. The coefficients of these providers do not significantly differ from each other. Private facilities exert no significant effect on chloroquine use (and no effect on good antimalarial treatment). Previously, we found children who seek treatment at other private facilities having a significantly higher chance to take any antimalarial drugs, which suggests that other private facilities predominantly administer chloroquine. Seeking advice of traditional healers is not associated with the type of antimalarial treatment.

Eventually, the fever regression results yield that, except traditional healers, all health care providers are more effective than self-medication in terms of relieving fever. The effects range from −3.3 (other public facility) to −8.8 (other private facility) percentage points. At the 10-percent level of significance, the coefficient of other private facilities is significantly lower than the coefficients of the other health care providers. Between public and private hospitals, other public facilities, and (pharmaceutical) shops, we do not observe significant differences. Other private facilities, public hospitals, and (pharmaceutical) shops have, in absolute terms, significantly larger coefficients than traditional healers (at the 10 percent level). In terms of relieving fever, traditional healers are as effective as other public facilities and private hospitals.

The magnitude of the observed heterogeneity in malaria treatment practices and success across health care providers is substantial. The largest coefficient (other public facility) in the antimalarial drug regression yields an increase of 89 percent (effect of 41.9 percentage points compared to 47.1 percent at baseline, i.e., 41.9/47.1*100). Seeking advice at a public hospital rises (reduces) the likelihood of good antimalarial (chloroquine) use by 65 (27) percent, while advice seeking at other private facilities increases the chance of being relieved of fever by 30 percent.

IV. Effect Heterogeneity by Socioeconomic Status, Country, and Time

In this section, we examine whether there are socioeconomic differences in the quality provided by different health care providers. Further investigations address heterogeneity in the effects across countries and time.

Socioeconomic Gradient in Treatment Quality

To assess socioeconomic differences, we run separate regressions for each of the five wealth index groups ("poorest", "poorer", "middle", "richer", "richest"). The results are presented in Table A3 in the appendix. Across wealth quintiles, we find substantial differences in the likelihood of receiving any antimalarial drug and in the odd to be relieved of fever for various health care providers. In contrast, we find no such heterogeneity with respect to the type (effective vs. ineffective) of antimalarial treatment conditional on any antimalarial treatment.[17]

Except traditional healers, the coefficients of all health care providers decrease from the poorest to the richest quintile for the antimalarial drug outcome. The differences between the coefficients of the poorest and richest quintile are statistically significant.

[17] The equality of coefficients test indicates for all providers (including traditional healer) significant differences across wealth quintiles for the antimalarial drug outcome. This holds only for private hospitals in the fever regressions.

Regarding the fever regression, we also find significant differences in the provider coefficients between the poorest and richest quintile for public hospital, private hospital (both at the 10-percent significane level), and other private facilities. The larger effects, in absolute terms, are observed in the poorest wealth quintile.

We explain these socioeconomic differences by a differential in both outcomes across wealth quintiles among children who did not seek any advice (the reference group). The richest people may, for instance, be well informed about antimalarial treatments and have reserves of antimalarial drugs at home. In line with this, we observe a differential (+20 and −6 percentage points) in the antimalarial utilization rate and the chance to remain febrile between the richest and the poorest quintile.

Health Care Provision by Country

Splitting the estimation sample by country enables us to examine differences in treatment practices across countries and, hence, across institutional settings. As displayed in Table A7 in the appendix, there is substantial variation in the costs of (public) health care and availability of antimalarial drugs across West sub-Saharan African countries. For instance, in Liberia (2006/2007) there were good antimalarial drugs and health care free of charge in the public sector, whereas patients had to pay fees for both public services in Benin (2006). Moreover, availability of good antimalarial drugs –far from being sufficiently available– was much higher in Liberia relative to Benin.[18]

Estimation results are presented in Table A4 and Table A5 in the appendix. Concerning the probability of receiving any antimalarial drug (Table A4, upper panel), we observe a considerable heterogeneity across countries (tests of equality of country-specific coefficients are significant for all health care providers), although the coefficients of public hospital, other public facility, and private hospital remain individually significant in each country. The maximal statistically signficant difference among the coefficients of public hospital is observed between Burkina Faso and Liberia, and amounts to approximately 40 percentage points. Very similar in terms of magnitude and significance is the difference in the public hospital coefficients between Benin and Liberia, for which we also observe a significant but much smaller differential of around 9 percentage points in the other public facility coefficients. At the same time, we observe a much larger difference in the share of children brought to a public hospital between Benin and Liberia compared to the cross-country difference in the share of children seeking treatment at other public facilities (Table 1). It seems plausible that quality of health care explains this cross-country difference in treatment seeking of febrile children.

We furthermore find that in Burkina Faso and Ghana, children brought to other private facilities are not signficantly more likely to take antimalarial drugs than children that were self-medicated. In the remaining countries, in contrast, other private facilities signficantly increase the likelihood of antimalarial use by at least 20 percentage points. Regarding traditional healers, we observe signficant differences compared to self-medication in Burkina Faso, Guinea, and Liberia. While patients of traditional healers in the former countries have a signficiantly lower likelihood of taking antimalarial drugs, traditional healers in Liberia are positively associated with antimalarial drugs use.

Concerning the type of antimalarial drug, the public and private sectors in Ghana (only 2008) stand out in terms of an increased likelihood of good antimalarial treatment (Table A4, lower panel). In this country, public and private hospitals, other public

[18] Note that drug availability in the public sector is indicative for overall drug availability.

facilties, and (pharmaceutical) shops all exhibit a significantly positive coefficient. Except other public facilities in Benin, we find no significant povider effects for other countries. This is surprising since first-line treatment in, for instance, Liberia is free in the public sector, while a fee is charged in Ghana (unless people have health insurance). Perhaps the low relative availability of effective antimalarial drugs in Liberia explains this pattern. Heterogeneity across countries is more pronounced with regard to chloroquine treatment (Table A5, upper panel). A significant higher likelihood of receiving chloroquine compared to self-medication is found in the public sector in Ghana, Guinea (both public hospitals), Burkina Faso, Mali, and Niger (other public faciltities). In Benin, Liberia, and Nigeria public sector patients are as likely to take chloroquine as self-medicating children. In Benin and Liberia, this may be explained by relatively low overall chloroquine utilization rates (Tabel 1). In Nigeria, however, chloroquine use is very common, which is rather indicative of a low quality of public services. In the private sector, children treated by private hospitals are significantly less likely to receive chloroquine only in Ghana and Liberia. Results for other private facilities confirm earlier findings and are not indicative of much heterogeneity across countries (although the country-specific coefficients are not equal at the 5-percent level). Surprisingly, while we found insignificant overall effects of seeking advice of traditional healers, traditional healers seem to discourage (encourage) the use of chloroquine in Nigeria (Ghana).

