Timeliness of Malaria Treatment in Children Under Five Years of Age in Sub Saharan Africa:

A Multicountry Analysis of National Household Survey Data

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List of Abbreviations

A&PS	Anemia and Parasite Prevalence Surveys
ACT	Artemisinin combination therapy
AL	Artemether-lumefantrine
ASAQ	Artesunate amodiaquine
CHAID	Chi-square Automatic Interaction Detector
DHS	Demographic and Health Surveys
MICS	Multiple Indicator Cluster Surveys
MIS	Malaria Indicator Surveys
PMI	President's Malaria Initiative
SSA	Sub Saharan Africa
UNICEF	United Nations Children's Fund
WHO	World Health Organization

Executive Summary

Background

Malaria is one of the most severe public health problems worldwide, particularly for children under five years of age. The World Health Organization (WHO) recommends prompt diagnosis and treatment with effective antimalarial medicines within 24 hours of the onset of fever. Delays in treatment can have fatal consequences, particularly if the infection is severe, but few studies systematically assess these delays among children under five years of age in Sub Saharan Africa (SSA). This study examined the extent to which children under five years of age across SSA received an antimalarial treatment within 24 hours of the reported onset of fever. The study also investigated children under five years of age who received a first-line artemisinin combination therapy (ACT) within 24 hours of the reported onset of fever. Finally, the study identified predictors of prompt treatment with ACT and describes profiles of children who received this recommended treatment. The study focuses on the following countries prioritized by the United States' President's Malaria Initiative (PMI): Angola, Benin, Ethiopia, Ghana, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Rwanda, Senegal, Tanzania mainland, Uganda, Zambia, and Zanzibar.

Methods

This study uses data from the most recent Demographic and Health Surveys (DHS), Malaria Indicator Surveys (MIS), or Anemia and Parasite Prevalence Survey (A&PS) conducted in each PMI priority country. The authors used a Chi-square Automatic Interaction Detector (CHAID) model to identify factors associated with prompt and effective treatment among children under five years of age.

Results

Treatment of fever among children under five years: On average, only 32% of children with fever received any antimalarial treatment, although coverage was above 50% in four countries: Benin, Liberia, Tanzania mainland, and Uganda. The percentage of children who received an ACT is below 10% in nearly half of the countries included in the analysis, with a range from 2% in Benin to 96% in Rwanda.

Prompt treatment of fever among children under five years: The percentage of children who had access to prompt treatment with any antimalarial drug varies from 42% in Madagascar to 87% in Zanzibar. Among those who received prompt treatment with any antimalarial drug, the percentage who received ACT ranged from 32% in Zambia to nearly 100% in Tanzania and Zanzibar.

Profiling children who received prompt treatment with first-line treatment: The cross-country CHAID analysis revealed that country of residence is the best predictor of prompt and effective treatment, followed by maternal education, household wealth quintile, maternal age, and place of residence.

Conclusion

Overall, the proportions of children who received prompt antimalarial treatment are highest among children whose mother has at least a secondary education, those living in urban areas, and those belonging to the highest (4th and 5th) wealth quintiles. In the effort to ensure universal access to prompt and effective treatment, particular attention must be paid to these groups to ensure they are effectively covered by malaria control interventions. This will require an effective monitoring and evaluation system capable of detecting disparities early. The authors recommend keeping these results in mind for future routine system strengthening activities.

Background

About 219 million malaria cases and an estimated 660,000 malaria deaths occurred in 2010,[1] making malaria one of the most severe public health problems worldwide. This is particularly true in Sub Saharan Africa (SSA), where 80% of the estimated cases and 91% of the estimated deaths are occurring.[1,2] The majority of malaria-related deaths (86%) occur among children under five years of age.[2]

Defeating malaria, part of Millennium Development Goals 4 and 6, requires a high level of political commitment and multisectorial engagement. The President's Malaria Initiative (PMI) represents a historic $1.2 billion, five-year expansion of United States Government resources to reduce the burden of malaria and help alleviate poverty in SSA within 15 priority countries. The goal of PMI is to reduce malaria-related deaths by 50% in these countries that have a high burden of malaria by expanding coverage of four highly effective malaria prevention and treatment interventions to 85% of the most vulnerable populations, including pregnant women and children under five years of age.[1,2,3] These interventions include insecticide-treated nets, indoor residual spraying, prompt and effective treatment, and intermittent preventive treatment during pregnancy.

According to the World Health Organization (WHO), prompt and effective treatment refers to treatment with recommended antimalarial medicines within 24 hours of the onset of fever and confirmation of malaria through appropriate diagnostic tests.[2] Timely access to effective treatment with first-line artemisinin combination therapies (ACTs) is fundamental to prevent progression of *P. falciparum* malaria to severe malaria and death, particularly among children under five years of age. Across SSA, only a small proportion of malaria patients, including children under five years of age, receive prompt and effective treatment.[2] In Kenya, a systematic review documented a delay in treatment, with only 5% of fever cases receiving prompt treatment with an antimalarial drug.[4] Similarly, in Tanzania, Khatib and colleagues found that less than 50% of fever cases received treatment with ACT within 24 hours.[5]

Potential reasons for low coverage to prompt and effective treatment among children include aspects related to affordability, acceptability, availability, and sometimes, adequacy.[6,7,8,9,10] Studies in SSA have suggested that it is important to proactively meet patient preferences[9] and adopt existing local words and treatment practices.[11]

Several studies have looked into a specific context, dimension, or population related to prompt and effective treatment for malaria; however, few studies systematically assess the delay between the onset of fever and the initiation of treatment among children under five years of age in SSA.[12,13] This study aims to fill this gap by examining the extent to which children under five years of age across SSA received an antimalarial treatment within 24 hours of the reported onset of fever (referred to here as "prompt treatment with any antimalarial drug"). The study also investigates children under five years of age who received a first-line ACT within 24 hours of the reported onset of fever (referred to here as "prompt treatment with ACT"). Finally, the study identifies predictors of prompt treatment with ACT and describes profiles of children who received this recommended treatment.

The work focuses on the following PMI priority countries with relevant national survey data: Angola, Benin, Ethiopia, Ghana, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Rwanda, Senegal, Tanzania mainland, Uganda, Zambia, and Zanzibar.[*]

[*] Due to the unique epidemiology of malaria in Zanzibar, it is treated independently from mainland Tanzania.

Data and methods

Data used for the analysis

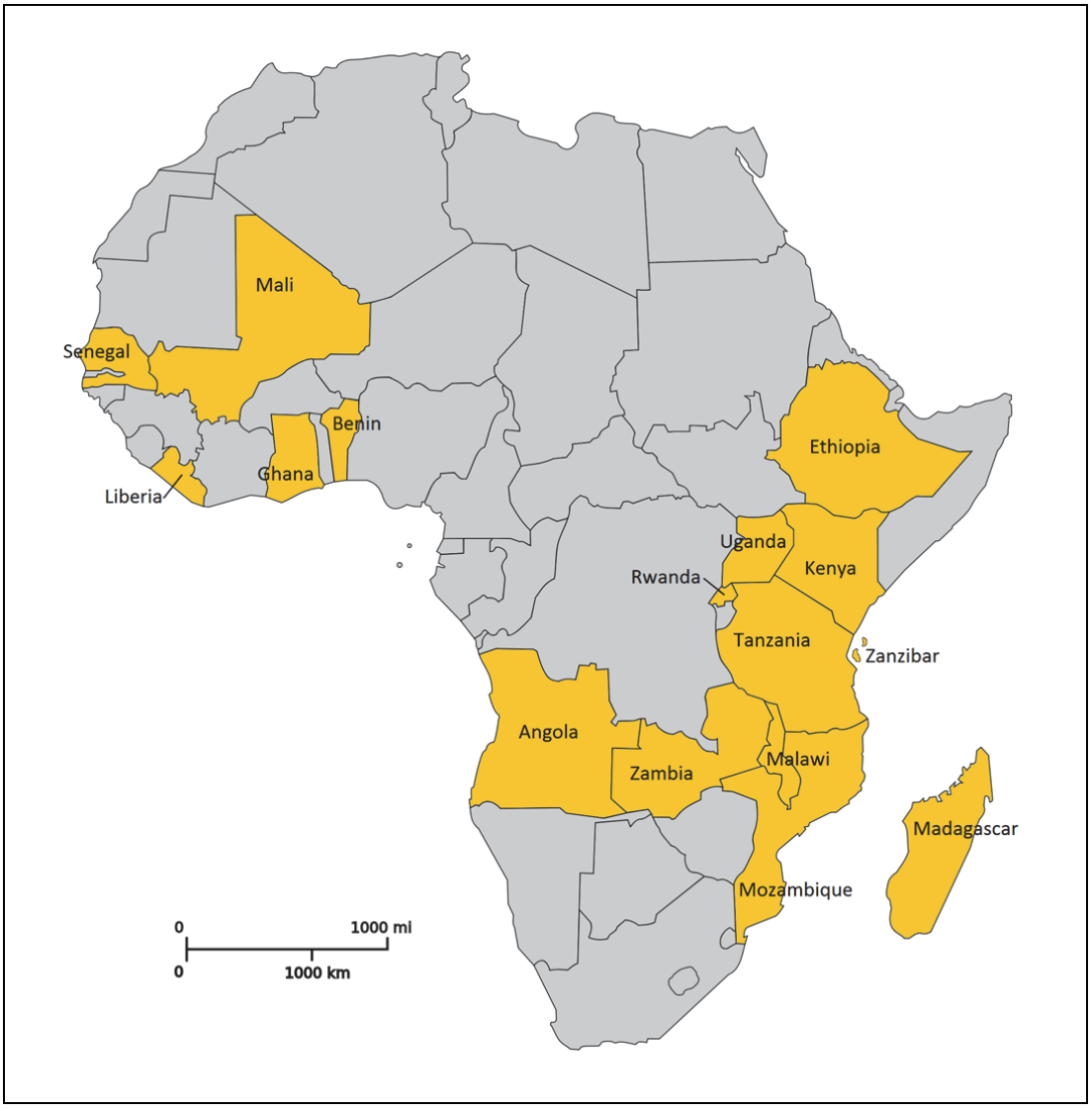
This study uses data from the most recent Demographic and Health Surveys (DHS), Malaria Indicator Surveys (MIS), or Anemia and Parasite Prevalence Survey (A&PS) conducted in each PMI priority country. Each of these surveys included a malaria module, in addition to the standard household and women's questionnaires. Table 1 presents the countries included in the analysis, in addition to the type and timing of the surveys used. Figure 1 shows the location of these countries. All surveys were conducted between 2006 (Benin) and 2012 (Malawi), with most carried out in 2010 and 2011. The countries belong to three geographical regions of SSA: (1) West, (2) Central, and (3) East.

