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Progress toward elimination of malaria in Nigeria: Uptake of artemisinin-based combination therapies for the treatment of malaria in households in Benin City

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Abstract

Background: The Roll Back Malaria (RBM) Partnership converged in Abuja in 2000. In 2005, Nigeria adopted artemisinin-based combination therapies (ACTs) as first-line therapy for uncomplicated malaria. It was determined that by 2010, 80% of persons with malaria would be effectively treated.

Objectives: To describe household practices for malaria treatment in Benin City; to explore demographic characteristics that may influence use of ACTs.

Materials and Methods: Multistage sampling technique was used to select households from each of the three local government areas in Benin City. Adult respondents were interviewed. Household reference persons (HRPs) were defined by International Labour Organization categories. Data were collected between December 2009 and February 2010 and were analyzed using Statistical Package for the Social Sciences Version 16.0, at a significance level of $P < 0.05$ (2-tailed).

Results: Of the 240 households selected, 217 were accessible, and respondents from 90% of these recalled the most recent episode (s) of malaria. One-third of malaria episodes had occurred in children younger than 5 years. ACTs were used in 4.9% of households; sulfadoxine-pyrimethamine was the chief non-ACT antimalarial, followed by artemisinin monotherapies. Patent medicine stores were the most common sources of antimalarial medicines (38.2%), followed by private hospitals (20.3%) and private pharmacies (10.6%). Only 8.3% of households got their medicines from government hospitals. Having a HRP in managerial or professional categories was associated with a 6 times higher odds of using ACTs, compared to other occupational categories [odds ratio (OR) 5.8; confidence interval (CI) 1.470–20.758, $P = 0.016$]. Fathers' tertiary or higher education was significantly associated with ACT use, but not mothers' (OR 0.054, CI 0.006–0.510; $P = 0.011$ and OR 0.905, CI 0.195–4.198; $P = 0.898$, respectively).

Conclusion: Ten years after the historic Abuja meeting, only 5% of households in Benin City used ACTs for the treatment of malaria, sourcing medicines chiefly from patent medicine stores and private hospitals. Fathers' level of education was significantly associated with ACT use. Interventions to eliminate malaria from Nigeria should mainstream the men folk and health care providers outside government hospitals, in line with the Nigerian reality.

Keywords: Artemisinin-based combination therapy, Benin City, households, malaria

Résumé

Fond: Le partenariat Roll Back Malaria (RBM) ont convergé à Abuja en 2000. En 2005, le Nigeria a adopté thérapies de combinaison à base d'artémisinine (Act) comme traitement de première intention contre le paludisme sans complications. Il a été déterminé que d'ici 2010, 80 % des personnes atteintes de paludisme serait effectivement traité.

Objectifs: Pour décrire les pratiques domestiques pour le traitement du paludisme à Benin City ; pour explorer les données démographiques qui peuvent influencer l'utilisation des Act.

Matériel et Méthodes: Technique d'échantillonnage Multistage a été utilisé pour sélectionner des ménages dans chacune des trois zones de gouvernement local à Benin City. Répondants adultes ont été interrogés. Personnes de référence domestique (HRPs) ont été définies par catégories de l'Organisation internationale du travail. Données ont été recueillies entre décembre 2009 et février 2010 et ont été analysées à l'aide de logiciel de statistiques pour la Sciences sociales Version 16.0, à un niveau de signification de $P < 0,05$ (2 à queue).

Résultats: De la 240 ménages sélectionnés, 217 étaient accessibles, et 90 % de ces répondants a rappelé les dernières épisodes de paludisme. Un tiers des épisodes de paludisme chez les enfants âgés de moins de 5 ans avait eu lieu. Actes servaient à 4,9 % des ménages ; sulfadoxine-pyriméthamine était le chef antipaludique de non-agir, suivie de l'artémisinine en monothérapie. Magasins de médicaments brevetés ont été les sources les plus courantes de médicaments antipaludiques (38,2 %), suivis des hôpitaux privés (20,3 %) et les pharmacies privées (10,6 %). Seulement 8,3 % des ménages obtenu leurs médicaments des hôpitaux publics. Avec un HRP dans des catégories de cadres ou professionnels a été associée à un 6 fois plus de chances d'utiliser les lois, par rapport aux autres catégories professionnelles [rapport de cotes (RC) 5,8 ; intervalle de confiance (IC) 1,470 – 20.758, $P = 0,016$]. Tertiaire ou l'enseignement supérieur des pères était significativement associée à la Loi sur l'utilisation, mais pas des mères (ou 0,054, CI 0,006 – 0,510 ; $P = 0,011$ et ou 0,905, CI 0,195-4.198 ; $P = 0,898$, respectivement).