The effectiveness of health care providers in terms of fever relief is highest in Liberia (Table A5, lower panel). All individual health care provider coefficients are significant and amount to more than 20 percentage points. In fact, there is no significant heterogeneity in the effectiveness across providers (*p*-value 62.4 percent). Hence, irrespective of the type of provider (including tradtional healers), seeking advice for a febrile child at any health care provider is strongly recommendable in Liberia. In the other countries, the difference in fever relief success across health care providers is less pronounced. Public hospitals and other private facilties have an individually significant effect in Ghana and Nigeria. Due to conservative sample sizes, however, we abstain from giving much weight on individually insignificant coefficients in the interpretation of the results.

Development of Treatment Provision in Ghana and Nigeria

For Ghana and Nigeria, we are able to use information on two waves, both from 2003 and 2008. The goal of this exercise is to determine whether there were differences in the effectiveness of the different providers between the two time periods. In both countries, programs to improve access to modern antimalarial drugs were implemented. One way to give an indication of the impact of these programs is to compare the estimates from 2003 to 2008 and see whether there were any improvements. The estimation results are provided in Table A6.

Ghana demonstrated a dramatic improvement across the board while Nigeria presents a rather mixed case. Considering, for instance, the likelihood of receiving antimalarial drugs, the difference between self-treatment and the other providers largely increased between the years 2003 and 2008 for Ghana. Private hospitals (from 0.11 to 0.51 percentage points) and pharmaceutical shops (from 0.18 to 0.39 presentage points) represent the most dramatic increases. In contrast, the corresponding estimates for Nigeria declined in each case. However, the likelihood for traditional healers to provide antimalarial drugs remains to be statistically indistinguishable from self-treatment for both countries over time.

For Ghana, decreases can be observed for the probability of providing chloroquine only to treat fever. For Nigeria in 2008, the likelihood of a traditional healer providing chloroquine only, conditional on providing any antimalarial drug at all, is even higher than self-treatment.

The improvement in Ghana may be explained by the country's effort to address chloroquine-resistant malaria in the country. In fact, the country replaced its own Anti-Malaria Drug Policy with one that was more in line with the World Health Organization's guidelines which not only required presumptive malaria treatment but also encouraged the adoption of artesunate with amodiaquine, an artemisinin-based combination therapy (ACT). Since 2002, taxes were waived on the importation of insecticide-treated bed nets in the country. Its distribution to poorer areas of the country, in particular to pregnant women and children under five, was also subsidized by the state. According to the DHS final report on Ghana for 2008, "Implementation of the new treatment policy began in the last quarter of 2005 with countrywide training of health care providers in both private and public sectors…The [Ghana Health Service] strongly advised caregivers of young children with signs and symptoms of malaria to access treatment at the nearest health facility."

Although a similar program was introduced in Nigeria as well, also in response to the rise of the chloroquine-resistant parasite, the ACT treatment in Nigeria was based on artemether with lumefantrine. Artesunate with amodiaquine (as in Ghana) was the alternative. The government has undertaken steps as well to ensure an increased access to ACT. However, it seems that their efforts were not nearly as successful as Ghana's.

V. Discussion & Conclusion

This paper assesses the quality of treatment provided to children below five years who had fever within the last two weeks by comparing utilization patterns of antimalarial drugs and cure rates. Malaria is the most likely cause of young childrens' illness and presumptive antimalarial treatment is recommended by the WHO and national guidelines. Several country case studies have argued for the importance of looking at differences in the quality of health care providers to understand (ineffective) antimalarial drug usage. We estimate the likelihood of traditional healers, private health care providers, and public health facilities (with self-treatment/self-medication as reference) to administer antimalarial drugs, first-line antimalarial drugs, as well as ineffective antimalarial drugs such as chloroquine in areas of known resistance, and to relieve fever in eight West sub-Saharan African countries.

Our main findings are that, compared to self-treatment, children who seek treatment at public and private hospitals, other public and private facilities, and (pharmaceutical) shops have a significantly higher likelihood to take any antimalarial drug. Traditional healers have no influence on antimalarial drug intake and are significantly less likely to advice antimalarial drug use compared to public and private facilities (including pharmaceutical shops). The largest effect is found for other public facilities: Government-run health centers, government field worker, and other public-sector health points increase the likelihood of antimalarial drug use by 89 percent. This is an important result since our data shows that guardians of children with fever who seek advice are most likely to visit other public facilities.

With respect to receiving good antimalarial treatment (conditional on having received any antimalarial drug), we only observe significant effects for public hospitals and other public facilities. This may be explained by national and international efforts to make artemisinin-based combination therapies available at a large-scale through public channels. As to the probability of taking chloroquine conditional on antimalarial treatment, we find significant effects for public and private hospitals, other public facilities, and (pharmaceutical) shops. For instance, seeking advice at a public hospital reduces the likelihood of chloroquine use by 27 percent compared to self-medication. While other private facilities such as private doctors and private maternity homes do not perform any better than self-treatment in terms of good antimalarial drug and chloroquine use, they are most effective in relieving fever.

Although we cannot claim that the estimates presented in this paper are surely unbiased, we have undertaken considerable effort to rule out confounding factors. On the one hand, we control for a wide range of individual, household, and environmental factors. On the other, we carried out several robustness tests. These include the gradual incorporation of proxy variables for income and the likelihood that the fever episode is due to malaria into our econometric model. Cross-country analyses enable us to examine the extent to which observed provider quality differences capture the effect of prices and drug availability on medical treatment practices.

An endogeneity concern may be that we do not directly observe whether a child actually has malaria. If malaria is associated with a higher chance of both seeking advice at, for instance, public health centers and (effective) antimalarial medication, our estimates will be biased. We are optimistic that this lack of information is not much of a problem for our antimalarial drug regression results for three substantive reasons. First, the presumptive treatment regimen makes these associations irrelevant because all febrile children should have received antimalarial medication. Second, the inclusion of malaria proxy variables such as indicators for access to safe water and bed net usage at night time did at most marginally change the provider coefficients. Even if presumptive treatment had not been in place (an abolishment was advocated in the literature, e.g., by Acremont et al., 2009; new WHO guidelines recommend presumptive treatment only in the absence of diagnostic tests),[19] back of the envelope calculations would still imply that a significantly positive effect of treatment at a certain health care provider on antimalarial drug use is indication of better treatment quality relative to self-treatment.[20] Third, we find similar quality differences across health care providers when we restrict the sample to children who received any antimalarial medication and look at the type of antimalarial drug used. By administering these children antimalarial drugs, health care providers make their assessment of a malaria case explicit, irrespectively of whether it is based on a diagnostic test result or physical appearance. Administering first-line antimalarial drugs is then a definite signal of good quality (and chloroquine use a signal of bad quality).