Table 1: Surveys included in the analysis

Country	Region	Survey	Survey year
Benin	West	DHS	2006
Ghana	West	DHS	2008
Liberia	West	MIS	2011
Mali	West	A&PS	2010
Senegal	West	DHS-MICS	2011
Angola	Central	MIS	2011
Ethiopia	East	DHS	2011
Kenya	East	DHS	2009
Madagascar	East	MIS	2011
Malawi	East	MIS	2012
Mozambique	East	DHS	2011
Rwanda	East	DHS	2010
Tanzania mainland	East	DHS	2010
Uganda	East	DHS	2011
Zambia	East	DHS	2007
Zanzibar	East	DHS	2010

Notes: DHS: Demographic and Health Surveys; MIS: Malaria Indicator Surveys; A&PS: Anemia and Parasite Prevalence Survey.

Figure 1: Countries included in the analysis



Antimalarial drug policies

All countries had adopted ACTs as first-line treatment by the time the surveys were conducted; however, the duration between policy adoption and the survey varies from 2 years (Benin) to 7 years (Liberia, Ethiopia, and Mozambique), with an average of 5.2 years (Table 2).

Table 2: Duration between year of ACT policy adoption and implementation of surveys

Country	Type of ACT	Year adopted	Year of survey	Time in years between policy adoption and survey
Angola	ALu	2006	2011	5
Benin	ALu	2004	2006	2
Ethiopia	ALu	2004	2011	7
Ghana	ASAQ, ALu	2004	2008	4
Kenya	ALu	2004	2009	5
Liberia	ALu	2004	2011	7
Madagascar	ASAQ	2006	2011	5
Malawi	ASAQ, ALu	2007	2012	5
Mali	ASAQ, ALu	2007	2010	3
Mozambique	ALu	2004	2011	7
Rwanda	ALu	2005	2010	5
Senegal	ASAQ	2005	2011	5
Tanzania mainland	ALu, ASAQ	2004	2010	6
Uganda	ALu	2004	2011	6
Zambia	ALu	2002	2007	5
Zanzibar	ASAQ	2004	2010	6

Notes: ALu: artemether-lumefantrine; ASAQ: arthesunate-amodiaquine.

Data quality checks

Each of these surveys collects information on fever and timing of treatment in the two weeks before the survey. Information collected retrospectively may be prone to inaccurate or incomplete responses,[14] so we performed data quality checks to identify potential problems. Data quality checks included assessing response rates, evaluating completeness of data for key variables, and assessing reliability of birth history data.

Response rate

Table 3 shows household and individual response rates for all surveys included in this study. Response rate refers to the percentage of the number of people or households in the sample that completed an interview. Response rates help to assess potential bias in the results, especially if the interview rates (1) depend on whether the respondent had a sick child during the two weeks preceding the survey or (2) vary significantly with the respondent's treatment-seeking behavior. We set a benchmark of at least 90% for response rates.

In each country, more than 90% of identified households and women were successfully interviewed, reaching the benchmark and confirming adequate response rates. The interview rates for the household surveys vary between 95% in Uganda and nearly 100% in Mali, Mozambique, and Rwanda. The response rates among women were also high, ranging from 92% in Senegal to 99% in Mozambique and Rwanda.

Table 3: Survey response rates by country

Country	Households				Women ages 15–49			
	Place of residence (%)			Number of households identified	Place of residence (%)			Number of women identified
	Urban	Rural	All		Urban	Rural	All	
Angola	96.2	97.9	97.2	2,675	94.5	95.1	94.8	3,136
Benin	98,8	99.2	99.1	17,675	93.7	94.9	94.4	18,851
Ethiopia	97.0	98.7	98.1	17,018	94.2	95.4	95.0	17,385
Ghana	98.5	99.1	98.9	11,913	96.6	96.4	96.5	5,096
Kenya	96.5	98.3	97.7	9,268	95.6	96.6	96.3	8,767
Liberia	97.7	98.7	98.2	4,237	97.7	98.5	98.1	4,014
Madagascar	98,8	98.7	98.7	8,197	98.0	98.8	98.6	8,287
Malawi	98.7	99.4	99.2	3,432	98.1	98.5	98.3	2,955
Mali *	99.6	99.8	99.8	1,621	n/a	n/a	n/a	n/a
Mozambique	99.6	99.8	99.8	13,951	98.6	99.4	99.1	13,871
Rwanda	99.8	99.8	99.8	12,570	99.2	99.1	99.1	13,790
Senegal	98.0	98.6	98.4	8,029	91.8	93.2	92.7	16,931
Tanzania mainland	97.6	98.8	98.8	7,832	95.8	96.2	96.1	8,055
Uganda	91.3	96.9	95.3	9,480	91.3	94.9	93.8	9,247
Zambia	98.0	97.6	97.8	7,326	95.7	97.1	96.5	7,408
Zanzibar	n/a	n/a	99.7	1,909	n/a	n/a	97.1	2,467

Note: * Women's questionnaire was not included in the survey.

Completeness of date of birth data

Analyzing fever and treatment trends among children under five years of age requires accurate reports of birth dates. Misreporting of ages or dates of birth can affect malaria estimates because malaria infection varies significantly by a child's age.[15,16]

In each country included in the study, at least 93% of children have complete information, including month and year of birth. A relatively low percentage of completeness is reported in Senegal and Mali, where complete information is available for only 93 to 94% of children (Table 4). This information is nearly complete in the rest of the study countries, so no country was eliminated due to incomplete information.

Table 4: Proportion of children under five years of age whose year and month of birth are known

Country	Place of residence		Overall (%)	Total live births	Region
	Urban (%)	Rural (%)			
Angola	99.9	100.0	99.9	8,242	Central
Benin	98.4	98.9	98.7	16,075	West
Ethiopia	100.0	100.0	100.0	11,654	East
Ghana	100.0	100.0	100.0	2,992	West
Kenya	100.0	100.0	100.0	6,079	East
Liberia	99.0	99.0	99.0	3,319	West
Madagascar	99.1	97.6	97.9	6,248	East
Malawi	99.8	99.3	99.4	2,283	East
Mali	97.2	93.2	94.3	2,059	West
Mozambique	99.1	99.2	99.1	11,102	East
Rwanda	100.0	100.0	100.0	9,002	East
Senegal	94.2	93.1	93.4	12,326	West
Tanzania mainland	100.0	100.0	100.0	6,389	East
Uganda	99.9	99.9	99.9	7,878	East
Zambia	100.0	100.0	100.0	6,401	East
Zanzibar	100.0	100.0	100.0	1,634	East

Reliability of birth history data

The validity of surveys that use retrospective questions depends on accurate recall of histories and accurate reporting of events. We assessed the reliability of maternal reporting by analyzing the number of live births over the last five years preceding the survey in each country. Some births that are followed by death in youth may not be reported by mothers in surveys, which can bias estimates because both malaria and increased time between the onset of fever and treatment are associated with greater risk of mortality among children under age five years.

Table 5 presents the number of births that occurred during the five years before the survey was conducted in each country. Overall, the number of births is high for the last four years preceding the survey (Y-4 to Y-1) but lower in Y-5. This could be a result of (1) artificial aging of children, who are designated age four years by some interviewers or respondents to decrease the number of eligible children for health modules; (2) recall biases, particularly for births followed by early deaths; or (3) the month of survey because more births are reported if the survey occurs late in the year (September to December) and fewer if the survey occurs early in the year (January to February). This distribution did not, however, affect the overall reliability of the birth history data.

Table 5: Number of births over the five years preceding the survey

Country	Y-5	Y-4	Y-3	Y-2	Y-1	Y	Y*	Survey year	Region
Angola	1,328	1,583	1,761	1,592	1,715	263		2011	Central
Benin	505	3,066	3,304	3,141	3,389	2,670		2006	West
Ethiopia	946	2,396	2,547	2,142	2,262	1,361		2011	East
Ghana	73	638	527	570	633	551		2008	West
Kenya	16	1,126	1,161	1,244	1,174	1,287	71	2008	East
Liberia	60	666	669	644	671	609		2011	West
Madagascar	751	1,260	1,325	1,163	1,370	379		2011	East
Malawi	265	456	423	537	476	126		2012	East
Mali	74	421	391	429	395	349		2010	West
Mozambique	531	2,114	2,201	2,149	2,565	1,542		2011	East
Rwanda	88	1,849	1,818	1,916	1,724	1,536	71	2010	East
Senegal	45	2,006	2,438	2,462	2,473	2,624	278	2010	West
Tanzania mainland	934	1,294	1,255	1,303	1,326	277		2010	East
Uganda	428	1,499	1,626	1,581	1,558	1,186		2010	East
Zambia	493	1,260	1,273	1,310	1,381	684		2007	East
Zanzibar	255	339	303	338	356	43		2010	East

Note: Y* = Y+1; for example: Kenya, Y = 2008 (last column); Y-1 = 2007; and Y* = 2009.

Availability of information on access to antimalarial treatment

Most surveys collected information on the type of antimalarial medicines taken and the timing (same or next day) for children under five years of age with reported fever in the two weeks before the survey. Table 6 lists availability of malarial treatment variables in each country's database. Of 16 locations, 14 have information on the time between the reported onset of fever and antimalarial treatment. Two countries, Ethiopia and Mali, were excluded from the bivariate and multivariate analyses because they do not include information on time to treatment. In addition, the Benin database does not have time to treatment for ACTs and was excluded from some analyses.