Conclusion: Dix ans après la réunion d'Abuja historique, seulement 5 % des ménages à Benin City utilisé agit pour le traitement du paludisme, approvisionnement en médicaments principalement de médicaments brevetés magasins et hôpitaux privés. Niveau des pères de l'éducation était significativement associée à la Loi sur l'utilisation. Interventions visant à éliminer le paludisme du Nigeria doit intégrer les hommes et les dispensateurs de soins en dehors des hôpitaux publics, conforme à la réalité nigériane.

Mots-clés: Ménages de thérapie, ville du Bénin, de combinaison à base d'artémisinine, le paludisme

Introduction

The year 2000 has gone down in history as the year in which the most influential alliance (till date) in efforts to eradicate malaria converged in Abuja, Nigeria. That was the Roll Back Malaria (RBM) Partnership, and the targets set have come to be known as the "Abuja Targets".^[1,2] One of the goals set by the RBM Partnership was that by 2010, 80% of patients with malaria would be diagnosed and treated with effective antimalarial medicines.^[3]

Over 1 decade later, malaria remains a public health concern in the world's poorest countries, Nigeria chief among them.^[4] As at 2010, deaths from malaria in Nigeria were the highest recorded worldwide.^[5] In 2005, artemisinin-based combination therapies (ACTs) were adopted as the first-line treatment for uncomplicated malaria in Nigeria.^[6,7] This policy change was in line with global trends^[8] and was hinged on demonstrated advantages of ACTs over chloroquine and sulfadoxine-pyrimethamine, including superior parasite clearance in persons infested with plasmodium species. ACTs have also been shown to reduce infectivity of mosquitoes and parasite transmission.^[6,7,9]

Appropriate case management of malaria is crucial for malaria control.^[10] Inappropriate treatments result in treatment failures, increased morbidity and mortality, spread of drug resistance,^[11] and myriad socioeconomic consequences.^[12] Inappropriate

case management also fosters the preservation of parasite reservoirs that contribute to continual malaria transmission.^[12,13] On the contrary, prompt and appropriate treatment of malaria decreases morbidity and mortality, and economic losses from malaria, which is estimated to be about 134 billion Naira (906 million U.S. dollars) annually.^[12] The likelihoods of complications and the emergence of resistance to antimalarial medicines are also reduced with appropriate case management using ACTs.^[4,14,15]

ACTs are much more expensive than chloroquine, 5-20 times more expensive, by some estimates.^[16] In Nigeria, over 90% of private health care costs are paid for out-of-pocket.^[17] Sadly too, over two-thirds of Nigerians lives on less than one U.S. dollar a day.^[17] In some circumstances, basic necessities of living have to be given up for health care.^[18] Thus, uptake of ACTs as first-line therapy for malaria may be hindered by economic barriers.^[19]

The national policy stipulating that ACTs should be used as first-line therapy for uncomplicated malaria has not delivered the expected changes in treatment practices. There is evidence that chloroquine and sulfadoxine-pyrimethamine are still the preferred medicines for the treatment of malaria in Nigeria.^[4,20,21] Apart from high costs, other factors that are known to contribute to the poor uptake of ACTs include frequent stock outs in public health facilities and low awareness of national treatment guidelines by health workers and the general public.^[4]

In recognition of the failure to achieve the Abuja Targets, due partly to gaps in access to treatment, the government of Nigeria instituted interventions including a redefinition of goals, and Home-based Management of Malaria using Community Medicine Distributors (CMDs).^[22-24] At the end of December 2010, the National Malaria Control Strategic Plan shifted the set date for the achievement of its redefined goals to 2013.^[4] One of these goals is that by the end of 2013, at least 80% of patients attending any health facility would get appropriate testing and treatment for malaria according to national guidelines.^[4]

Household surveys evaluating the uptake of interventions to eliminate malaria do not usually include questions on malaria treatment.^[25] This study was undertaken to evaluate the success (or otherwise) of the National Malaria Control Program's scale up of interventions to improve malaria therapy, from the perspective of household practices in Benin City. The overall objective was to provide an overview of population demographics, to assess practices undertaken for the treatment of malaria in households, and to explore what demographic factors (if any) play a role in the uptake of ACTs as therapy for malaria. On the basis of anecdotal evidence, our *a priori* hypotheses were (i) most households in Benin City may not be using ACTs for the treatment of malaria and (ii) households with HRPs in higher educational and occupational categories may be more likely to use ACTs.