Of course, these considerations do not apply to our analyses with regard to the fever outcome, wherefore reported differences in fever treatment success across health care providers may be biased. However, we expect an underestimation of the effect since with increasing severity the likelihood of seeking professional care should rise.

Cross-country comparisons of the estimated health care provider effects on antimalarial drug use and currently having fever reveal substantial heterogeneity in the provided

[19] Several studies such as English et al. (2009), Bisoffi et al. (2010), and Graz et al. (2011) have claimed continuation of presumptive treatment practice in febrile children in sub-Saharan Africa.

[20] Brinkmann and Brinkmann (1991) estimate that about 40 percent of all fever cases are due to malaria. Hence, even if the presumptive treatment regimen is not persued, approximately 40 percent of the children in our dataset should receive (effective) antimalarial drugs. However, slightly less than 30 percent of children in the self-medication group actually use any antimalarial drug.

quality of care across countries. Variation across insititutional frameworks allows us to assess whether unobserved price elasticities influence our results. Heterogeneity in the willingness to pay for health care is likely to be associated with provider choice and the likelihood of purchasing (effective) antimalarial drugs as long as these services are not free of charge, i.e., price elastic patients are less likely to seek advice and to buy medical drugs. We do not find indication for this in the data. Liberia and Nigeria (2008) are two countries where both advice and antimalarial drugs are free of charge in the public sector. In one country (Liberia), public facilities perform above average in terms of treatment quality (except good antimalarial drug use). In the other country, they achieve average results. If public providers actually exert no influence on antimalarial drug utilization and our results are mainly driven by price elasticities, we should not find considerable effects for public sector entities in these countries because due to the absence of health care fees individual heterogeneity in the willingness to pay for health care cannot take effect.

Eventually, variation in drug availability within regions may seem to be another source of bias. Consider the case where there is a private health center in the child`s district which has no access to (effective) antimalarial drugs and there is a government health center which provides antimalarial treatment. We would most likely observe differences in actual treatment practices between the two providers even though both had a similar competence. We argue that, in areas of low access to national guidelines' first-line medical treatment, health care providers are responsible for drug availability. It seems awkward to advice the use of a certain drug with explicit knoweldge of no or limited access. This means that we consider drug availability as part of the provider production function. This consideration has influence on the interpretation of our results. Placing health facilities in distant areas, for instance, will only contribute to better malaria control in febrile children if supply of the respective antimalarial drug is granted.

Enormous efforts have been undertaken to improve private sector access to arteminisin-based combination therapies. The Affordable Medicines Facility-malaria (AMFm) managed by the Global Fund to Fight AIDS, Tuberculosis and Malaria represents an effective way to close the ACT-availability gap between the public and private sector. Based on the initial idea of Arrow (2004), AMFm works by negotiating with drug manufacturers to reduce the price of ACTs, and to require that sales prices must be the same for both public and private sector first-line buyers. Tougher et al. (2012) show in several pilots that there were large increases in ACT availability and market share driven mainly by changes in the private for-profit sector.

Our results confirm the need for such initiatives since private sector treatment (including pharmaceutical shops) is not found to be any better than self-medication in terms of first-line ACT compliance. Nevertheless, we are concerned that such instruments do not reach the poorest unless they come along with effective measures to increase advice-seeking rates. In line with our data, Filmer (2005) finds lowest advice-seeking rates among the poorest, and we observe that those who do not seek any treatment have the lowest likelihood to take any antimalarial drug (and conditional on taking such drugs they have the highest likelihood to take the wrong ones). We therefore recommend to complement national and international efforts directed towards the availability of ACTs by measures to improve service utilization among the poor.

As possible instruments demand-side and supply-side performance-based incentives schemes have been suggested in the literature (e.g., Eichler et al., 2009). Rewarding the poorest families for seeking care for their febrile children, on the one hand, and rewarding providers for the use of rapid diagnostic tests and (conditional on a positive test result) to administer ACTs, on the other, seem to be obvious candidates for such interventions. Performance-based provider incentives would have the attractive feature of pushing towards the achievement of higher treatment-seeking rates. There are several ways how a provider may be able to increase the utilization of its services. Service quality is certainly an important lever. At least our cross-country comparison gives indication of the plausible association between service quality and utilization.

VI. Literature

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Appendix

In this appendix, we describe in detail how the relevant variables were constructed from the information available in the Demographic and Health Surveys.

Provider choice

Public hospitals include public polyclinics. Other public facilities include government-run health centers, health posts, mobile clinics, government field worker, and other public-sector health points. Private hospitals include private clinics. Other private facilities include private doctors, private mobile clinics, private maternity homes, private fieldworkers, private fertility clinics, and other private-sector health points. Pharmacies and shops also include markets where drugs may be procured. Traditional healers include drug peddlers and mobile sellers.

Outcome variables

Antimalarial drugs are defined as any drug that is specifically designed to treat malaria. This excludes ibuprofen, paracetamol, and other antibiotics, antipyretics, and antinflammatories. Herbal concoctions and "others" are also not considered to be antimalarial drugs. Antimalarial drugs recommended by national guidelines are considered good antimalarial drugs. Artesunate with amodiaquine was first-line treatment for uncomplicated malaria in Benin, Mali, and Niger at the time of the interviews, while it was artemether with lumefantrine in Ghana, Guinea, and Liberia. In Nigeria, both artemisinin-based combination therapies (ACT) were recommended. National guidelines of Burkina Faso, Ghana (2003), and Nigeria (2003) did not recommend ACTs as first-line treatment although they were, in principle, available at that time and considered as most effective. The good antimalarial indicator is not constructed for countries without ACTs as first-line national guideline treatment or missing information on ACT usage. We also identify those children receiving chloroquine only (and not in combination with any other antimalarial drug). Finally, we identify those children who currently have fever despite having reported a fever episode within the last two weeks.

Region and time indicators

Country-specific region indicators are constructed based on the region and country information available. In total, there are 73 regions distributed over eight countries in our selected sample. In addition, time indicators are also generated based on the year and month of interview. As the different DHS waves occurred at different years for different countries, we believe it is more appropriate to control for the year and month of interview as opposed to the DHS wave. An indicator for a rural region is also included.

Child-related variables

To control for the status—particularly health status—of children, we generated indicators for being the first-born child, the first male child, sex, having had a cough within the last two weeks, and having had diarrhea within the last two weeks. We also include the age (and its square), height-for-age percentile, weight-for-age percentile, and weight-for-height percentile of the child.