Table 6: Availability of information on access to antimalarial treatment

Country	Antimalarial drug	Timing of treatment	Treatment duration	Source of treatment	Diagnostic test	Home management	Had fever
Angola	Yes	Yes	Yes	Yes	No	Yes	2,645
Benin	Yes	Yes*	Yes	Yes	No	No	4,204
Ethiopia	Yes	No	No	Yes	No	No	2,082
Ghana	Yes	Yes	Yes	Yes	No	Yes	751
Kenya	Yes	Yes	Yes	Yes	No	Yes	1,385
Liberia	Yes	Yes	No	Yes	No	No	1,617
Madagascar	Yes	Yes	Yes	Yes	No	No	959
Malawi	Yes	Yes	Yes	Yes	No	Yes	676
Mali	Yes	No	No	Yes	No	No	705
Mozambique	Yes	Yes	Yes	Yes	Yes	No	1,313
Rwanda	Yes	Yes	No	Yes	No	No	1,332
Senegal	Yes	Yes	No	Yes	No	No	2,314
Tanzania mainland	Yes	Yes	No	Yes	No	No	1,320
Uganda	Yes	Yes	No	Yes	No	No	2,860
Zambia	Yes	Yes	Yes	Yes	No	Yes	1,034
Zanzibar	Yes	Yes	No	Yes	No	No	282

Note: *Although artemisinin combination therapy (ACT) policy had been adopted in Benin in 2004, the drugs were not fully available at the time of the survey; therefore, information on timing of treatment is available for other antimalarial treatments but not for ACT.

Statistical analysis

The analysis included two steps. The first step involved computing proportions and conducting chi-square tests for each country to identify associations between prompt treatment and selected background characteristics of children, their primary caretakers, and their households. We weighted data to account for the complex design of national household surveys.

The second step consisted of pooling data from all countries and running a Chi-square Automatic Interaction Detector (CHAID) model.[17] This method helped to (1) identify predictors of prompt access to antimalarial treatment and (2) describe profiles of children under five years of age who received prompt treatment with first-line antimalarial drugs. CHAID is a nonparametric technique that makes no distributional assumptions on outliers, collinearities, heteroskedasticity, or distributional error structures.[17, 18] CHAID uses regression and classification algorithms and offers a nonalgebraic method for partitioning data that lends itself to graphical displays.

The method is a sequential fitting algorithm, with later effects dependent on earlier ones. At each step, the model chooses the predictor variable that has the strongest interaction

with an outcome of interest: prompt and effective treatment. The variable with the strongest association becomes the first branch of the tree, with a leaf for each category that is significantly different. CHAID then assesses the category groupings to pick the most significant combination of variables. The process is repeated to find the predictor variable on each leaf that is most significantly related to the outcome of interest, until no significant predictors remain.

The CHAID analysis included all children with fever who received any antimalarial medicine. The covariates were child's sex, child's age group in months (<6, 6–23, 24–59), child's relationship to the head of household (child or stepchild, grandchild, other), maternal age, maternal education (none, primary, secondary, higher), place of residence (urban, rural), household wealth quintiles, and country of residence.

The output of the CHAID model is presented in a hierarchical tree structure and consists of several levels of branches: root node, parent nodes, child nodes, and terminal nodes. The root node, "Node 0," comprises children who received any antimalarial medicine. Parent nodes are upper nodes compared to lower-level child nodes. Terminal nodes are any node that does not have child nodes. For each terminal node, the CHAID model provides the following indicators:

1. Demographic weight in the sample, which refers to the number and percentage of children that belong to a selected category *j* (prompt and effective treatment);
2. Gain, which is calculated as the number of children who received prompt and effective treatment in the terminal node, divided by the total number of children who received any antimalarial treatment;
3. Response, which is the proportion of children who received prompt and effective treatment among all those within the terminal node; and
4. Gain index percentage, which represents the increased probability of prompt and effective treatment in the terminal node compared to the overall population. This is obtained by dividing the proportion of children in category *j* in each terminal node by the proportion of children that present category *j* in the total sample.

Results

Treatment for fever among children under five

Table 7 reports the percentage of children under five years of age with fever who received antimalarial treatment in the study countries. Among children with fever, the percentage that received any antimalarial treatment varies from 4% in Ethiopia to 65% in Uganda. On average, only 32% of children with fever received an antimalarial drug, although coverage was above 50% in four countries: Benin, Liberia, Tanzania mainland, and Uganda.

The percentage of children under five years of age with fever who received an ACT is below 10% in nearly half of the countries included in the analysis. The percentage that received an ACT is highest in Uganda (44%), Liberia (40%), and Tanzania mainland (38%). Coverage was particularly low in Benin (1%), where ACTs were rolled out in 2004, just two years before the survey. Between 2004 and 2005, AL, Coartem®, and ASAQ, Arsucam®, the recommended first-line treatments, were unavailable in some Benin health facilities.[19]

The percentage of children under five years of age who received an ACT, among those who received any antimalarial treatment, varies from 2% in Benin to 96% in Rwanda.

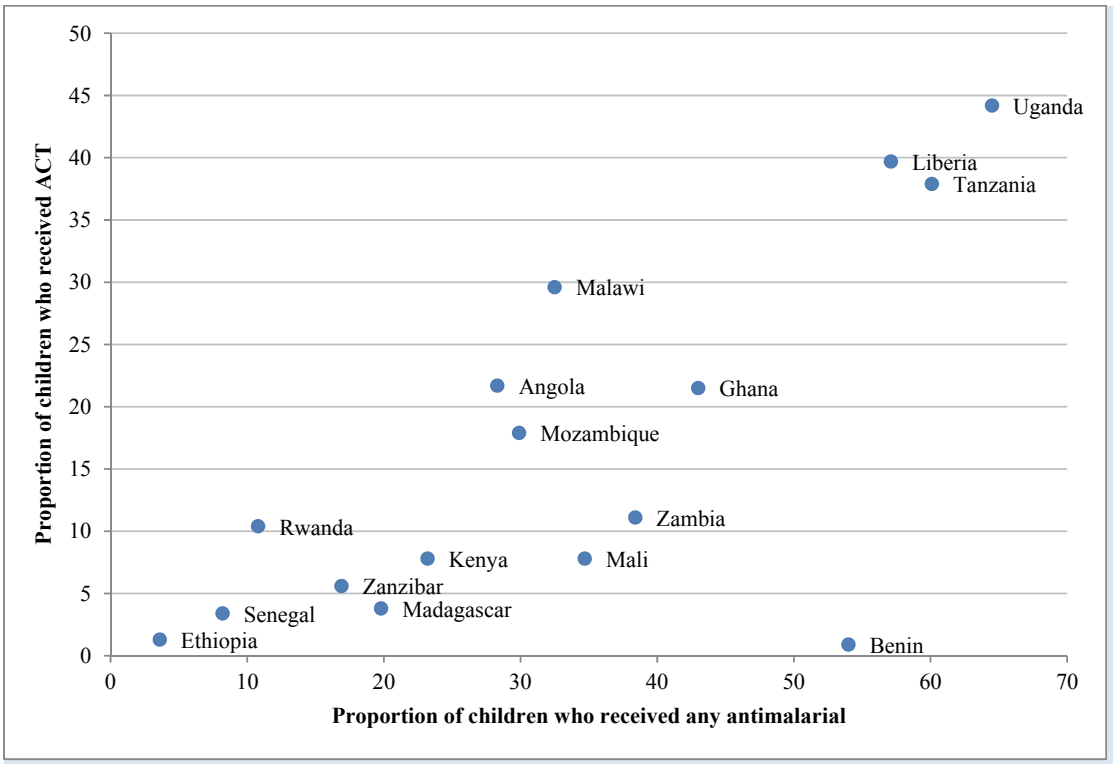
Table 7: Percentage of children under five years of age with fever two weeks before the survey who received antimalarial treatment

Country	Children with fever in the two weeks before the survey			Children who received ACT among those who received any antimalarial treatment		
	Received any antimalarial	Received ACT				
	% (95% CI)	% (95% CI)	N	% (95% CI)	N	Year
Angola	28.3 (26.6–30.0)	21.7 (20.1–23.2)	2,645	76.6 (73.5–79.6)	738	2011
Benin*	54.0 (52.5–55.5)	0.9 (0.6–1.1)	4,204	1.6 (1.1–2.1)	2,243	2006
Ethiopia	3.6 (2.8–4.4)	1.3 (0.8–1.8)	2,082	36.3 (27.8–44.9)	124	2011
Ghana	43.0 (38.8–47.1)	21.5 (18.1–24.9)	551	50.0 (44.5–56.6)	225	2008
Kenya	23.2 (20.9–25.4)	7.8 (6.3–9.2)	1,385	33.5 (28.2–38.7)	311	2009
Liberia	57.1 (54.7–59.5)	39.7 (37.3–42.1)	1,617	69.6 (66.5–72.6)	895	2011
Madagascar	19.8 (17.3–22.4)	3.8 (2.6–5.0)	959	19.3 (13.4–25.1)	177	2011
Malawi	32.5 (29.0–36.0)	29.6 (26.1–33.0)	676	91.0 (87.1–94.8)	216	2012
Mali	34.7 (31.2–38.2)	7.8 (5.8–9.7)	705	22.4 (17.1–27.6)	243	2010
Mozambique	29.9 (27.4–32.4)	17.9 (15.8–20.0)	1,313	59.9 (54.9–64.9)	366	2011
Rwanda	10.8 (9.2–12.5)	10.4 (8.7–12.0)	1,332	95.7 (92.3–99.1)	140	2010
Senegal	8.2 (7.1–9.3)	3.4 (2.6–4.1)	2,314	41.0 (33.7–48.3)	176	2010
Tanzania mainland	60.1 (57.4–62.7)	37.9 (35.1–40.6)	1,320	63.1 (59.7–66.5)	785	2010
Uganda	64.5 (62.7–66.2)	44.2 (42.4–46.1)	2,860	68.6 (66.5–70.7)	1,849	2010
Zambia	38.4 (35.4–41.3)	11.1 (9.2–13.0)	1,034	29.0 (24.6–33.4)	417	2007
Zanzibar	16.9 (12.5–21.3)	5.6 (2.9–8.3)	282	33.1 (18.3–48.0)	42	2010

Notes: 95% CI: 95% confidence interval; N: number of children. * Artemisinin combination therapy was rolled out in Benin only two years before the survey.

