Evidence for Malaria Medicines Policy

ACTwatch 2009 Supply Chain Survey Results
Uganda

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Acknowledgements

Contents

Definitions & Key Indicator Descriptions

Acceptable storage conditions for medicines: A wholesaler or outlet is considered to have acceptable storage conditions for medicines if it is in compliance with all the following three standards: (1) medicines are stored in a dry area; (2) medicines are protected from direct sunlight; and (3) medicines are not kept on the floor.

Adult equivalent treatment dose (AETD): The number of milligrams of an antimalarial treatment needed to treat a 60kg adult whereby all dosage types found (tablet, suspension, syrup, etc.) are converted regardless of their original presentation (whether for child or adult). The number of mg/kg used to determine the dose is defined as what is recommended for a particular drug combination in the treatment guidelines for uncomplicated malaria in areas of low drug resistance issued by the WHO. Where this does not exist, a product manufacturer's treatment guidelines are consulted. See Appendix 6.3 for additional details

Antimalarial combination therapy: The use of two or more classes of antimalarial drugs/molecules in the treatment of malaria that have independent modes of action.

Antimalarial: Any medicine recognized by the WHO for the treatment of malaria. Medicines used solely for the prevention of malaria were excluded from analysis in this report.

Artemisinin and its derivatives: Artemisinin is a plant extract used in the treatment of malaria. The most common derivatives of artemisinin used to treat malaria are artemether, artesunate, and dihydroartemisinin.

Artemisinin monotherapy (AMT): An antimalarial medicine that has a single active compound, where this active compound is artemisinin or one of its derivatives.

Artemisinin-based Combination Therapy (ACT): An antimalarial that combines artemisinin or one of its derivatives with an antimalarial or antimalarials of a different class. Refer to combination therapy (below).

Availability of any antimalarial or RDTs: The proportion of wholesalers in which the specified antimalarial medicine or RDT was found on the day of the survey, based upon an audit conducted by the interviewer. For indicators of availability, all wholesalers who were eligible to participate after screening (i.e. had any antimalarial or RDT in stock at present or at any point in the 3 months prior to interview) are included in the denominator.

Booster sample: A booster sample is an extra sample of units (or in this case outlets) of a type not adequately represented in the main survey, but which are of special interest. In Uganda the ACTwatch Outlet Survey included a booster sample of all public health facilities in the entire county in which a selected subcounty/parish was located; and registered pharmacies in the entire district in which a selected subcounty/parish was located.

Censused sub-district: Subcounties (or parishes, in the case of Kampala) where field teams conducted a full census of all outlets with the potential to sell antimalarials as part of the ACTwatch Outlet Survey.

Combination therapy: The use of two or more classes of antimalarial drugs/molecules in the treatment of malaria that have independent modes of action.

Credit to consumers: A wholesaler is considered to provide credit to consumers based on the response of the wholesaler.

Distribution chain: The chain of businesses operating from the factory gate/port of entry down to the retail level. Also sometimes referred to as downstream value chain. In this report, the terms distribution chain and supply chain are used interchangeably. More specifically, the 'private commercial sector distribution chain' refers to any type of public or private wholesaler who served private commercial outlets, as well as private commercial wholesalers who served public sector or NGO outlets so that any transactions between public, NGO and private commercial sectors are noted.

Dosing/treatment regimen: The posology or timing and number of doses of an antimalarial used to treat malaria. This schedule often varies by patient weight.

First-line treatment: The government recommended treatment for uncomplicated malaria. Uganda's first-line treatment for *Plasmodium falciparum* malaria is artemether-lumefantrine, 20mg/120mg.

Inter-quartile range (IQR): A descriptive statistic that provides a measure of the spread of the middle 50% of observations. The lower bound value of the range is defined by the 25th percentile observation and the upper bound value is defined by the 75th percentile observation.

Mark-up: The difference between the price at which a product is purchased, and that at which it is sold. Sometimes also referred to as margin. In this report, the terms mark-up and margin are used interchangeably. May be expressed in absolute or percent terms. Because it is common for wholesalers to vary their prices with the volumes they sell, minimum, mid and maximum mark-ups were calculated in this report using price data collected from interviewees. Key findings on price mark-ups at the wholesale level are reported using mid mark-up data. As maximum and minimum selling prices were not collected at the retail level, only one set of absolute and percent retail mark-ups is calculated.

> **Absolute mark-up**: The absolute mark-up is calculated as the difference between the selling price and the purchase price per full-course adult equivalent treatment dose. In this report, absolute mark-ups are reported in US dollars. The average exchange rate during the data collection period for wholesale purchase prices (13 February to 6 April 2009) was 2049.16 Uganda Shillings (UGX) to US$1; the average exchange rate during the data collection period for retail purchase prices (16 March to 7 April 2009) was 2113.53 Uganda Shillings (UGX) to US$1 (www.oanda.com).