Mother-related variables

Variables in relation to the sociodemographic characteristics of the mother include an indicator for illiteracy, occupation (excluding those in the armed forces), highest educational attainment, civil status, and whether she has ever terminated a pregnancy before. The age of the mother is also included.

Income and household size

The household size is included in the control variables. In addition to this, we also proxy for the income status of the household by introducing indicators for the household's position in the wealth index. The wealth index variable is readily available in the DHS dataset and is based on information about household ownership of a number of consumer items such as a television and car; dwelling characteristics such as flooring material; type of drinking water source; toilet facilities; and other characteristics that are related to wealth status. Each of these assets is assigned a factor score generated through principal components analysis. The resulting asset scores are standardized in relation to a standard normal distribution with a mean of zero and a standard deviation of one and are used to create the break points that define wealth quintiles (further datails are available in the DHS manuals). Further property indicators used in the analysis are access to electricity and posession of radio, television, refrigerator, bicycle, motorcycle, and a car.

Environmental factors

To account for the effect of the surroundings of the child, we include indicators for having access to safe water, using a hygienic toilet, having good flooring for the house, having a bed net, and whether the child slept under a bed net the previous night. Safe sources of water are defined as those piped into the dwelling, piped into the yard, sourced from a public tap or standpipe, sourced from a tube well or borehole, sourced from a protected well, sourced from a protected spring, sourced from rainwater, sourced from a tanker truck or from a card with a small tank, or from bottled water or from a sachet. Hygienic toilets are those with a flushing system or ventilated improved pit latrines; composting, bucket, or pan toilets are also considered to be hygienic in this context. Good flooring is defined as those made out of parquet, polished wood, ceramic tiles, terrazzo, cement, woolen or synthetic carpets, and linoleum or rubber carpets.

Treatment of missing values

Where information for the percentile indicators (height-for-age, weight-for-age, and weight-for-height) is not available, we use the mean value for the specific region (pooled over time where there is more than one wave available). For indicator variables related to the income proxies as well as whether the child slept under a bed net the night before, we replaced the variable with a zero whenever it is missing. To control for that, we generated corresponding indicator variables that are equal to 1 whenever such a replacement was performed and 0 otherwise. Note, however, that this is not done for the outcome and treatment variables. Where there are missing values for those two sets of variables, the observation is dropped from the analysis.

Other excluded observations

For a small number of cases with missing information on the following variables, the observations were dropped instead of imputing values: illiteracy of the mother, the child having diarrhea within the last two weeks, the child having a cough within the last two weeks, whether the mother had ever terminated a pregnancy, and whether there is a bed net available for sleeping.

Descriptive statistics

Summary statistics for the most important sociodemographic variables in the analysis are presented in Table A1. The calculations are based on pooled observations over time and across countries.

TABLE A1

MEANS AND STANDARD DEVIATIONS OF CONTROL VARIABLES

Variable	Mean (Standard Deviation)
First child	0.7847
First boy	0.4040
Female	0.4867
Had cough	0.5324
Had diarrhea	0.3024
Illiterate	0.7963
Married	0.9426
Ever terminated a pregnancy	0.1805
Access to safe water	0.4676
Hygienic toilet	0.2863
Good house flooring	0.4112
Has bed net for sleeping	0.4698
Child slept under bed net	0.2656
Wealth index (poorest)	0.2354
Wealth index (poorer)	0.2197
Wealth index (middle)	0.2160
Wealth index (richer)	0.1923
Wealth index (richest)	0.1367
Has electricity	0.1599
Has radio	0.6860
Has television	0.1689
Has refrigerator	0.0571
Has bicycle	0.4395
Has motorcycle	0.2403
Has car	0.0402
Occupation (not working)	0.2009
Occupation (professional/technical/managerial)	0.0142
Occupation (clerical)	0.0032
Occupation (sales)	0.2723
Occupation (agricultural, self-employed)	0.3203
Occupation (agricultural)	0.0370
Occupation (household and domestic)	0.0034
Occupation (services)	0.0130
Occupation (skilled manual)	0.0626
Occupation (unskilled manual)	0.0080
Education (no education)	0.6964
Education (incomplete primary)	0.1218
Education (complete primary)	0.0529
Education (incomplete secondary)	0.0840
Education (complete secondary)	0.0327
Education (higher)	0.0122
Rural area	0.7439
Child's age (s.d.)	1.6865 (1.3280)
Mother's age (s.d.)	29.3171 (7.1285)
Height-for-age percentile	21.4500 (26.3941)
Weight-for-age percentile	18.5813 (22.8572)
Weight-for-height percentile	33.5048 (27.3058)
Observations	19267

NOTES: The regional, interview year, and interview month identifiers are excluded from the summary statistics. Standard deviations are reported only for the continuous variables. Statistics are based on the sample before exclusion of observations outside the common support. SOURCE: Authors' own calculation based on the DHS.