Figure 2 shows a correlation between the percentage of children who received any antimalarial drug and the percentage of children who received ACT. Low proportions of children who received any antimalarial drug correspond to low proportions of children who received ACT in Ethiopia and Senegal. In a similar comparison, higher proportions (at least 50%) of children who received any antimalarial drug correspond to higher proportions of children who received ACT in Liberia, Tanzania mainland, and Uganda.

Figure 2: Proportion of children who received any antimalarial drug compared to those who received an ACT



Prompt treatment of fever among children under five

Access to prompt treatment

The percentage of children who had access to prompt treatment with any antimalarial drug varies from 42% in Madagascar to 87% in Zanzibar. Among those who received prompt treatment with any antimalarial medicine, the percentage who received ACT ranged from 32% in Zambia to nearly 100% in Tanzania and Zanzibar (Table 8).

Table 8: Percentage of children who received prompt treatment

Country	Prompt treatment with any antimalarial drug out of those who received any antimalarial treatment		Prompt treatment with ACT among those who received prompt treatment with any antimalarial drug	
	% (95% CI)	N*	% (95% CI)	N*
Angola	57.8 (51.2-61.4)	738	72.4 (68.0-76.8)	398
Benin [a]	77.8 (76.0-79.5)	2,243	n/a	n/a
Ethiopia [b]	n/a	n/a	n/a	n/a
Ghana	55.2 (48.6-61.7)	225	51.0 (42.0-59.9)	124
Kenya	50.6 (50.0-56.1)	311	36.1 (28.1-44.0)	145
Liberia	61.3 (58.1-64.5)	895	69.9 (66.0-73.8)	539
Madagascar	42.1 (34.8-49.4)	177	36.6 (25.9-4.3)	81
Malawi	73.3 (67.4-79.3)	216	88.6 (83.6-93.7)	156
Mali [b]	n/a	n/a	n/a	n/a
Mozambique	74.4 (69.9-78.9)	366	69.2 (63.9-74.5)	292
Rwanda	70.8 (63.2-78.4)	140	98.0 (95.1-100.0)	101
Senegal	73.0 (67.0-80.3)	176	47.5 (38.8-56.2)	131
Tanzania mainland	68.9 (66.7-72.1)	785	99.6 (99.9-100.0)	548
Uganda	65.4 (63.2-67.5)	1,849	71.8 (69.3-74.4)	1,240
Zambia	53.4 (48.6-58.2)	417	32.2 (26.1-38.4)	225
Zanzibar	87.2 (76.7-97.8)	42	100.0 (100.0-100.0)	36

Notes: 95% CI: 95% confidence interval; N: number of children. * Although weighted proportions are presented, the N values are unweighted, and therefore, may not match exactly. [a] Children who received only artemisinin combination therapy are excluded because the database does not contain information on when they started the treatment. [b] No information on time to treatment.

Predictors of prompt treatment with any antimalarial

Table 9 presents socioeconomic and demographic characteristics associated with children who received prompt treatment with any antimalarial medicine. These variables include child's sex, age, and relationship to the head of household; maternal age and education; region; place of residence; and household wealth quintile. The table also reports the specific category within each variable with the highest proportion of children who received prompt treatment with any antimalarial medicine. Tables A1 to A13 in the appendix provide further details.

Children's demographic characteristic differences in prompt access to any antimalarial treatment were significant only in Ghana, Senegal, and Tanzania mainland. In Ghana, the percentage of children who received prompt treatment was higher among males (59%) than females (50%). In contrast, 84% of females in Senegal received prompt treatment compared to 66% of males. In Tanzania mainland, the percentage of children who received prompt treatment was highest among children ages 24–59 months (73%) compared to younger children.

Maternal characteristics were associated with prompt treatment with any antimalarial medicine in some countries. In general, the percentage of children who received prompt treatment was high among children whose mother had at least a secondary education. In Kenya and Mozambique, prompt access to treatment with any antimalarial medicine was significantly lower among children with mothers ages 15–19 years (7% and 71%, respectively) and higher among those with mothers ages 20–29 years (53% and 79%, respectively).

Access to prompt treatment with any antimalarial medicine varied, depending on the administrative region of residence and type of place of residence. In several countries, urban residence was significantly associated with prompt treatment. Liberia was an exception, with more rural children receiving prompt treatment.

In most countries, children in the two highest wealth quintiles were most likely to have access to prompt treatment. In contrast, children in the lowest wealth quintile in Angola and Liberia were most likely to have received prompt treatment.

Table 9: Socioeconomic and demographic characteristics significantly associated with access to prompt treatment with any antimalarial agent

	Variable significantly associated with prompt treatment with any antimalarial drug		Category with highest percentage of children who received prompt treatment with any antimalarial drug	
Country	Variable	*p*-value	Category	% (95% CI)
A	B	C	D	E
Angola	Relationship to the head of household	0.0321	Grandchild	64.2 (55.3–73.2)
	Education level of the mother	0.0292	Secondary and above	68.1 (60.7–75.6)
	Region of residence (endemicity)	0.0323	Mesoendemica estavel	67.4 (61.0–75.6)
	Place of residence	0.0421	Urban	62.6 (57.9–67.3)
	Wealth quintiles	0.0301	Lowest	67.5 (54.3–80.6)
Benin	Education level of the mother	<0.0001	Secondary and above	85.2 (79.4–91.0)
	Region of residence	<0.0001	Littoral	91.0 (85.6–96.1)
	Place of residence	<0.0001	Urban	84.5 (81.9–87.1)
	Wealth quintiles	<0.0001	Highest	84.1 (80.0–88.1)
Ethiopia*	n/a	n/a	n/a	n/a
Ghana	Child's sex	0.0490	Male	59.4 (50.5–68.3)
	Region of residence	<0.0001	Upper East	87.0 (72.9–100.0)
Kenya	Age of the mother	0.0431	20–29 years	53.0 (45.3–60.6)
	Education level of the mother	0.0082	Secondary and above	66.5 (54.3–78.7)
	Region of residence	<0.0001	Central province	86.0 (63.0–100.0)
	Wealth quintiles	0.0230	Fourth	65.5 (51.4–79.6)
Liberia	Place of residence	0.0251	Rural	65.6 (61.0–70.0)
	Wealth quintiles	<0.0001	Lowest	69.8 (63.6–75.9)
Madagascar	Region of residence	<0.0001	n/a**	n/a
Malawi	Relationship to the head of household	0.0331	Child	75.5 (69.4–81.6)
Mali*	n/a	n/a	n/a	n/a
Mozambique	Age of the mother	<0.0001	20–29 years	79.1 (73.1–85.1)
	Region of residence	<0.0001	Tete	99.7 (74.3–100.0)
Rwanda	Wealth quintiles	0.0510***	Highest	81.1 (64.6–97.6)
Senegal	Child's sex	0.0460	Female	84.0 (75.1–92.9)
Tanzania mainland	Child's age	0.0560***	24–59 months	73 .0(68.0–77.0)
	Region of residence	<0.0001	Mtwara	96.4 (89.6–100.0)
Uganda	Region of residence	<0.0001	Karamoja	81.1 (75.0–87.1)
	Place of residence	0.0390	Urban	68.6 (63.6–73.6)
Zambia	Education level of the mother	0.0070	Secondary and above	65.7 (56.2–75.2)
	Region of residence	<0.0001	Southern	78.9 (66.5–91.3)
	Wealth quintiles	<0.0001	Fourth	66.8 (56.9–76.8)
Zanzibar*	n/a	n/a	n/a	n/a

Notes: 95% CI: 95% confidence interval; N: number of children. *p*-values (column C) indicate that the corresponding variable (column B) is significantly associated with prompt treatment with any antimalarial drug; categories in column D are those that have the highest proportion of children who received prompt treatment with any antimalarial drug for each corresponding variable in column B. * Data on time to treatment was not available. ** Region of residence is significantly associated with prompt treatment with any antimalarial drug; however, the number of children for each of the 20 regions is fewer than 30, so percentages were not computed. *** Although these values are p>0.05, they were included because they show borderline significance.

Profiling children who received prompt treatment with ACT

To identify the socioeconomic profile of children who received prompt and effective treatment, data from all children who received any antimalarial drug across the 13 locations with available data were pooled. Box 1 shows summary information on the specifications used to build the final CHAID model. Eight independent variables were examined, but only five were included in the final model. The model comprises 20 nodes, of which 13 are terminal nodes. Parent nodes include at least 100 children, whereas child nodes include at least 50 children.

Box 1: Summary of Chi-Square Automatic Interaction Detector model

Model components	Model specification	Results
Dependent variable	Time between the onset of fever and treatment with ACT	Same day (within 24 hours): 67.8%
Independent variables	Child's sex, age, and relationship to the head of household; maternal age and education; region; country and place of residence; household wealth quintile; duration of ACT implementation	Country of residence, maternal education, household wealth quintile, maternal age, place of residence, duration of ACT implementation
Maximum tree depth	3	3
Minimum number of children in parent node	100	100
Minimum number of children in child node	50	50
Number of nodes	n/a	20
Number of terminal nodes	n/a	13
Overall predicted correct percentage	n/a	64.8

CHAID tree diagram

The tree diagram depicted in Figure 3a shows that "country" is the best predictor of access to prompt treatment with ACTs (p-value<0.0001). Countries with available data are classified into six parent nodes: (1) Angola, Ghana, and Zambia; (2) Kenya and Madagascar; (3) Liberia; (4) Malawi, Rwanda, Senegal, and Tanzania mainland; (5) Mozambique and Zanzibar; and (6) Uganda.

Node 1–Angola, Ghana, and Zambia: Figure 3b shows that among children who received any antimalarial treatment in Angola, Ghana, and Zambia, education level of the mother was the best predictor of prompt treatment with ACT (p-value=0.009). The group was further split into two subgroups: children whose mothers have secondary education of higher (Node 7) and those whose mothers have primary education or no formal education (Node 8).

Children in Angola, Ghana, and Zambia whose mothers have secondary education or higher (Node 7) comprise 6% of the total number of children who received any

antimalarial treatment. Of these children, 62% received prompt treatment with ACT. Education level of the mother was the only predictor for this subgroup; therefore, Node 7 is a terminal node.