> **Percent mark-up**: The percentage mark-up is calculated as the difference between the selling price and the purchase price, divided by the purchase price.

> **Maximum mark-up**: For wholesale level only, the absolute and percent maximum mark-ups are calculated as above using the difference between *maximum* wholesale selling price and the wholesale purchase price.

> **Minimum mark-up**: For wholesale level only, the absolute and percent minimum mark-ups are calculated as above using the difference between *minimum* wholesale selling price and the wholesale purchase price.

> **Mid mark-up**: For wholesale level only, the absolute and percent mid mark-ups are calculated as above using the difference between the *average* wholesale selling price (i.e. the mid-point between the maximum and minimum wholesale selling price) and wholesale purchase price.

Median: A descriptive statistic given by the middle (or 50th percentile) value of an ordered set of values (or the average of the middle two in a set with an even number of values), which is an appropriate measure of central tendency of a skewed distribution of continuous data.

Monotherapy: An antimalarial medicine that has a single mode of action. This may be a medicine with a single active compound or a synergistic combination of two compounds with related mechanisms of action.

Non-artemisinin therapy (nAT): An antimalarial treatment that does not contain artemisinin or any of its derivatives.

Non-WHO-prequalified ACTs: ACTs that do not meet acceptable standards of quality, safety and efficacy as assessed by the WHO Prequalification of Medicines Programme, or have yet to be assessed as such. (See WHO-prequalified ACTs below)

Oral artemisinin monotherapy: Artemisinin or one of its derivatives in a dosage form with an oral route of administration. These include tablets, suspensions, and syrups and exclude suppositories and injections.

Outlet: Any point of sale or provision of a commodity to an individual. Outlets are not restricted to stationary points of sale and may include mobile units or individuals. Refer to Appendix 6.3 for a description of the outlet types visited as part of the ACTwatch Outlet Survey.

Purchase price: The price paid by businesses (i.e. wholesalers or outlets) for their most recent purchase of an antimalarial product from their suppliers. This is different from selling price (see below). Prices are reported in terms of full adult equivalent treatment dose treatment. Prices are shown in US dollars. The average exchange rate during the data collection period for wholesale purchase prices (13 February to 6 April 2009) was 2049.16 Uganda Shillings (UGX) to US$1; the average exchange rate during the data collection period for retail purchase prices (16 March to 7 April 2009) was 2113.53 Uganda Shillings (UGX) to US$1 (www.oanda.com).

Rapid-Diagnostic Test (RDT) for malaria: Malaria rapid diagnostic tests, sometimes called "dipsticks" or malaria rapid diagnostic devices, assist in the diagnosis of malaria by providing evidence of the presence of malaria parasites in human blood. RDTs do not require laboratory equipment, and can be performed and interpreted by non-clinical staff.

Screening/Eligibility criteria: The set of requirements that must be satisfied before the full questionnaire is administered. In the ACTwatch Supply Chain Survey, a wholesaler met the screening criteria if (1) they had any antimalarial or RDTs in stock at the time of the survey visit, or (2) they report having stocked either antimalarials or RDTs in the past three months.

Second-line treatment: The government recommended second-line treatment for uncomplicated malaria. Uganda's second-line treatment for *Plasmodium falciparum* malaria is quinine.

Selling price: The price paid by customers to purchase antimalarials. For outlets, these customers are patients or caretakers; for wholesalers, these customers are other businesses or health facilities. Because it is common for wholesalers to vary their selling prices depending on the volumes purchased by the customer, data on maximum and minimum selling price charged for one unit by wholesalers were collected for each antimalarial product type in stock at the time of interview.

Stock outs of ACT: Reported in the affirmative as the percentage of interviewed wholesalers who reported to have always had at least one ACT in stock over the past 3 months. All eligible (see Screening criteria above) wholesalers who were successfully interviewed were included in the denominator.

Sub-district (SD): The primary sampling unit, or cluster, for the ACTwatch Outlet Survey is generally defined in Uganda as the subcounty, which typically hosts a population size of approximately 10,000 to 15,000 inhabitants. However, in Kampala where the subcounty populations far exceed this approximate size, a smaller sub-division, the parish, has been used as the sub-district.

Top selling antimalarial: The antimalarial with the largest volume of adult equivalent treatment doses sold or distributed in the past week as reported by individual wholesalers.

Volumes: Volumes of antimalarials sold in the previous week are reported in terms of full-course adult equivalent treatment doses (or AETDs; see above for description).

WHO-prequalified ACTs: ACTs that meet acceptable standards of quality, safety and efficacy as assessed by the WHO Prequalification of Medicines Programme. This is a service provided by WHO to guide bulk medicine purchasing of international procurement agencies and countries for distribution in resource limited settings, often using funds for development aid (e.g. Global Fund grants). More details on the list of prequalified medicines and the prequalification process may be found on the WHO website at: http://www.who.int/mediacentre/factsheets/fs278/en/index.html.