TABLE A2
COMPREHENSIVE ESTIMATION RESULTS

	Antimalarial		Good antimalarial		Chloroquine only		Has fever now	
Public hospital	0.3499***	(0.0157)	0.0489**	(0.0185)	-0.0812***	(0.0189)	-0.0570***	(0.0152)
Other public facility	0.4191***	(0.00892)	0.0336***	(0.0092)	-0.0691***	(0.0133)	-0.0326***	(0.00912)
Private hospital	0.3474***	(0.0187)	0.0054	(0.0160)	-0.0804***	(0.0208)	-0.0470*	(0.0185)
Other private facility	0.2817***	(0.0145)	-0.0038	(0.0109)	-0.0013	(0.0205)	-0.0887***	(0.0140)
Pharmacy/shop	0.1645***	(0.0114)	-0.0083	(0.0139)	-0.0639***	(0.0174)	-0.0462***	(0.0110)
Traditional healer	-0.0079	(0.0127)	0.0059	(0.0115)	-0.0098	(0.0221)	-0.0218	(0.0129)
First child	0.0190	(0.0132)	-0.0078	(0.0140)	-0.0225	(0.0179)	-0.0174	(0.0129)
First boy	-0.0158	(0.0163)	0.0028	(0.0170)	-0.0134	(0.0229)	-0.0100	(0.0162)
Female	-0.0232	(0.0145)	0.0088	(0.0149)	0.0030	(0.0204)	-0.0229	(0.0144)
Had cough	-0.0142*	(0.0070)	0.0061	(0.0075)	-0.0265**	(0.0096)	0.0678***	(0.0069)
Had diarrhea	0.0022	(0.0074)	-0.0103	(0.0093)	0.0137	(0.0105)	0.0744***	(0.0076)
Illiterate	-0.0227	(0.0147)	0.0157	(0.0140)	0.0172	(0.0185)	0.0184	(0.0138)
Married	-0.0007	(0.0152)	-0.0109	(0.0176)	-0.0044	(0.0186)	-0.0159	(0.0148)
Ever termin. a pregnancy	-0.0052	(0.0089)	0.0097	(0.0096)	-0.0088	(0.0118)	-0.0004	(0.0088)
Access to safe water	0.0045	(0.0081)	-0.0162	(0.0083)	-0.0401***	(0.0115)	-0.0093	(0.0081)
Hygienic toilet	0.0110	(0.0091)	0.0312*	(0.0129)	-0.0302*	(0.0124)	-0.0076	(0.0091)
Good house flooring	0.0109	(0.0102)	-0.0332**	(0.0112)	-0.0479***	(0.0138)	-0.0170	(0.0102)
Has bed net for sleeping	0.0046	(0.0095)	-0.0012	(0.0126)	-0.0142	(0.0134)	0.0011	(0.0095)
Child slept under bed net	0.0130	(0.0105)	0.0035	(0.0127)	-0.0308*	(0.0147)	-0.0109	(0.0103)
Wealth index (poorest)	0.0263*	(0.0104)	0.0075	(0.0119)	0.0011	(0.0166)	-0.0091	(0.0109)
Wealth index (poorer)	0.0424***	(0.0123)	0.0378*	(0.0150)	0.0032	(0.0185)	0.0047	(0.0126)
Wealth index (middle)	0.0839***	(0.0151)	0.0148	(0.0185)	-0.0096	(0.0217)	0.0004	(0.0152)
Wealth index (richer)	0.0971***	(0.0215)	-0.0078	(0.0258)	-0.0169	(0.0296)	-0.0009	(0.0211)
Wealth index (richest)	-0.0110	(0.0137)	0.0369	(0.0210)	-0.0326	(0.0180)	-0.0023	(0.0131)
Has electricity	-0.0110	(0.0137)	0.0369	(0.0210)	-0.0326	(0.0180)	-0.0023	(0.0131)
Has radio	0.0114	(0.0085)	-0.0006	(0.0094)	0.0044	(0.0121)	-0.0006	(0.0086)
Has television	-0.0078	(0.0134)	0.0101	(0.0132)	-0.0035	(0.0165)	-0.0108	(0.0128)
Has refrigerator	-0.0669***	(0.0191)	0.0130	(0.0226)	-0.0008	(0.0218)	-0.0230	(0.0169)
Has bicycle	-0.0032	(0.0085)	-0.00002	(0.0079)	0.0234*	(0.0117)	0.0117	(0.0084)
Has motorcycle	-0.0006	(0.0092)	-0.0064	(0.0079)	-0.0072	(0.0123)	0.0181*	(0.0091)
Has car	0.0024	(0.0194)	0.0550*	(0.0222)	-0.0110	(0.0237)	-0.0046	(0.0174)
Occup. (prof/...)	0.0166	(0.0337)	0.0296	(0.0363)	0.0536	(0.0341)	-0.0428	(0.0293)
Occup. (clerical)	-0.0702	(0.0650)	-0.0054	(0.0590)	0.0729	(0.0952)	0.0348	(0.0555)
Occup. (sales)	0.0174	(0.0099)	0.0119	(0.0111)	0.0126	(0.0138)	-0.0045	(0.0098)
Occup. (agr. self-empl.)	0.0057	(0.0116)	-0.0014	(0.0135)	0.0332*	(0.0162)	-0.0250*	(0.0117)
Occup. (agric.)	0.0169	(0.0202)	0.0490*	(0.0227)	0.0481	(0.0349)	0.0233	(0.0220)
Occup. (hh, domestic)	0.0495	(0.0638)	0.2594	(0.3630)	0.1957*	(0.0976)	-0.0220	(0.0651)
Occup. (services)	0.0244	(0.0301)	0.0065	(0.0428)	-0.0091	(0.0397)	-0.0081	(0.0294)
Occup. (skilled manual)	0.0199	(0.0146)	0.0167	(0.0169)	0.0132	(0.0212)	-0.0159	(0.0147)
Occup. (unskilled manual)	-0.0287	(0.0388)	-0.0438**	(0.0168)	-0.0894*	(0.0373)	-0.0654	(0.0356)
Educ. (incompl. primary)	-0.0060	(0.0119)	-0.0088	(0.0114)	-0.0234	(0.0153)	-0.0173	(0.0115)
Educ. (compl. primary)	0.0008	(0.0185)	0.0043	(0.0207)	-0.0432	(0.0260)	-0.0281	(0.0181)
Educ. (incompl. second.)	0.0009	(0.0199)	0.0022	(0.0201)	-0.0293	(0.0242)	0.0005	(0.0187)
Educ. (compl. sec.)	0.0478	(0.0279)	0.0698*	(0.0290)	-0.0687*	(0.0332)	-0.0430	(0.0254)
Educ. (higher)	0.0711	(0.0400)	0.0806	(0.0447)	-0.0753	(0.0478)	-0.0095	(0.0378)
Rural area	0.0004	(0.0102)	-0.0121	(0.0096)	0.0290*	(0.0131)	0.0143	(0.0100)
Child's age	0.0380***	(0.0085)	0.0129	(0.0093)	-0.0379**	(0.0119)	-0.0171*	(0.0085)
Child's age (sqaure)	-0.0061**	(0.0021)	-0.0035	(0.0023)	0.0066*	(0.0030)	-0.0004	(0.0021)
Mother's age	0.0003	(0.0005)	0.0001	(0.0006)	0.0001	(0.0007)	0.0009	(0.0005)
Height-for-age percentile	0.0004*	(0.0002)	-0.0001	(0.0003)	-0.0000	(0.0002)	-0.0002	(0.0002)
Weight-for-age percentile	-0.0007*	(0.0003)	0.0001	(0.0003)	0.0002	(0.0004)	-0.0000	(0.0002)
Weight-for-height perc.	0.0004*	(0.0002)	-0.0001	(0.0002)	-0.0002	(0.0003)	-0.0011***	(0.0002)
Constant	0.2724***	(0.0729)	0.0912	(0.0671)	0.6100**	(0.0906)	0.3546***	(0.0694)
Observations	18069		4305		8593		18069	

NOTES: Regression results are based on the full model specification. Results for dummy variables with respect to region, time (interview year and month), and missing values are omitted. * significant at 5%, ** significant at 1%, *** significant at 0.1%. Robust standard errors in parentheses. We have no information available on whether good antimalarial drugs were provided in Burkina Faso, Guinea, Mali, and Niger. For Ghana and Nigeria, good antimalarial drug refers to the year 2008 only.