Children in Angola, Ghana, and Zambia whose mothers have primary education or less (Node 8) comprise 16% of the total children who received any antimalarial treatment. Of these children, 52% received prompt treatment with ACT. Among children in Node 8, household wealth quintile was the best predictor of prompt treatment with ACT (*p*-value=0.0290), with 55% of children in the lowest, fourth, and highest wealth quintiles (Node 18) receiving prompt treatment with ACT, compared to only 45% of their counterparts in the second and third quintiles (Node 19).

Node 2–Kenya and Madagascar: As depicted in Figure 3c, 8% of children who received any antimalarial treatment live in these two countries. Among children in Node 2, 46% received prompt treatment with ACT. Education level of the mother was the best predictor (*p*-value=0.0360), with 57% of children whose mothers have at least a secondary education (Node 9) receiving prompt treatment with ACT, compared to just 43% of children whose mothers have primary or no education (Node 10).

Node 3–Liberia: Figure 3d shows that this group represents 14% of children who received treatment with any antimalarial medicine. Household wealth quintile was the best predictor of prompt treatment with ACT among children in Liberia (*p*-value <0.0001). Sixty-eight percent of children from the highest and lowest quintiles (Node 11), 48% of children from the fourth quintile (Node 12), and 59% of children from the second and third quintiles (Node 13) received prompt treatment with ACT.

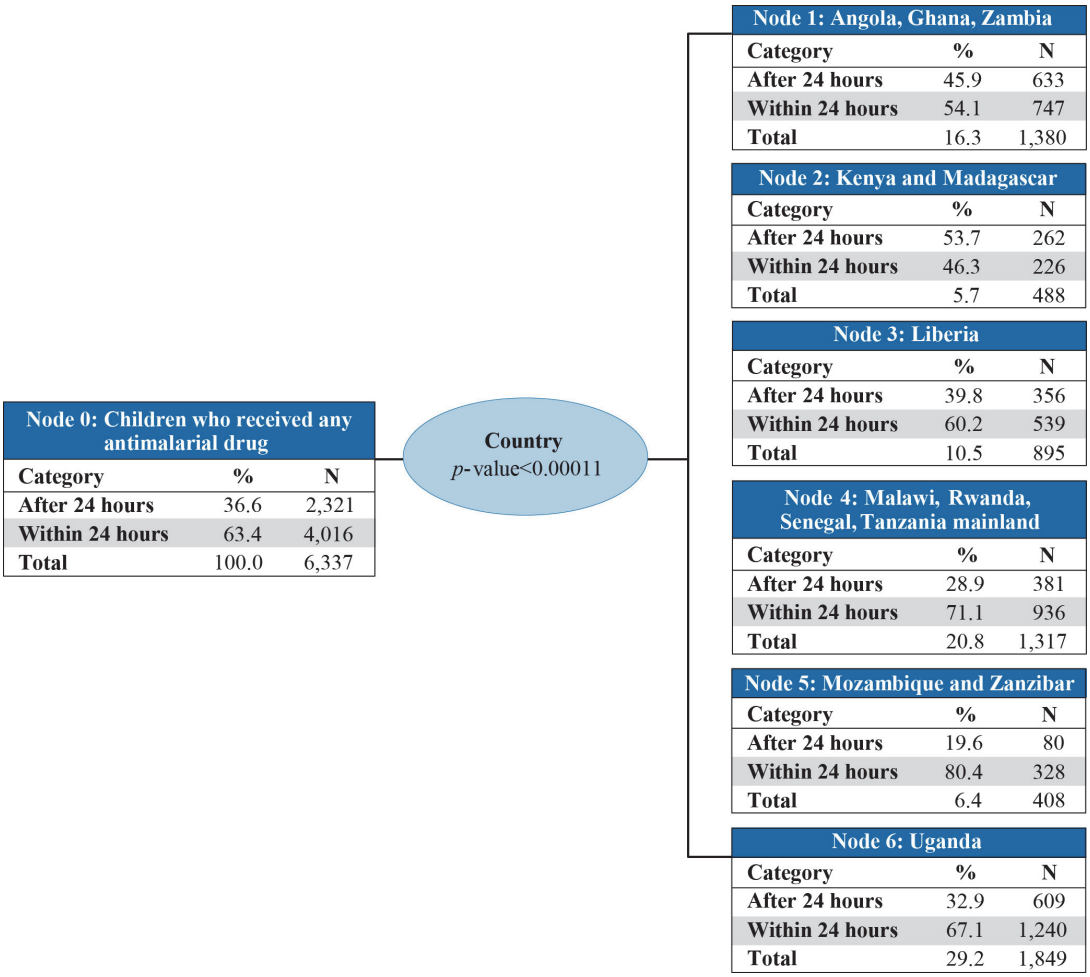
Node 4–Malawi, Rwanda, Senegal, and Tanzania mainland: Country was the only predictor for children from these four countries; therefore, Node 4 is terminal. Figure 3a shows that this group represents 21% of children who received treatment with any antimalarial medicine. Among these children, 71% received prompt treatment with ACT.

Node 5–Mozambique and Zanzibar: Figure 3e shows that children living in Mozambique and Zanzibar comprise just 6% of children who received any antimalarial treatment. Age of the mother was the best predictor of prompt treatment with ACT for these children (*p*-value <0.0001). This group is split into two subgroups: children whose mother is 20–29 years of age (Node 14) and children whose mother is either 15–19 years of age or 30–49 years of age (Node 15). The proportion of children who received prompt treatment with ACT was significantly higher (86%) among those with mothers ages 20–29 years, compared to their counterparts (75%, *p*-value=0.0180).

Node 6–Uganda: Figure 3f represents children in Uganda, who make up 11% of all children who were treated with any antimalarial medicine. Among children living in Uganda who received any antimalarial treatment, 67% received prompt treatment with ACT. Place of residence was the best predictor, with 71% receiving prompt treatment with ACT in urban areas (Node 16) compared to 66% in rural areas (Node 17) (*p*-value=0.0391).

Figure 3: Prompt treatment with ACT among children treated with any antimalarial drug – CHAID tree diagram

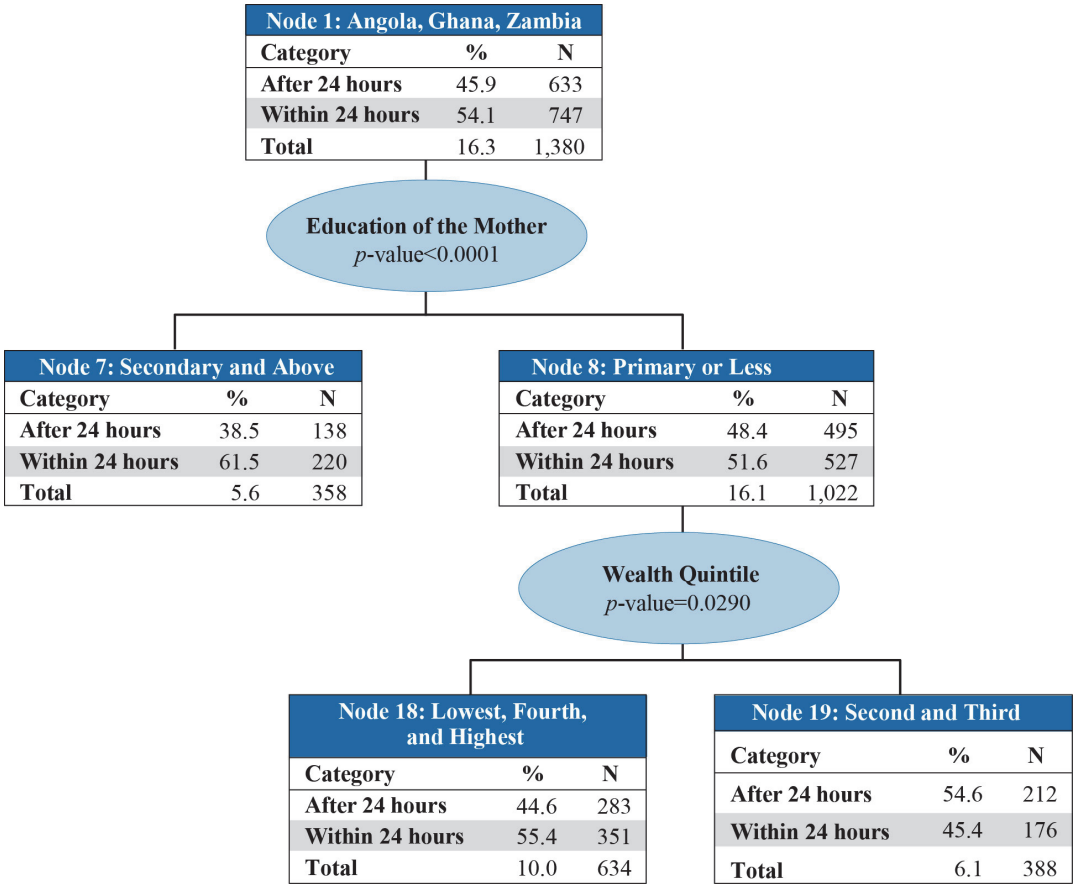
(a)



Notes: N: number of children. The **Total** line of each box represents the share of the total number of children who received any antimalarial treatment.