Wholesalers: Businesses that supply other businesses, which may include retailers or other wholesalers. In this report, wholesalers are classified further into more specific categories defined by the type of businesses that they supply. As some wholesalers will supply different types of businesses (e.g. both retail outlets and other wholesalers), these categories are not mutually exclusive and such wholesalers may appear in multiple categories. These are defined below.

> **Terminal wholesalers:** Wholesalers that supply retail outlets *directly*. For example, wholesaler X is a terminal wholesaler if it supplies antimalarials to pharmacies and drug shops from which patients buy medicines. Terminal wholesalers may supply retail outlets only, but may also supply other wholesalers.

> **Intermediate-1 wholesalers**: Wholesalers that supply terminal wholesalers *directly*. Intermediate-1 wholesalers may supply terminal wholesalers only, but may also supply other types of wholesalers (such as other intermediate-1 wholesalers) and retail outlets.

> **Intermediate-2 wholesalers**: Wholesalers that supply Intermediate-1 wholesalers *directly*. Intermediate-2 wholesalers may supply Intermediate-1 wholesalers only, but may also supply other types of wholesalers (such as terminal wholesalers) and retail outlets.

> **Intermediate-3 wholesalers**: Wholesalers that supply Intermediate-2 wholesalers *directly*. Intermediate-3 wholesalers may supply Intermediate-2 wholesalers only, but may also supply other types of wholesalers (such as intermediate-1 or terminal wholesalers) and retail outlets.

> **Intermediate-4 wholesalers**: Wholesalers that supply Intermediate-3 wholesalers *directly*. Intermediate-4 wholesalers may supply Intermediate-3 wholesalers only, but may also supply other types of wholesalers (such as intermediate-2, intermediate-1 or terminal wholesalers) and retail outlets.

> **Wholesalers supplying retailers**: This is an analytical category specific to ACTwatch that groups together all wholesalers that may be categorised as a terminal wholesaler.

> **Wholesalers supplying wholesalers**: This is an analytical category specific to ACTwatch that groups together all wholesalers that may be categorised as operating at an intermediate level of the supply chain (e.g. in this report, intermediate-1, intermediate-2 and intermediate-3 wholesalers).

Abbreviations

ACT	artemisinin-based combination therapy
AETD	adult equivalent treatment dose
AL	artemether lumefantrine
AMFm	Affordable Medicine Facility - malaria
AMT	artemisinin monotherapy
AR	artemether
AS	artesunate
ASAQ	aretesunate-amodiaquine
ASMQ	artesunate and mefloquine
CMD	Community Medicine Distributor
CQ	chloroquine
DHA	dihydroartemisinin
DHA+PP	dihydroartemisinin and piperaquine
HBM	Home-based management of fever for children
INT	intermediate level (wholesaler of supply chain)
IPT	intermittent preventive treatment of malaria
IQR	inter-quartile range
IRS	indoor residual spraying
ITN	insecticide treated net
JMS	Joint Medical Stores
LSHTM	London School of Hygiene & Tropical Medicine
MEC	mutually-exclusive category of wholesalers
MOH	Ministry of Health
MQ	mefloquine
nAT	non-artemisinin therapy
NDA	National Drug Authority, Uganda
NGO	non-governmental organisation
NMCP	National Malaria Control Programme
NMS	National Medical Stores
OS	ACTwatch Outlet Survey
OTC	over-the-counter
PACE	Program for Accessible Health, Communication and Education (Uganda)
Pf	*Plasmodium falciparum*
PMI	US President's Malaria Initiative
POM	prescription only medicine
PPS	probability proportional to size
PSI	Population Services International
RDT	rapid diagnostic test
SP	sulphadoxine pyrimethamine
WHO	World Health Organization
WS	Wholesaler

Executive Summary

Background

In Uganda, as in many low-income countries, private commercial providers play an important role in the treatment of malaria. To design effective interventions for improved access to accurate diagnosis and effective malaria treatment, there is a need to understand retailer behaviour and identify the factors that influence their stocking and pricing decisions. Private commercial retailers are the last link in a chain of manufacturers, importers and wholesalers and their supply sources are likely to have an important influence on the price and quality of malaria treatment that consumers can access. However, there is limited rigorous evidence on the structure and operation of the distribution chain for antimalarial drugs that serves the retail sector.

The ACTwatch Supply Chain Study, one of the ACTwatch project components, aims to address this gap by conducting quantitative and qualitative studies on distribution chains for antimalarials in the ACTwatch countries (Uganda, Cambodia, Zambia, Nigeria, Benin, Madagascar and the Democratic Republic of Congo (DRC)). Other elements of ACTwatch include Retail Outlet and Household Surveys led by Population Services International (PSI). This report presents the results of a cross-sectional survey of antimalarial drug wholesalers conducted in Uganda between February and April 2009.