TABLE A3
ESTIMATION RESULTS BY WEALTH INDEX

	Poorest	Poorer	Middle	Richer	Richest
Antimalarial					
Public hospital	0.3955***	0.4849***	0.3712***	0.2973***	0.1473***
	(0.0392)	(0.0362)	(0.0364)	(0.0331)	(0.0366)
Other public facility	0.4867***	0.4576***	0.4132***	0.3991***	0.2504***
	(0.0198)	(0.0192)	(0.0189)	(0.0201)	(0.0260)
Private hospital	0.4589***	0.4272***	0.3482***	0.3298***	0.1704***
	(0.0520)	(0.0537)	(0.0452)	(0.0356)	(0.0382)
Other private facility	0.3109***	0.3719***	0.2657***	0.2131***	0.1451***
	(0.0294)	(0.0303)	(0.0324)	(0.0349)	(0.0405)
Pharmacy/shop	0.2073***	0.2187***	0.1472***	0.1335***	−0.0026
	(0.0211)	(0.0233)	(0.0262)	(0.0284)	(0.0356)
Traditional healer	0.0251	0.0135	−0.0840**	−0.0066	−0.0219
	(0.0229)	(0.0254)	(0.0266)	(0.0349)	(0.0490)
Observations	4127	3937	3853	3563	2589
Good antimalarial					
Public hospital	0.0497	0.0709	0.0122	0.0561	0.0798
	(0.0650)	(0.0364)	(0.0379)	(0.0347)	(0.0494)
Other public facility	0.0098	0.0692***	0.0349	0.0261	0.0651*
	(0.0206)	(0.0200)	(0.0214)	(0.0191)	(0.0304)
Private hospital	−0.0022	0.0138	−0.0400	0.0099	0.0399
	(0.0444)	(0.0478)	(0.0412)	(0.0313)	(0.0366)
Other private facility	−0.0373	0.0052	−0.0178	0.0094	−0.0044
	(0.0236)	(0.0252)	(0.0237)	(0.0260)	(0.0255)
Pharmacy/shop	−0.0476	0.0632*	−0.0536	0.0258	−0.0021
	(0.0281)	(0.0317)	(0.0375)	(0.0302)	(0.0321)
Traditional healer	−0.0303	0.0197	0.0156	0.0378	−0.0356
	(0.0291)	(0.0239)	(0.0237)	(0.0237)	(0.0301)
Observations	823	909	981	972	620
Chloroquine only					
Public hospital	−0.1529**	−0.0190	−0.1669***	−0.0794*	−0.0109
	(0.0555)	(0.0512)	(0.0427)	(0.0384)	(0.0399)
Other public facility	−0.0600	−0.0819*	−0.0694*	−0.0889**	−0.0277
	(0.0342)	(0.0324)	(0.0286)	(0.0276)	(0.0319)
Private hospital	−0.1132	−0.0695	−0.0833	−0.1457***	−0.0244
	(0.0714)	(0.0644)	(0.0525)	(0.0365)	(0.0421)
Other private facility	−0.0347	0.0765	−0.0006	−0.0717	−0.0209
	(0.0503)	(0.0478)	(0.0469)	(0.0440)	(0.0479)
Pharmacy/shop	−0.0595	−0.0743	−0.0792*	−0.0916*	0.0113
	(0.0438)	(0.0409)	(0.0385)	(0.0364)	(0.0455)
Traditional healer	−0.0471	0.0847	−0.0087	−0.0057	−0.0214
	(0.0491)	(0.0502)	(0.0494)	(0.0486)	(0.0584)
Observations	1531	1689	1887	1964	1522
Has fever now					
Public hospital	−0.0811*	−0.0532	−0.0737*	−0.0838**	0.0159
	(0.0397)	(0.0386)	(0.0372)	(0.0312)	(0.0323)
Other public facility	−0.0525*	−0.0269	−0.0121	−0.0243	−0.0262
	(0.0206)	(0.0200)	(0.0203)	(0.0209)	(0.0231)
Private hospital	0.1146	−0.0903	−0.0752	−0.0871*	−0.0070
	(0.0611)	(0.0514)	(0.0452)	(0.0361)	(0.0344)
Other private facility	−0.1324***	−0.0665*	−0.0968**	−0.0817*	−0.0339
	(0.0292)	(0.0312)	(0.0311)	(0.0334)	(0.0367)
Pharmacy/shop	−0.0214	−0.0600*	−0.0614*	−0.0564*	−0.0202
	(0.0220)	(0.0233)	(0.0252)	(0.0266)	(0.0302)
Traditional healer	−0.0210	−0.0006	−0.0215	−0.0216	−0.0056
	(0.0247)	(0.0270)	(0.0283)	(0.0321)	(0.0422)
Observations	4127	3937	3853	3563	2589

NOTES: Regression results are based on the full model specification. * significant at 5%, ** significant at 1%, *** significant at 0.1%. Robust standard errors in parentheses. We have no information available on whether good antimalarial drugs were provided in Burkina Faso, Guinea, Mali, and Niger. For Ghana and Nigeria, good antimalarial drug refers to the year 2008 only.

TABLE A4

PROVIDER DIFFERENCES BY COUNTRY (ANTIMALARIAL)