Materials and Methods

Setting

The study was undertaken in Benin City, capital of Edo State, Nigeria. Benin City has three of the fourteen local government areas (LGAs) in the Edo State-Egor, Ikpoba-Okha, and Oredo LGAs. Each of these LGAs has 26, 27, and 30 enumeration areas (EAs), respectively. The reported population of Benin City at the time of this survey was 762,719.^[26]

Design and sample size calculation

A quantitative, cross-sectional design was used. Epi Info software for population survey was used to calculate the required sample size.^[27] The estimated number of households was 159 at 99% confidence level. On the basis of published work on nonresponse rates,^[28,29] and choosing to adopt a worst case scenario, an additional 50% allowance was allowed for anticipated non-consents, giving a sample size that was rounded up to 240 households.

Sampling procedures and materials

A multistage sampling technique was used. Lists of all households in Benin City, grouped according to

their respective EAs were obtained from the State Office of the National Bureau of Statistics.^[30] In each LGA, 4 EAs were selected by simple random sampling. A sampling frame was then obtained by listing all households in the selected EAs, for each LGA. In order to select 80 households from this sampling frame, 80 random numbers were electronically generated^[31] per LGA, and marked off on the respective household lists. Questionnaires were both pretested and pilot tested using two different convenience samples of households.

Participants and data collection

Adults who were competent and willing to give informed consent were interviewed in the selected households. Consent was formalized by participants signing or thumb printing on consent forms. Information obtained from respondents included household demographics such as numbers of persons living in the households, ages of household members, and occupations of parents/guardians. Respondents were also requested to recall the most recent episode of malaria in any household member, how long ago the malaria episode had occurred, and the age(s) of household members who had been presumed to have malaria. Additionally, they provided information regarding whether or not such malaria episodes had been treated, what medicines had been used, and how/where those medicines were sourced. We recorded malaria treatments as "uncertain" if there was any doubt as to what category of antimalarial medicine had been given.

Ethics

Ethical clearance was obtained from the University of Benin Teaching Hospital Research and Ethics Committee, and the University of Liverpool Committee on Research Ethics, prior to data collection, the latter because this study was undertaken in part-fulfillment of the requirements for the award of a Master of Public Health degree of the University of Liverpool.

Data analyses

The occupations of working adults in each household were used to determine who the household reference persons (HRPs) should be. In households where more than one parent (or guardian) was employed, the person whose occupation was judged to provide a higher income was taken as the HRP.^[32] The occupational status of HRPs was further classified using the International Labour Organization (ILO) occupational classification,^[33] with additional categories added to accommodate retirees and unemployed persons. All medicines reported to have been used for the treatment of malaria were grouped to determine what proportions each category of medicines contributed.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 16.0; graphs were redrawn using Microsoft Excel software. Where expected count in any cell was less than 5, Fisher's exact test was used.^[34] A 2-tailed *P* value less than 0.05 was considered statistically significant. Significant associations between categorical variables were validated using appropriate logistic regression models.

Results

A total of 217 households were surveyed: In 19 of the 240 households selected into the sample, no adult was available to provide informed consent after repeated visits. These households were, therefore, excluded. Consent was denied in four of the remaining households (non-consent rate of 1.7%). Figure 1 is an illustration of the distribution of HRP's according to occupational categories: Sales and service workers were in the majority (34.6%).

Mothers were on the whole less educated than fathers: 10 out of 218 mothers (4.6%) versus 3 out of 201 fathers (1.5%) had no formal education; 42 mothers (19.3%) versus 47 fathers (23.4%) had attained tertiary education [Figure 2]. The difference in educational levels between fathers and mothers in Benin City was, however, not statistically significant (Chi-square statistic 5.44, *df* 4; *P* = 0.24).

Over 90% of respondents could recall the most recent episode of malaria that had occurred in their respective households. In 8 (3.7%) households no one had ever suffered from malaria [Table 1]. A third of malaria episodes had occurred in children younger than X5 years old [Figure 3].