Figure 3 ***(continued)***

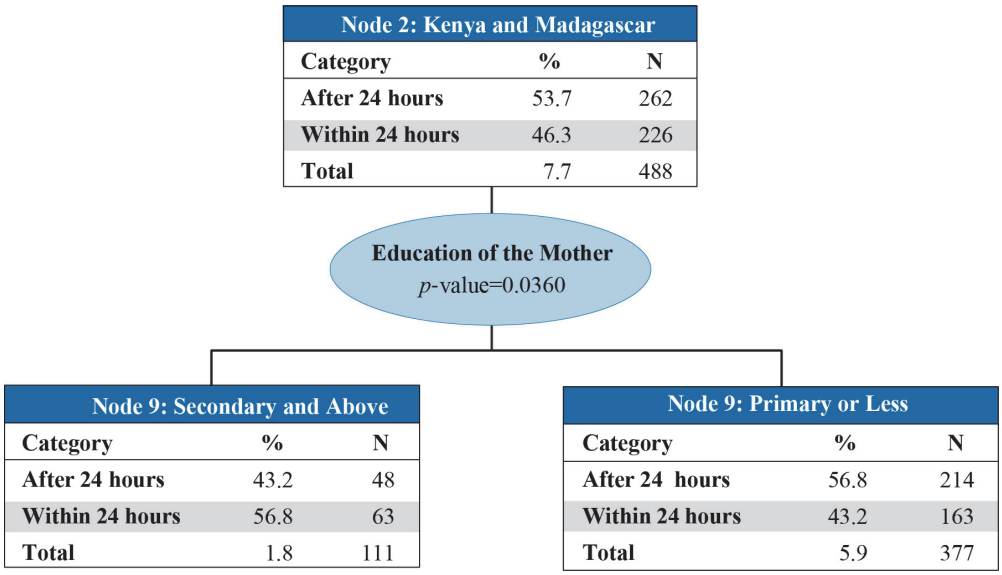
(b)



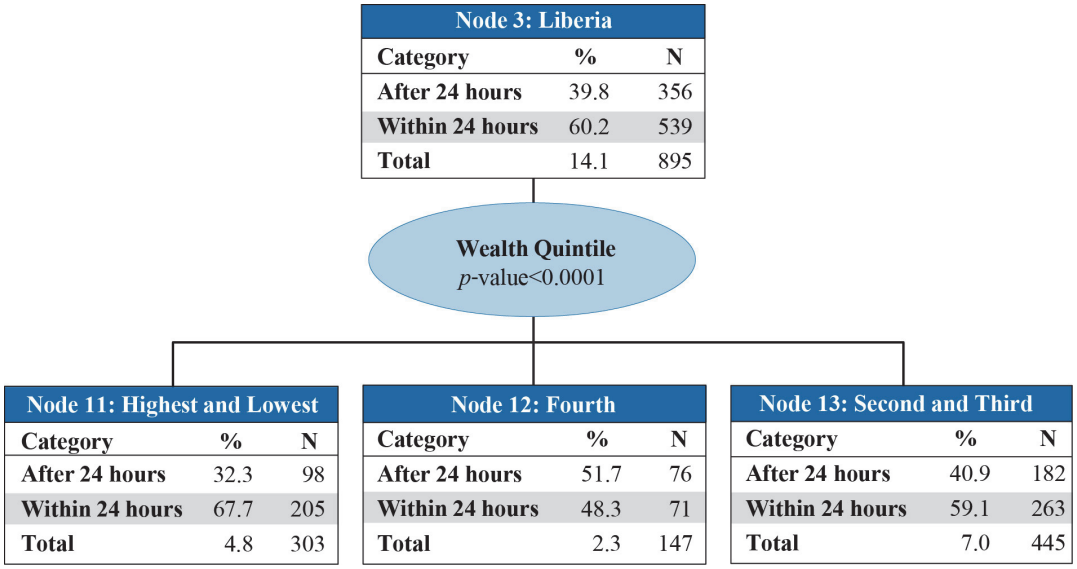
Notes: N: number of children. The **Total** line of each box represents the share of the total number of children who received any antimalarial treatment.

Figure 3 (*continued*)

(c)



(d)



Notes: N: number of children. The **Total** line of each box represents the share of the total number of children who received any antimalarial treatment.

Figure 3 (*continued*)

(e)

Node 5: Mozambique and Zanzibar		
Category	**%**	**N**
After 24 hours	19.6	80
Within 24 hours	80.4	328
Total	6.4	408

Age of the Mother
p-value=0.0180

Node 14: 20–29 Years		
Category	**%**	**N**
After 24 hours	14.1	28
Within 24 hours	85.9	171
Total	3.1	199

Node 15: 15–19 and 30–49 Years		
Category	**%**	**N**
After 24 hours	24.9	52
Within 24 hours	75.1	157
Total	3.3	209

(f)

Node 6: Uganda		
Category	**%**	**N**
After 24 hours	32.9	609
Within 24 hours	67.1	1,240
Total	10.5	895

Place of Residence
p-value=0.0391

Node 16: Urban		
Category	**%**	**N**
After 24 hours	28.1	94
Within 24 hours	71.1	240
Total	5.3	334

Node 17: Rural		
Category	**%**	**N**
After 24 hours	34.0	515
Within 24 hours	66.0	1,000
Total	23.9	1,515

Note: N: number of children. The **Total** line of each box represents the share of the total number of children who received any antimalarial treatment.

CHAID gain index

The 13 terminal nodes of the CHAID tree diagram represent 13 homogenous subgroups of children who received any antimalarial treatment. Table 10 describes these groups by their composition (columns A and B), demographic weight in the sample (columns C and D), share in prompt treatment with ACT (columns E and F), and corresponding proportion of children who received prompt and effective treatment (column G). The 13 homogenous subgroups can be grouped into three major clusters.

Cluster 1 represents 33% of children who received treatment with any antimalarial medicine, among which 73% of children received prompt treatment with ACT. The cluster includes children living in Mozambique and Zanzibar (Nodes 14 and 15), children living in urban areas of Uganda (Node 16), and children living in Malawi, Rwanda, Senegal, and Tanzania-mainland (Node 4). This cluster accounts for 38% of all children who received prompt treatment with ACT.

Cluster 2 accounts for 53% of children who received treatment with any antimalarial medicine, among which 62% of children received prompt treatment with ACT. This cluster includes six subgroups: (1) children in Liberia from the highest and lowest wealth quintiles (Node 11), (2) children in Liberia from the second and third wealth quintiles (Node 13), (3) children in rural areas of Uganda (Node 17), (4) children in Kenya and Madagascar whose mothers have at least secondary education (Node 9), (5) children in Angola, Ghana, and Zambia whose mothers have at least secondary education (Node 7), and (6) children in Angola, Ghana, and Zambia whose mothers did not attend secondary education but are from the lowest, fourth, or highest wealth quintile (Node 18). This cluster accounts for 52% of all children who received prompt treatment with ACT.

Cluster 3 represents 14% of children who received treatment with any antimalarial medicine. The cluster includes children from the fourth wealth quintile in Liberia (Node 12), children living in Angola, Ghana, and Zambia belonging to the second and the third wealth quintiles whose mothers did not attend secondary school (Node 19), and children from Kenya and Madagascar whose mothers did not attend secondary school (Node 10). In this cluster, 45% of children received prompt treatment with ACT, representing 10% of all children who received prompt treatment with ACT.

Table 10: CHAID gains for nodes

Cluster Node	Node description	Node		Gain		% prompt[e]	Index[f]
		N[a]	%[b]	N[c]	%[d]		
A	B	C	D	E	F	G	H
Cluster 1		**2,059**	**32.5**	**1,504**	**37.5**	**73.0**	**115.3**
14	Mozambique and Zanzibar: Children from 20–29 years old mothers	199	3.1	171	4.3	85.9	135.6
15	Mozambique and Zanzibar: Children from 20–29 years old mothers	209	3.3	157	3.9	75.1	118.5
16	Uganda: Children from urban areas	334	5.3	240	6.0	71.9	113.4
4	Malawi, Rwanda, Senegal, and Tanzania: All children	1,317	20.8	936	23.3	71.1	112.1
Cluster 2		**3,366**	**53.1**	**2,102**	**52.3**	**62.4**	**98.5**
11	Liberia: Children from lowest and highest wealth quintiles	303	4.8	205	5.1	67.7	106.8
17	Uganda: Children from rural areas	1,515	23.9	1,000	24.9	66.0	104.2
7	Angola, Ghana, and Zambia: Children from mothers with secondary education and above	358	5.6	220	5.5	61.5	97.0
13	Liberia: Children from second and middle quintiles	445	7.0	263	6.5	59.1	93.3
9	Kenya and Madagascar: Children from mothers with secondary education and above	111	1.8	63	1.6	56.8	89.6
18	Angola, Ghana, and Zambia: Children from mothers with primary or no education; children from lowest, fourth, and highest wealth quintiles	634	10.0	351	8.7	55.4	87.4
Cluster 3		**912**	**14.4**	**410**	**10.2**	**45.0**	**70.9**
12	Liberia: Children from the fourth wealth quintile	147	2.3	71	1.8	48.3	76.2
19	Angola, Ghana, and Zambia: Children from mothers with primary or no education; children from second and middle wealth quintiles	388	6.1	176	4.4	45.4	71.6
10	Kenya and Madagascar: Children from mothers with primary or no education	377	5.9	163	4.1	43.2	68.2
Total		6,337	100	4,016	100	63.4	n/a

Notes: N: number of children. [a] Number of children who received any antimalarial treatment per node (demographic size in the sample). [b] Demographic size in percentage = (.1/Σ.1)*100. [c] Number of children who received prompt treatment with artemisinin combination therapies (ACT). [d] Demographic size among children who received prompt treatment with ACT in percentage = (.3/Σ.3)*100. [e] Proportion of children who received prompt treatment with ACT out of those who received any antimalarial medicine = (.3/Σ.1)*100. [f] Node index = [(.3/Σ3)/(.1/Σ.1)]*100.

Summary

Key findings

This study assessed the extent to which children under five years of age have access to prompt treatment with ACT in selected countries in SSA. Descriptive analyses revealed that a low proportion of children who had fever received an antimalarial treatment (32% on average). Although all of the priority countries identified by PMI had adopted ACTs as first-line treatment for malaria by 2005, the majority of children with fever who received an antimalarial medicine were not given an ACT. The exceptions are Rwanda and Malawi, where nearly all children with fever who received an antimalarial treatment were given an ACT.

Further analyses revealed that while the proportion of children with fever who received treatment with any antimalarial medicine is below 40% in most countries surveyed, the proportion of these children who received the treatment promptly is over 50% in nearly all the countries. For instance, only 30% of children in Mozambique and 17% of children in Zanzibar received treatment with any antimalarial medicine, but a high proportion of those children (74% and 87%, respectively) received that treatment within 24 hours of the onset of fever. Similar results were reported for Senegal and Rwanda.