	Burkina Faso	Benin	Ghana	Guinea	Liberia	Mali	Nigeria	Niger
Antimalarial								
Public hospital	0.2077**	0.2499***	0.3547***	0.5685***	0.6023***	0.3814***	0.3000***	0.3004***
	(0.0718)	(0.0466)	(0.0402)	(0.0645)	(0.0423)	(0.1148)	(0.0257)	(0.0813)
Other public facility	0.3552***	0.4088***	0.2749***	0.5317***	0.4976***	0.4229***	0.4151***	0.5398***
	(0.0207)	(0.0191)	(0.0422)	(0.0284)	(0.0348)	(0.0288)	(0.0224)	(0.0263)
Private hospital	0.5441***	0.2618***	0.2804***	0.5640***	0.5472***	0.3591**	0.3494***	0.3172**
	(0.0433)	(0.0372)	(0.0697)	(0.1231)	(0.0456)	(0.1217)	(0.0324)	(0.1081)
Other private facility	0.0639	0.3752***	0.1489	0.3366***	0.5429***	0.2165*	0.2607***	0.2340***
	(0.1028)	(0.0285)	(0.1239)	(0.0905)	(0.0541)	(0.0865)	(0.0226)	(0.0340)
Pharmacy/shop	0.1461***	0.0311	0.2343***	0.2631***	0.3683***	0.1995**	0.1917***	0.1318***
	(0.0364)	(0.0279)	(0.0417)	(0.0368)	(0.0446)	(0.0616)	(0.0193)	(0.0322)
Traditional Healer	–0.1585***	0.0113	0.0326	–0.0869*	0.1266*	0.0263	–0.0603	0.0708
	(0.0363)	(0.0238)	(0.0698)	(0.0377)	(0.0520)	(0.0284)	(0.0317)	(0.0569)
Observations	2482	3661	1144	1438	1372	1710	4413	1849
Good antimalarial								
Public hospital	–	0.0094	0.2957*	–	0.0302	–	0.0556	–
		(0.0098)	(0.1457)		(0.0636)		(0.0313)	
Other public facility	–	0.0148***	0.3561*	–	–0.0048	–	0.0326	–
		(0.0044)	(0.1439)		(0.0581)		(0.0238)	
Private hospital	–	–0.0010	0.3937*	–	–0.0714	–	0.0056	–
		(0.0036)	(0.1752)		(0.0631)		(0.0334)	
Other private facility	–	–0.0018	0.2984	–	–0.0729	–	–0.0100	–
		(0.0027)	(0.2698)		(0.0716)		(0.0207)	
Pharmacy/shop	–	–0.0035	0.3710*	–	–0.1132	–	0.0232	–
		(0.0031)	(0.1449)		(0.0632)		(0.0292)	
Traditional Healer	–	0.0068	0.0758	–	–0.0976	–	–0.0313	–
		(0.0069)	(0.2885)		(0.0842)		(0.0278)	
Observations		2108	209		786		1202	

NOTES: Regression results are based on the full model specification. * significant at 5%, ** significant at 1%, *** significant at 0.1%. Robust standard errors in parentheses. We have no information available on whether good antimalarial drugs were provided in Burkina Faso, Guinea, Mali, and Niger. For Ghana and Nigeria, the information on good antimalarial drugs refers to the year 2008.

TABLE A5
PROVIDER DIFFERENCES BY COUNTRY (CHLOROQUINE, FEVER)

	Burkina Faso	Benin	Ghana	Guinea	Liberia	Mali	Nigeria	Niger
Chloroquine only								
Public hospital	−0.1288	0.0401	−0.1106*	−0.1424*	−0.0635	−0.1243	−0.0792	0.0676
	(0.0812)	(0.0444)	(0.0543)	(0.0663)	(0.0579)	(0.1296)	(0.0424)	(0.1220)
Other public facility	−0.1149***	0.0416	−0.0982	−0.0853	0.0006	−0.1145*	−0.0513	−0.1583**
	(0.0295)	(0.0228)	(0.0588)	(0.0438)	(0.0535)	(0.0494)	(0.0399)	(0.0595)
Private hospital	−0.0380	−0.0494	−0.1933**	−0.0985	−0.0023	−0.2507**	−0.0288	0.0532
	(0.1787)	(0.0350)	(0.0664)	(0.0766)	(0.0574)	(0.0886)	(0.0487)	(0.1526)
Other private facility	0.1932	−0.0148	−0.0919	−0.1811	0.0135	−0.0372	0.0422	−0.0700
	(0.1240)	(0.0326)	(0.0914)	(0.1107)	(0.0702)	(0.1259)	(0.0434)	(0.0716)
Pharmacy/shop	−0.0142	−0.0204	−0.0864	−0.1194*	0.0142	−0.1438	−0.0520	−0.0282
	(0.0563)	(0.0327)	(0.0552)	(0.0552)	(0.0624)	(0.0893)	(0.0424)	(0.0797)
Traditional Healer	0.0267	0.0230	−0.0766	−0.1331	−0.1061	0.1318	0.2899*	−0.3943**
	(0.1001)	(0.0279)	(0.1027)	(0.1148)	(0.0768)	(0.0690)	(0.1245)	(0.1196)
Observations	1361	2108	663	648	786	628	1723	676
Has fever now								
Public hospital	−0.0052	−0.0378	−0.1057*	−0.1168	−0.2447***	−0.0222	−0.0571*	0.0916
	(0.0595)	(0.0429)	(0.0417)	(0.0686)	(0.0481)	(0.0922)	(0.0261)	(0.0659)
Other public facility	0.0144	−0.0249	−0.0598	−0.0290	−0.2952***	−0.0336	−0.0245	0.0211
	(0.0207)	(0.0196)	(0.0439)	(0.0319)	(0.0364)	(0.0290)	(0.0244)	(0.0252)
Private hospital	−0.1215	0.0202	−0.1017	−0.0619	−0.2296***	−0.1017	−0.0700*	−0.0167
	(0.1103)	(0.0376)	(0.0662)	(0.1254)	(0.0483)	(0.1026)	(0.0326)	(0.0743)
Other private facility	−0.1218	−0.0478	−0.2262**	0.0207	−0.2885***	−0.0854	−0.1042***	−0.0372
	(0.0639)	(0.0324)	(0.0799)	(0.0876)	(0.0544)	(0.0730)	(0.0242)	(0.0284)
Pharmacy/shop	−0.0254	−0.0398	−0.0494	−0.0519	−0.2563***	−0.0285	−0.0381	−0.0202
	(0.0350)	(0.0238)	(0.0417)	(0.0365)	(0.0450)	(0.0601)	(0.0218)	(0.0293)
Traditional Healer	0.0192	0.0212	−0.1883**	−0.0228	−0.2869***	−0.0097	−0.0117	−0.0401
	(0.0406)	(0.0220)	(0.0661)	(0.0463)	(0.0488)	(0.0299)	(0.0440)	(0.0558)
Observations	2482	3661	1144	1438	1372	1710	4413	1849

NOTES: Regression results are based on the full model specification. * significant at 5%, ** significant at 1%, *** significant at 0.1%. Robust standard errors in parentheses.