Orthodox medicines were used for the treatment of malaria in 154 (70.5%) households. One in ten households used traditional medicines for the treatment of malaria, in combination with orthodox medicines; 6 (2.8%) used traditional medicines alone [Table 2]. ACTs were used for the treatment of malaria in 10 (4.9%) households [Table 3]. No household member had received treatment from a Community Medicine Distributor (CMD).

Of all the medicines that were used for the treatment of malaria, paracetamol and other analgesics comprised the highest proportions (21.6%), followed by vitamins (as single or multivitamin preparations). Sulfadoxine-pyrimethamine was the most commonly used antimalarial medicine, with artemisinin monotherapies coming next [Figure 4]. ACTs accounted for 3.6% of all medicines used, behind antibiotics, traditional medicines, chloroquine and quinine. As a proportion of anti-malarial medicines, sulfadoxine-pyrimethamine accounted

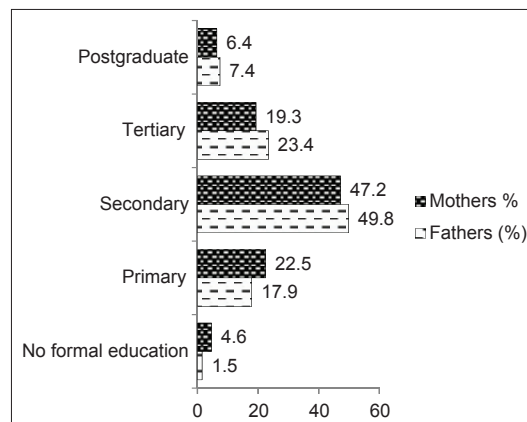


Figure 2: Educational levels attained by parents/guardians in households in Benin City

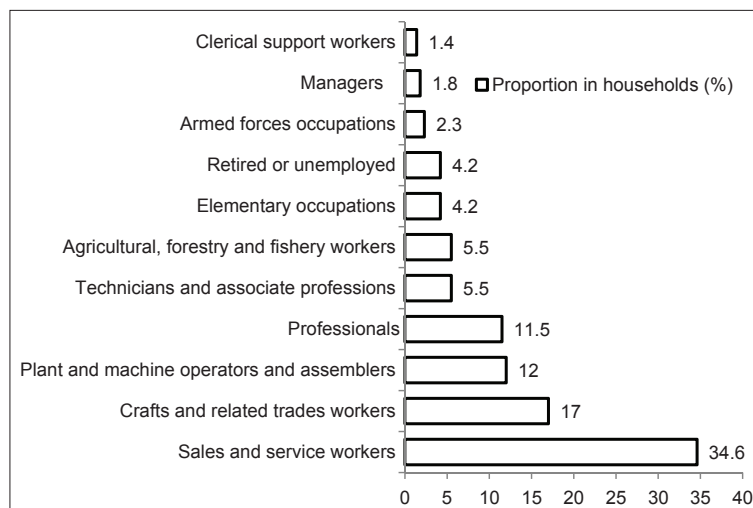


Figure 1: Proportions of household reference persons in different occupational categories in Benin City

Table 1: The most recent episodes of malaria reported in households in Benin City

Most recent malaria episode	Number of households (%)
This week	24 (11.0)
1 week ago	18 (8.3)
2 weeks ago	13 (6.0)
1 month ago	37 (17.1)
Over 1 month ago	113 (52.1)
Cannot remember	4 (1.8)
No one ever had malaria	8 (3.7)
Total	217 (100)

Table 2: Categories of medicines used for the treatment of malaria in households in Benin City

Category of medicine	Number of households (%)
Orthodox medicines	153 (70.5)
"Do not know"	23 (10.6)
Orthodox plus traditional medicines	22 (10.1)
Not applicable*	8 (3.7)
Traditional medicines	6 (2.8)
No treatment	5 (2.3)
Total	217 (100)

*No one had ever had malaria

Table 3: Artemisinin-based combination therapies* as a proportion of medicines used for the treatment of malaria in households in Benin City

Medicines used	Number of households (%)
Non-ACT	136 (66.7)
Uncertain	58 (28.4)
ACT	9 (4.4)
ACT plus herbal treatment	1 (0.5)
Total	204 (100)
Not applicable†	13 (6.0)
Grand total	217 (100)

*Artemisinin-based combination therapies, †Total of those who had never had malaria plus those who had taken no treatment for malaria, ACT=Artemisinin-based combination therapies

for nearly 40%, artemisinin monotherapies 24.6%; chloroquine and quinine jointly comprised over 25%. ACTs accounted for 8.6% of all antimalarial medicines [Figure 5]. Patent medicine stores were the most frequently accessed sources for medicines used for the treatment of malaria; the least accessed were government hospitals [Table 4].