The study also looked at characteristics of children who received prompt and effective treatment. At the country level, chi-square tests showed that the children most likely to receive prompt and effective treatment were those whose mothers have at least a secondary education, those living in urban areas, and those belonging to the highest wealth quintiles. These results are in line with broader health data that indicate that these groups tend to have more access to education and resources.

Securing the supply chain of ACT is another important consideration if children are to receive prompt and effective treatment for malaria. ACT procurement has increased dramatically in recent years, in part due to the Affordable Medicines Facility-malaria (AMFm) initiative, which was more successful in some countries than others.[20] As shown in Figure 2, most countries with high access to any antimalarial treatment also had high access to ACT. This is, perhaps, unsurprising because one is dependent on the other. In Mali and Benin, however, both of which somewhat eschew this trend, it is likely that the market share of ACTs is particularly low. In a similar way, ACT policy was adopted in both countries shortly before the survey was conducted. These countries show how important policy and markets are to ensure access to prompt and effective treatment for malaria.

The cross-country CHAID analysis revealed that the country of residence is the best predictor of prompt and effective treatment, followed by maternal education, household wealth quintile, maternal age, and place of residence. Maternal education is the best predictor of prompt treatment with ACT for children in Angola, Ghana, Zambia, Kenya, and Madagascar. Household wealth quintile is the best predictor of access to prompt antimalarial treatment for children in Liberia. Among children in Mozambique and Zanzibar, maternal age is the best predictor of prompt treatment with ACT, while place of residence is the best

predictor of prompt access to antimalarial treatment for children living in Uganda. No predictor, however, is available for children in Malawi, Rwanda, Senegal, and Tanzania mainland. Another strong predictor of access to prompt and effective treatment for children in Angola, Ghana, and Zambia is household wealth quintile.

Limitations

Although this study presents informative findings, it does have limitations. It is difficult to track the extent to which patients with diagnosed malaria receive prompt and effective treatment because testing and treatment data are traditionally not linked in survey and routine data collection. This inability to follow the trajectory of individual patients is a major limitation in understanding treatment delays. This might be overcome by linking survey data and routine data.

The Roll Back Malaria Monitoring and Evaluation Reference Group discourages the use of self-reported survey data to measure prompt treatment. Malaria is one of many causes of fever in most of the countries in this study, and often it is a fairly rare one as evidenced by malaria test positivity rates.[21,22] Although the most recent DHS, MIS, and MICS include blood testing for malaria, the majority of the datasets included in this study either did not include that information or had low response rates.

In addition, data were collected over a six-year span from 2006 to 2012. This time difference among countries could be a liability in cross-country comparisons, particularly those related to malaria treatment policy. Most African countries had adopted ACT as first-line treatment by 2005,[2] but differences in access to ACTs could be at least partially explained by the stage of malaria policy implementation or ACT rollout.

Finally, the data collected in these surveys do not examine additional factors related to the social acceptability of malaria treatment and services. This information could help refine the profiles of children who received prompt and effective treatment.

Conclusions

Measuring treatment received within 24 hours is a difficult task, and new recommendations for case management indicators[23] emphasize care-seeking behavior, diagnostic testing, and treatment with ACT, regardless of time. Malaria control professionals must continue to work on overcoming treatment delays, even if the 24-hour threshold is no longer a specific focus.

In light of this study's findings, maternal education, place of residence, and standards of living could be considered key predictors of prompt access to malarial treatment. Mounting evidence suggests a need for national policies that integrate education, improved standards of living, and use of health services to improve malaria treatment and care. In the effort to ensure universal access to effective treatment, particular attention must be paid to specific groups to ensure they are effectively covered. This will require an effective monitoring and evaluation system capable of detecting disparities early. The authors recommend keeping these results in mind for future routine system strengthening activities.

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Annexes

Table A1 – Proportion of children in Angola who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	57.7	359	0.01	0.910
Female	57.9	379		
Age of the child (months)				
<6	56.6	45		
6–23	58.2	304	0.40	0.820
24–59	56.7	389		
Relationship				
Child or step child	57.4	585		
Grandchild	64.3	122	6.86	0.032
Other	40.5	31		
Age of mother (years)				
15–19	61.3	74		
20–30	59.0	425	1.61	0.448
30–49	54.7	239		
Education of mother				
None	51.2	135		
Primary	56.3	452	7.06	0.029
Secondary and above	68.1	151		
Region of residence				
Hiperendemica	50.4	114		
Mesoendemica estavel	67.4	207	8.83	0.032
Mesoendemica instavel	45.2	166		
Luanda	54.2	251		
Place of residences				
Urban	62.6	416	4.13	0.042
Rural	53.1	322		
Wealth quintiles				
Poorest	67.5	52		
Second	58.1	63		
Middle	48.8	114	10.74	0.030
Fourth	54.5	262		
Richest	62.5	247		
Total	**57.8**	**738**		

Table A2 – Proportion of children in Benin who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	p-value
Sex				
Male	78.8	1,145	1.67	0.196
Female	76.5	1,098		
Age of the child (months)				
<6	80.2	146		
6–23	76.2	993	3.92	0.141
24–59	78.8	1,104		
Relationship				
Child or step child	77.9	2,011		
Grandchild	76.7	187	0.11	0.948
Other	76.6	45		
Age of the mother (years)				
15–19	75.9	81		
20–29	77.5	1,098	0.06	0.970
30–49	78.2	1,064		
Education of the mother				
None	76.6	1,646		
Primary	82.6	450	15.62	<0.0001
Secondary and above	85.2	147		
Region of residence				
Alibori	72.5	128		
Atacora	67.8	198		
Atlantique	72.3	333		
Borgou	76.8	193	58.64	<0.0001
Collines	71.0	266		
Couffo	79.0	141		
Donga	87.1	138		
Littoral	90.8	119		
Mono	77.8	62		
Queme	83.5	243		
Plateau	88.0	114		
Zou	79.6	308		
Place of residence				
Urban	84.5	772	22.48	<0.0001
Rural	74.4	1,471		
Wealth quintiles				
Poorest	70.5	436		
Second	74.1	468		
Middle	76.6	519	37.63	<0.0001
Fourth	83.8	508		
Richest	84.1	312		
Total	**77.8**	**2,243**		

Table A3 – Proportion of children in Ghana who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	59.4	121	3.87	0.049
Female	50.0	104		
Age of the child (months)				
<6	32.3	3		
6–23	56.3	82	0.78	0.679
24–59	55.1	140		
Relationship				
Child or step child	55.8	188	0.02	0.888
Other	51.6	37		
Age of the mother (years)				
15–19	55.1	8		
20–29	54.3	96	0.09	0.957
30–49	56.0	121		
Education of the mother				
None	52.5	65		
Primary	59.7	55	1.34	0.512
Secondary and above	54.0	105		
Region of residence				
Western	57.1	9		
Central	71.1	18		
Greater Accra	49.7	15		
Volta	57.5	20		
Eastern	55.6	11		
Ashanti	43.3	43	28.16	0.001
Brong Ahafo	72.2	28		
Northern	31.1	33		
Upper East	87.1	25		
Upper West	49.2	23		
Place of residence				
Urban	51.0	91	1.29	0.257
Rural	58.5	134		
Wealth quintiles				
Poorest	49.5	51		
Second	58.2	47		
Middle	55.6	47	0.11	0.999
Fourth	53.3	56		
Richest	62.1	24		
Total	**55.2**	**225**		

Table A4 – Proportion of children in Kenya who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	46.3	166	0.01	0.928
Female	55.8	145		
Age of the child (months)				
<6	65.1	11		
6–23	39.8	129	1.42	0.491
24–59	56.5	171		
Relationship				
Child or step child	51.7	262	0.33	0.565
Other	43.7	49		
Age of the mother (years)				
15–19	7.8	14		
20–29	53.0		6.30	0.043
30–49	49.9	297		
Education of the mother				
None	32.4	58		
Primary	49.3	192	9.59	0.008
Secondary and above	66.5	61		
Region of residence				
Nairobi	46.3	7		
Central	86.0	12		
Coast	42.7	55		
Eastern	81.0	23	18.76	0.009
Nyanza	46.5	83		
Rift valley	25.2	40		
Western	62.2	65		
Northeastern	33.9	26		
Place of residence				
Urban	59.8	71	0.06	0.808
Rural	52.4	240		
Wealth quintiles				
Poorest	32.9	90		
Second	54.0	56		
Middle	48.4	64	11.30	0.023
Fourth	65.5	47		
Richest	62.5	54		
Total	**50.6**	**311**		

Table A5 – Proportion of children in Liberia who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	61.6	467	0.42	0.515
Female	60.9	428		
Age of the child (months)				
<6 months	60.2	60		
6–23 months	62.6	293	0.01	0.997
24–59 months	60.7	542		
Relationship				
Child or step child	62.6	665		
Grandchild	58.3	106	0.96	0.619
Other	56.7	124		
Age of the mother (years)				
15–19	56.3	59		
20–29	60.5	459	0.98	0.612
30–49	63.0	377		
Education of the mother				
None	64.2	379		
Primary	57.0	298	1.58	0.453
Secondary and above	62.1	218		
Region of residence				
Monrovia	58.2	98		
North western	63.8	146		
South central	57.1	153	4.20	0.521
South eastern a	60.0	155		
South eastern b	61.5	180		
North central	65.2	163		
Place of residence				
Urban	55.6	399	5.01	0.025
Rural	65.6	496		
Wealth quintiles				
Poorest	69.8	219		
Second	63.1	259		
Middle	59.1	186	16.03	0.003
Fourth	45.0	147		
Richest	69.1	84		
Total	**61.3**	**895**		