TABLE A6

ESTIMATION RESULTS FOR GHANA AND NIGERIA FOR 2003 AND 2008

	Ghana		Nigeria	
	2003	2008	2003	2008
Antimalarial				
Public hospital	0.3148***	0.4408***	0.4260***	0.2573***
	(0.0536)	(0.0656)	(0.0460)	(0.0307)
Other public facility	0.2298***	0.3370***	0.5438***	0.3893***
	(0.0599)	(0.0632)	(0.0455)	(0.0257)
Private hospital	0.1119	0.5108***	0.5288***	0.3081***
	(0.0941)	(0.1051)	(0.0593)	(0.0385)
Other private facility	0.0099	0.3446*	0.3694***	0.2398***
	(0.1751)	(0.1435)	(0.1064)	(0.0238)
Pharmacy/shop	0.1682**	0.3933***	0.3010***	0.1434***
	(0.0572)	(0.0745)	(0.0318)	(0.0245)
Traditional healer	0.0064	0.0224	–0.0739	–0.0190
	(0.1161)	(0.1005)	(0.0456)	(0.0449)
Observations	664	480	1231	3182
Good antimalarial				
Public hospital	–	0.2775***	–	0.0446**
		(0.0559)		(0.0140)
Other public facility	–	0.2343***	–	0.0379***
		(0.0535)		(0.0108)
Private hospital	–	0.3514***	–	0.0318
		(0.0955)		(0.0172)
Other private facility	–	0.1385	–	0.0106
		(0.1054)		(0.0061)
Pharmacy/shop	–	0.2158***	–	0.0111
		(0.0627)		(0.0079)
Traditional healer	–	0.0260	–	–0.0074
		(0.0611)		(0.0051)
Observations		408	517	3182
Chloroquine only				
Public hospital	–0.0458	–0.2404*	–0.0782	–0.0925
	(0.0706)	(0.0992)	(0.0966)	(0.0492)
Other public facility	–0.0684	–0.1970	–0.1153	–0.0530
	(0.0749)	(0.1007)	(0.0970)	(0.0452)
Private hospital	–0.1178	–0.2316*	0.0673	–0.0772
	(0.1202)	(0.0903)	(0.1121)	(0.0557)
Other private facility	–0.0285	–0.1583	–0.0590	0.0472
	(0.1654)	(0.1190)	(0.1518)	(0.0463)
Pharmacy/shop	–0.0071	–0.1838	–0.0624	–0.0466
	(0.0685)	(0.1002)	(0.0903)	(0.0544)
Traditional healer	0.0441	–0.2748*	0.3600	0.3090*
	(0.1432)	(0.1206)	(0.3041)	(0.1430)
Observations	454	209	521	1202
Has fever now				
Public hospital	–0.1308*	–0.1214	0.0703	–0.0950**
	(0.0554)	(0.0677)	(0.0485)	(0.0312)
Other public facility	–0.0310	–0.1046	0.1007*	–0.0579*
	(0.0631)	(0.0656)	(0.0479)	(0.0281)
Private hospital	–0.1569	–0.1091	–0.0164	–0.0768
	(0.0931)	(0.0932)	(0.0584)	(0.0404)
Other private facility	–0.2909*	–0.1464	0.0158	–0.1068***
	(0.1359)	(0.1145)	(0.0977)	(0.0257)
Pharmacy/shop	–0.0895	–0.0721	0.0226	–0.0575*
	(0.0574)	(0.0729)	(0.0368)	(0.0284)
Traditional healer	–0.1734	–0.2645**	0.0844	–0.0294
	(0.1047)	(0.0955)	(0.0700)	(0.0585)
Observations	664	480	1231	3182

NOTES: Regression results are based on the full model specification. * significant at 5%, ** significant at 1%, *** significant at 0.1%. Robust standard errors in parentheses. We have information available on good antimalarial drugs in year 2008 only.

TABLE A7
COUNTRY PROFILES

Country	Year	CQ Resistance	First-line Treatment$	Free ACT!	Free Diag-nosis!	Antimal. Coverage (Percent)!+	ACT Coverage (Percent)!+
Burkina Faso	2003	yes	no ACT	no	no	422	33 (2007)
Benin	2006	yes	AL	no	no	342 (2008)	0.5
Ghana	2003	yes	no ACT	no	no	91 (2006)	91 (2006)
Ghana	2008	yes	AS+AQ	no	no	246	246
Guinea	2005	yes	AS+AQ	no	no	160 (2009)	160 (2009)
Liberia	2006/2007	yes	AS+AQ	yes	yes	–	64
Mali	2006	yes	AL	yes	no	272 (2008)	272 (2008)
Niger	2006	yes	AL	yes	no	74	74
Nigeria	2003	yes	no ACT	no	no	66	0 (2004)
Nigeria	2008	yes	AL/ AS + AQ	yes	yes	584	292

NOTES: Artemisinin Combination Therapy (ACT); $ Chloroquine (CQ), artemether-lumifantrine (AL), Artesunate (AS), Amodiaquine (AQ); ! This information applies to the public sector. + Year of closest available data in parenthesis. The number of antimalarial treatment courses (ACT courses) delivered to public sector health facilities divided by the number of reported malaria cases (falsiparum malaria cases) attending public sector health facilities times 100. SOURCE: WHO World Malaria Report 2012, 2010, 2008.

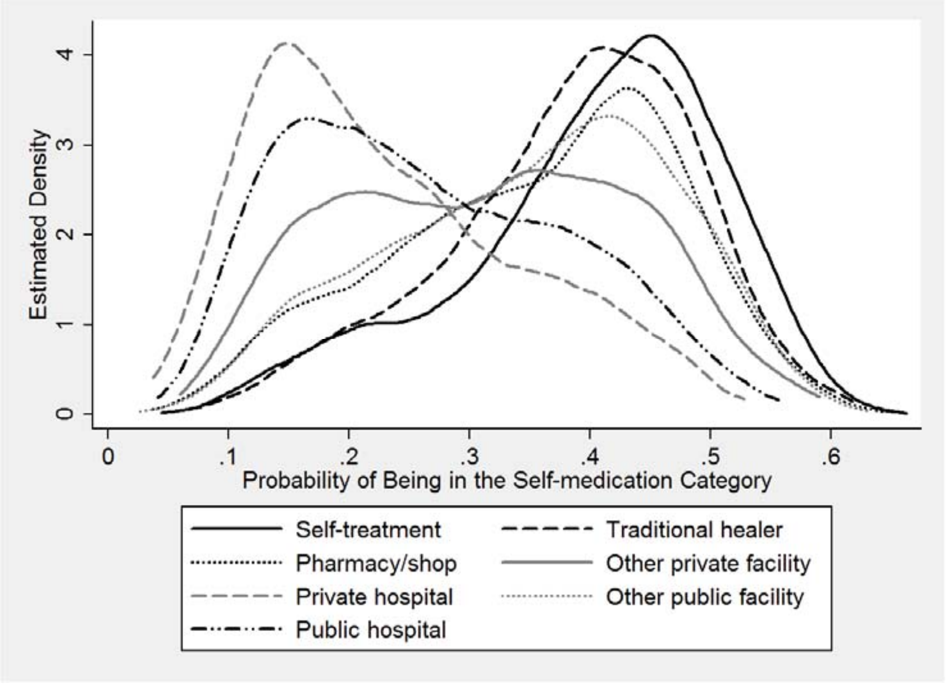

FIGURE A1
ESTIMATED PROBABILITY TO SELF-MEDICATE BY HEALTH CARE PROVIDER CATEGORY