There was a statistically significant association between fathers' attainment of tertiary (or higher) education and use of ACTs, when compared to fathers who had not attained this level of education (OR 0.054, CI 0.006-0.510; $P = 0.011$). This association was not significant for mothers' attainment of tertiary (or higher) education (OR 0.905, CI 0.195-4.198; $P = 0.898$; Table 5). Households with HRP's in occupational categories other than "managerial" or "professional" were 6 times more likely to use non-artemisinin antimalarial therapies compared to households in which the HRP's were either professionals or in

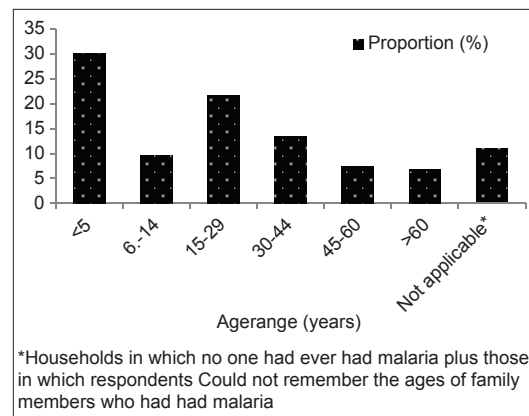


Figure 3: Distribution of malaria episodes by age categories in households in Benin City

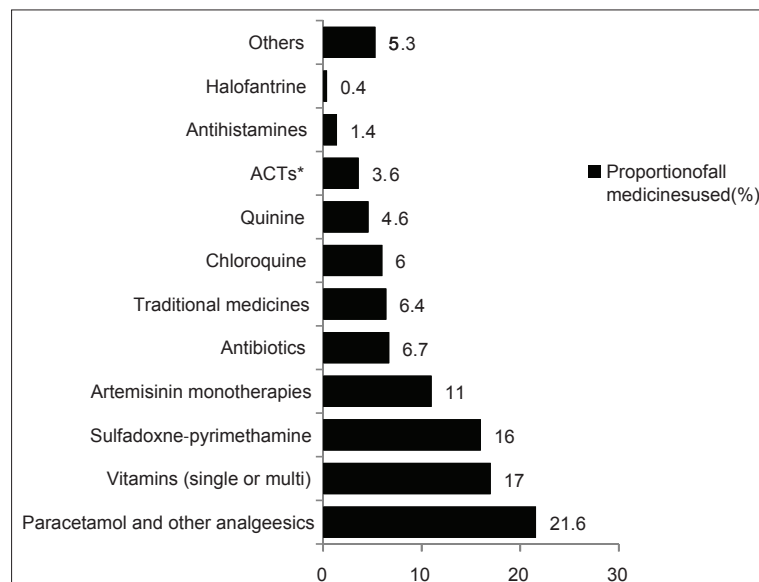


Figure 4: Medicines used for the treatment of malaria in households in Benin City. *Artemisinin-based combination therapy

the managerial category (OR 5.8; CI 1.470-20.758, $P = 0.016$) [Table 6].

Discussion

As at February 2010, only about 5% of households in Benin City used ACTs for the treatment of malaria. We did not assess what proportions of households had used ACTs as their *first option* for malaria treatment but this proportion would predictably have been less. Our findings provide additional evidence that ACTs for the treatment of malaria in Nigeria (at least in Benin City) is still more a matter of policy than practice.^[35]

Several factors may underlie gaps between policy and practice. In Kenya, change in malaria treatment practices lagged behind policy change by two years, chiefly because it took that long for ACTs to be distributed to hospitals in the public health sector.^[36] Stock-outs of ACTs (while

sulfadoxine-pyrimethamine and amodiaquine were in stock) were another reason for the lag, in Kenya.^[37] A review of prescriptions written in Nigeria within the year following the national policy change to ACTs as first line medicines for the treatment of malaria, showed that only 5.9% of prescriptions for the treatment of malaria were for ACTs, and antimalarial prescribing practices did not differ significantly between rural and urban health facilities.^[38]