Table A6 – Proportion of children in Madagascar who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	40.4	94	0.09	0.766
Female	44.2	83		
Age of the child (months)				
<6	34.6	12		
6–23	33.8	67	3.61	0.165
24–59	48.7	98		
Relationship				
Child or step child	39.0	157	0.00	0.942
Other	66.3	20		
Age of the mother (years)				
15–19	57.6	15	2.11	0.348
20–29	42.6	76		
30–49	40.0	86		
Maternal education				
None	56.4	55		
Primary	29.3	72	3.42	0.181
Secondary and above	50.8	50		
Region of residence				
Analamanga	31.6	9		
Itasy	92.6	3		
Bongolava	100.0	3		
Haute Matsiatra	58.9	8		
Amoron i Mania	100.0	1		
Yatovavy Fitovinany	45.9	29		
Ihorombe	50.0	2	33.41	0.022
Atsimo Atsinanana	55.1	12		
Atsinanana	19.5	12		
Analanjirofo	11.0	12		
Alaotra Mangoro	50.0	2		
Boeny	100.0	1		
Sofia	38.9	10		
Betsiboka	25.8	6		
Atsimo Andrefana	76.0	20		
Androy	25.3	24		
Anosy	58.1	19		
Menabe	0.0	1		
Diana	0.0	1		
Sava	16.5	2		
Place of residence				
Urban	44.5	23	0.05	0.831
Rural	42.0	154		
Wealth quintiles				
Poorest	45.2	44		
Second	36.0	37		
Middle	33.3	42	2.51	0.642
Fourth	59.5	23		
Richest	48.6	31		
Total	**42.1**	**177**		

Table A7 – Proportion of children in Malawi who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	**72.3**	**106**	**0.22**	**0.636**
Female	**74.3**	**110**		
Age of the child (months)				
<6	**100.0**	**2**		
6–23	**74.6**	**90**	**0.83**	**0.659**
24–59	**71.9**	**124**		
Relationship				
Child or step child	**75.5**	**195**	**4.56**	**0.033**
Other	**52.8**	**21**		
Age of the mother (years)				
15–19	**53.8**	**10**		
20–29	**69.5**	**125**	**2.42**	**0.298**
30–49	**80.5**	**81**		
Maternal education				
None	**68.5**	**35**		
Primary	**73.8**	**140**	**0.88**	**0.643**
Secondary and above	**76.6**	**41**		
Region of residence				
Northern	**88.2**	**25**		
Central	**75.4**	**83**	**2.14**	**0.342**
Southern	**69.7**	**108**		
Place of residence				
Urban	**74.4**	**45**	**0.04**	**0.852**
Rural	**73.2**	**171**		
Wealth quintiles				
Poorest	**77.7**	**49**		
Second	**63.4**	**46**		
Middle	**83.7**	**33**	**5.25**	**0.263**
Fourth	**66.8**	**47**		
Richest	**81.8**	**41**		
Total	**73.3**	**216**		

Table A8 – Proportion of children in Mozambique who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	69.7	183	0.61	0.435
Female	79.6	183		
Age of the child (months)				
<6	100.0	11		
6–23	68.3	135	3.98	0.137
24–59	76.8	220		
Relationship				
Child or step child	74.2	309	0.04	0.851
Other	75.2	57		
Age of the mother (years)				
15–19	70.7	38		
20–29	79.1	179	8.68	0.013
30–49	70.6	149		
Maternal education				
None	76.3	117		
Primary	73.7	222	1.72	0.423
Secondary and above	70.1	27		
Region of residence				
Niassa	83.6	43		
Cabo Delgado	100.0	18		
Nampula	83.3	43		
Zambezia	47.9	70		
Tete	88.7	22	55.90	<0.0001
Manica	84.2	50		
Sofala	84.7	66		
Inhambane	86.6	23		
Gaza	84.7	25		
Maputo Provincia	100.0	2		
Maputo Cidade	100.0	4		
Place of residence				
Urban	78.7	84	0.09	0.761
Rural	73.1	282		
Wealth quintiles				
Poorest	73.6	82		
Second	66.0	65		
Middle	78.0	111	5.67	0.226
Fourth	78.4	77		
Richest	75.9	31		
Total	**74.4**	**366**		

Table A9 – Proportion of children in Rwanda who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	68.8	73	0.06	0.802
Female	73.1	67		
Age of the child (months)				
<6	75.5	3		
6–23	68.1	55	0.13	0.937
24–59	72.5	82		
Relationship				
Child or step child	71.0	127	0.06	0.806
Other	69.4	13		
Age of the mother (years)				
15–19	45.4	2		
20–29	65.2	73	2.69	0.260
30–49	78.2	65		
Maternal education				
None	69.9	24		
Primary	72.1	107	0.19	0.912
Secondary and above	57.2	9		
Region of residence				
Kigali city	74.4	11		
South	68.3	63		
West	73.1	26	1.72	0.786
North	100.0	4		
East	69.1	36		
Place of residence				
Urban	90.0	15	1.76	0.184
Rural	68.9	125		
Wealth quintiles				
Poorest	69.7	41		
Second	51.4	26		
Middle	76.3	31	9.44	0.051
Fourth	79.0	17		
Richest	81.1	25		
Total	**70.8**	**140**		

Table A10 – Proportion of children in Senegal who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	66.0	107	4.00	0.046
Female	84.0	69		
Age of the child (months)				
<6	91.9	12		
6–23	72.1	58	0.624	0.732
24–59	71.2	106		
Relationship				
Child or step child	67.8	83	0.07	0.788
Other	77.1	93		
Age of the mother (years)				
15–19	44.5	9		
20–29	75.3	77	0.54	0.765
30–49	73.3	90		
Maternal education				
None	70.4	109		
Primary	69.0	49	2.22	0.330
Secondary and above	94.9	18		
Region of residence				
Dakar	74.8	34		
Ziguinchor	100.0	7		
Diourbel	45.9	10		
Saint-Louis	58.7	15		
Tambacounda	83.6	25		
Kaolack	76.2	4		
Thies	85.5	7	20.55	0.082
Louga	46.2	13		
Fatick	82.5	9		
Kolda	79.9	17		
Matam	63.7	12		
Kaffrine	66.6	7		
Kedougou	100.0	3		
Sedhiou	94.3	13		
Place of residence				
Urban	74.9	74	0.00	0.978
Rural	70.1	102		
Wealth quintiles				
Poorest	61.6	38		
Second	76.8	43		
Middle	62.2	30	6.07	0.194
Fourth	66.0	34		
Richest	87.7	31		
Total	**73.0**	**176**		

Table A11 – Proportion of children in Tanzania mainland who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	70.4	402	0.46	0.497
Female	67.3	383		
Age of the child (months)				
<6	70.8	40		
6–23	63.5	307	5.78	0.056
24–59	72.6	438		
Relationship				
Child or step child	69.8	620		
Grandchild	66.1	108	1.94	0.379
Other	64.7	57		
Age of the mother (years)				
15–19	68.1	41		
20–29	67.5	390	0.75	0.687
30–49	70.6	354		
Education of the mother				
None	64.6	194		
Primary	70.7	533	2.88	0.237
Secondary and above	67.5	58		
Region of residence				
Dodoma	63.6	45		
Arusha	73.3	16		
Kilimanjaro	82.4	17		
Tanga	77.6	26		
Morogoro	75.6	46		
Pwani	74.8	31		
Dar es Salaam	84.5	38		
Lindi	92.3	32		
Mtwara	96.4	33		
Ruvuma	88.4	34		
Iringa	78.3	9		
Mbeya	58.9	26		
Singida	71.1	45		
Tabora	79.4	35	74.12	0.000
Rukwa	69.4	34		
Kigoma	61.0	72		
Shinyanga	47.0	43		
Kagera	74.3	36		
Mwanza	63.9	70		
Mara	43.2	84		
Manyara	89.5	13		
Place of residence				
Urban	73.5	187	0.99	0.319
Rural	67.0	598		
Wealth quintiles				
Poorest	64.0	174		
Second	67.0	176		
Middle	73.2	160	1.25	0.870
Fourth	68.7	158		
Richest	72.3	117		
Total	**68.9**	**785**		

Table A12 – Proportion of children in Uganda who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	66.4	892	1.14	0.285
Female	64.4	957		
Age of the child (months)				
<6	63.0	64		
6–23	63.7	699	3.01	0.222
24–59	66.5	1,086		
Relationship				
Child or step child	66.3	1,549		
Grandchild	58.5	197	2.78	0.251
Other	64.2	103		
Age of the mother (years)				
15–19	71.7	95		
20–29	63.9	1,025	3.03	0.220
30–49	66.6	729		
Education of the mother				
None	64.8	281		
Primary	64.8	1,217	1.93	0.380
Secondary and above	67.9	351		
Region of residence				
Kampala	70.0	88		
Central 1	60.9	158		
Central 2	74.3	186		
East central	57.6	264	73.29	<0.000
Eastern	68.8	384		
North	62.2	209		
Karamoja	81.1	164		
West-Nile	80.1	203		
Western	56.8	146		
Southwest	38.1	47		
Place of residence				
Urban	68.6	334	4.24	0.039
Rural	65.0	1,515		
Wealth quintiles				
Poorest	66.5	541		
Second	67.3	390		
Middle	59.0	312	8.73	0.068
Fourth	64.2	290		
Richest	69.1	316		
Total	**65.4**	**1,849**		

Table A13 – Proportion of children in Zambia who received treatment with any antimalarial medicine within 24 hours of the onset of the fever (prompt) among children with fever who received any antimalarial treatment, by background characteristics.

Background characteristics	Prompt treatment (%)	Total	Chi-square	*p*-value
Sex				
Male	55.0	217	0.59	0.441
Female	51.8	200		
Age of the child (months)				
<6	54.9	23		
6–23	54.7	195	0.56	0.758
24–59	52.0	199		
Relationship				
Child or step child	52.3	341		
Grandchild	52.6	50	2.62	0.269
Other	72.2	26		
Age of the mother (years)				
15–19	66.9	30		
20–29	56.8	228	5.01	0.081
30–49	46.8	159		
Education of the mother				
None	47.1	51		
Primary	50.7	267	10.01	0.007
Secondary and above	65.7	99		
Region of residence				
Central	56.8	48		
Copperbelt	55.9	50		
Eastern	54.6	63		
Luapula	36.5	23		
Lusaka	62.7	32	22.48	0.004
Northern	44.6	69		
Northwestern	53.8	37		
Southern	78.9	45		
Western	35.6	50		
Place of residence				
Urban	59.4	148	1.59	0.207
Rural	51.1	269		
Wealth quintiles				
Poorest	52.4	79		
Second	42.7	97		
Middle	49.6	98	18.13	0.001
Fourth	66.8	90		
Richest	64.9	53		
Total	**53.4**	**417**		