Monotherapy with artemisinin compounds is common, as reported in this study. The practice stems partly from limited access to ACTs, costs, and a poorly regulated pharmaceutical market.^[39,40] Amongst countries in which malaria is endemic, Nigeria is one of those with the highest median costs of ACTs.^[41] Although artemisinin monotherapies may eradicate malaria parasitaemia, they need to be taken for a full 7 days in order to achieve parasite clearance.^[39] However, early resolution of symptoms upon commencement of monotherapy does not encourage completion of the required course of antimalarial therapy.^[39] Malaria treated with artemisinin monotherapies thus exposes parasites to sub-therapeutic levels of artemisinin compounds, fostering the development of resistance to ACTs, the only group of medicines with the least reports of resistance of plasmodium species currently.^[39]

It is noteworthy that illness presumed to be malaria was more often treated with medicines without activity against the causative plasmodium species, such as paracetamol and other analgesics, as well as vitamin preparations, rather than antimalarial medicines.

In Nigeria, education of females is not at par with males.^[42] Importantly, there was no significant difference in the use of ACTs by households whose mothers had attained at least a tertiary level of education, compared to households with mothers who had not (OR 0.905; CI 0.195-4.198; $P = 0.90$). On the other hand, there was a significant difference in the odds of ACT use in households with fathers who had attained at least a tertiary level of education, compared to households whose fathers had secondary education or less. The odds of ACT use in households with more educated

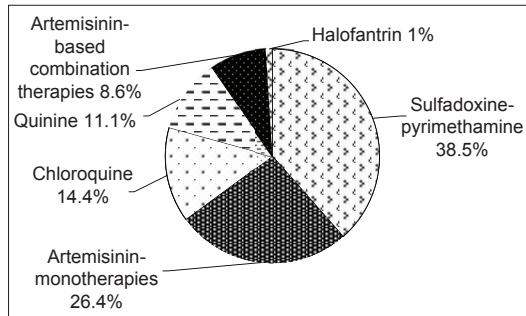


Figure 5: Artemisinin-based combination therapies as a proportion of all antimalarial medicines used in households in Benin City

Table 4: Sources of antimalarial medicines used in households in Benin City

Source of antimalarial medicine	Number of households (%)
Patent medicine store	83 (38.2)
Private hospital	44 (20.3)
Cannot remember	29 (6.9)
Private pharmacy	23 (10.6)
Government hospital	18 (8.3)
Not applicable*	13 (12.4)
Other sources	6 (2.8)
Home stock	1 (0.5)
Total	217 (100)

*Did not have malaria, or did not take treatment for malaria

Table 5: Regression analysis for parents'/guardians' education and use of artemisinin-based combination therapies for the treatment of malaria in households in Benin City

	Variables in the equation	Variables in the equation		Variables in the equation		95% CI for Exp (B)			
		B	SE	Wald	df	Sig	Exp (B)	Lower	Upper
Step 1	Education of father above secondary (1) [†]	-2.916	1.144	6.494	1	0.011	0.054	0.006	0.510
	Education of mother above secondary (1) [‡]	-0.100	0.783	0.016	1	0.898	0.905	0.195	4.198
	Constant	4.330	1.012	18.316	1	0.000	75.933		

Df = 1; CI = Confidence interval: [†]0.006-0.510; [‡]0.195-4.198; Standard error: [†]1.14; [‡]0.78

Table 6: Use of artemisinin-based combination therapies* and occupational categories of HRP† in Benin City

	Occupational category of HRP		Total
	Managerial or professional	Other categories	
Was antimalarial therapy ACT or not?			
Yes	5	5	10
No	20	116	136
Total	25	121	146‡

*ACT=Artemisin-based combination therapy, †HRP=Household reference person. ‡After exclusion of households in which no one had malaria, no one was treated for malaria or treatment for malaria was uncertain [Table 3]

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fathers (i.e. tertiary level and above) was 18.5 times less than the odds of ACT use in households with fathers with secondary level education or less (OR 0.054, CI 0.006-0.510; $P = 0.011$). This difference may be a pointer to gender-based power relations that underline treatment choices for malaria in Nigerian households, and should be further explored. It also has implications for who should be the targets of public health interventions aimed at eliminating malaria in sub-Saharan Africa. Remarkably, most (if not all) interventions for malaria control in Nigeria target women/mothers. In a society as strongly patriarchal as Nigeria, there is wisdom in advocating for a shift in focus that will foster the involvement of more of the menfolk in malaria control interventions. This strategy has been employed in Kenya with success.^[43] Fathers also played key roles in the success story of malaria eradication in Aneityum Island.^[44]

Another point of note in the relationship between parents'/guardians' education and ACT use is that, contrary to our *a priori* hypothesis, higher level education (in fathers) was associated with lower odds of household members getting ACTs for the treatment of malaria. The confidence interval associated with this odds ratio is wide, suggesting variability. Although we are cautious in interpreting this association, it warrants further thought, especially as the study was well powered and the values are not close to unity.

Belonging to occupational categories other than “managerial” or “professional” was associated with significantly higher odds of using non-ACT medicines for malaria treatment compared to households with HRPs in the managerial or professional categories (OR 5.8, CI 1.470-20.758; $P = 0.016$). In the hierarchy of occupational categories, managerial and professional groups were the two highest (with regards to the ILO classification). Failure to use ACTs for the treatment

of malaria was thus significantly associated with being in ‘lower’ occupational categories. This aligned with our *a priori* hypothesis. Hierarchical ranking of occupation depicts monetary and other social/societal benefits, but socioeconomic status is a multidimensional construct, and a single measure such as occupation cannot reliably be used as proxy for socioeconomic status.^[45]

There is evidence that patent medicine vendors are the chief sources of malaria treatment in Nigeria.^[46,47] Our study provides further evidence in this regard, whereas only 8.3% of households obtained antimalarial medicines from government hospitals, nearly 40% obtained their medicines from patent medicine stores. In a national study that included states from eastern, northern, and western Nigeria, sulfadoxine-pyrimethamine was the most frequently stocked antimalarial medicine in patent medicine shops, and less than half of patent medicine vendors were aware of the policy change requiring ACTs to be used as first line therapy for uncomplicated malaria.^[46] The preference for patent medicine vendors rather than hospitals (government or privately owned) would be multifactorial, poverty being one of them. Poverty is perpetuated by malaria and vice versa.^[12,48] This relationship can be likened to the proverbial one between the chicken and egg, which came first?

Efforts to eliminate malaria from Nigeria must integrate the many-faceted effects of poverty on Nigerians' living conditions and treatment seeking behaviors/choices. The role of providers of health care in the informal sector must not be ignored.^[49] Although there have been efforts to train patent medicine vendors using strategies for behavioral change,^[22] the magnitude of the challenge deserves more aggressive, focused, and more far-reaching interventions.

Community uptake of ACTs appears to be low because current interventions to shore up the uptake of ACTs appear to be overly focused on government owned health facilities, which are not the preferred sources of care for the majority of community members. The reality of the Nigerian situation therefore requires that more attention be given to nongovernment providers of health care, including the informal sector. It is not clear how this will be achieved, especially as interventions are mostly donor-driven. Social marketing to redirect interventions for overall public good is needful and hopefully should be successful.

The predominance of children aged less than 5 years old in episodes of malaria in households is in keeping with national and regional statistics.^[50,51] The details of practices undertaken for the treatment

of malaria in this age group in households in Benin City are beyond the scope of this paper and will be reported differently.

Conclusion

Ten years after the Abuja Targets were set, and 5 years after the national policy change to ACTs for the treatment of uncomplicated malaria in Nigeria, only 5% of households in Benin City used ACTs for the treatment of malaria. In households in Benin City, mothers' higher levels of education (tertiary and above) was not significantly associated with the use of ACTs. Contrariwise, fathers' higher level of education (tertiary or above) was associated with less use of ACTs. Both of these findings negate our initial hypothesis regarding level of education and ACT use. In line with our *a priori* hypothesis, occupational status is a key determinant of ACT use.

Patent medicine vendors, private hospitals, and pharmacies were the most accessed sources of medicines for the treatment of malaria and thus cannot be ignored if the targets for effective malaria treatment in Nigeria are to be achieved.

Strengths and weaknesses

Strengths

The research question that this study sought to answer is relevant to the current targets of the RBM Partnership in Nigeria. Using randomly selected households assures that the findings are generalizable to the population from which the sample was drawn (external validity). Internal validity is assured as questionnaires were administered by competent personnel; data were also competently managed and analyzed to reach the stated conclusions.

Weaknesses

We relied on self-reported febrile illnesses, presumed to be malaria. As respondents were required to recall details of the most recent episodes of malaria, the likelihood of recall bias cannot be excluded. The LGAs from which all households were selected were predominantly urban. The findings may not be generalizable to rural populations.

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