Methods

The Supply Chain survey was implemented by the London School of Hygiene & Tropical Medicine (LSHTM), with support from the Program for Accessible Health, Communication and Education (PACE) Uganda/PSI, following shortly after the ACTwatch Outlet Survey conducted by PSI. Wholesalers operating at different levels of the supply chain that served a representative sample of Uganda's malaria endemic and epidemic-prone areas were sampled through a bottom-up approach during which wholesalers were identified by their customers until the top of the chain was reached. For this purpose, all 38 sub-districts from the ACTwatch Outlet Survey were included in the sample. The sampling procedure used the list of the two top antimalarial wholesale sources (termed the terminal wholesalers) reported by each antimalarial retail outlet that participated in the Outlet Survey. From these data a list of all terminal wholesalers mentioned was created. All these terminal wholesalers were visited and invited to participate in the Supply Chain survey. Wholesalers were eligible to participate if they met the following screening criteria: they had either an antimalarial or rapid diagnostic test (RDT) in stock at the time of interview, or they reported to have stocked either antimalarials or RDTs in the three months prior to interview. During the interview, eligible wholesalers were also asked about their two top supply sources for antimalarials (termed the intermediate-1 wholesalers). From these data, we created a list of all intermediate-1 wholesalers mentioned. All these intermediate-1 wholesalers were visited and invited to participate in the Supply Chain survey, during which, as at previous levels, they were asked about their two top supply sources for antimalarials (termed the intermediate-2 wholesalers). This process was repeated until the factory gate or port of entry was reached.

The supply chain survey collected data on the structure of the private commercial sector supply chain; wholesaler characteristics and business practices; wholesale outlet licensing and inspection; wholesaler knowledge, qualifications and training; and wholesale availability, purchase prices and mark-ups for antimalarials and RDTs. Retail outlets' purchase prices and mark-ups for antimalarials collected during the Outlet Survey are also presented in this report as they form the last step of the supply chain before antimalarials reached patients/caretakers and are therefore relevant to the study of the distribution chain.

Results

STRUCTURE OF THE SUPPLY CHAIN: A total of 142 antimalarial wholesalers were identified, and 129 interviews were conducted. The maximum number of steps from manufacturers' factory gate to retail outlets was 6 with wholesalers operating across 5 overlapping levels: intermediate-4 (INT 4 WS), intermediate-3 (INT 3 WS), intermediate-2 (INT 2 WS), intermediate-1 (INT 1 WS) and terminal (TERMINAL WS) levels. (Figure 1) However, most antimalarials were likely to go through 3 steps from manufacturer to retailer (or 4 steps from manufacturer to end-user) as 81.4% of all wholesalers supplied antimalarials to retailers, and of these, only 3.9% were observed to purchase antimalarials directly from manufacturers as one of their two top suppliers. As a result, the supply chain is shaped as a pyramid with a particularly broad base. Each red dot on Figure 1 represents a mutually exclusive group of wholesalers and the array of arrows emanating from them describes the specific supply chain levels that each wholesaler group serves. Their percentage share is attached to each group. The dashed line from manufacturer to retailer indicates that there may be some retailers who purchase antimalarials directly from manufacturers; however, these transactions were rare. Figure 2 illustrates how the overlapping analytical categories used throughout this report are derived from the different mutually exclusive wholesaler categories depicted in Figure 1.

Figure 1: Representation of the antimalarial distribution chain showing interactions between supply chain levels by mutually exclusive wholesaler category
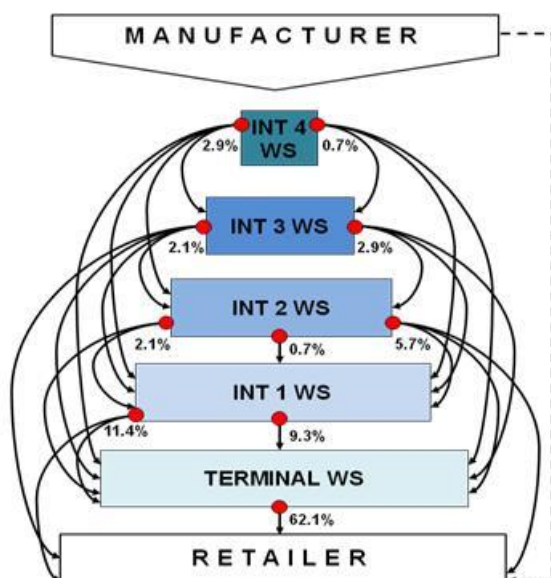
Figure 2: Representation of the antimalarial distribution chain showing the overlap between wholesaler categories used for analysis

Note: WS: wholesaler; INT: intermediate
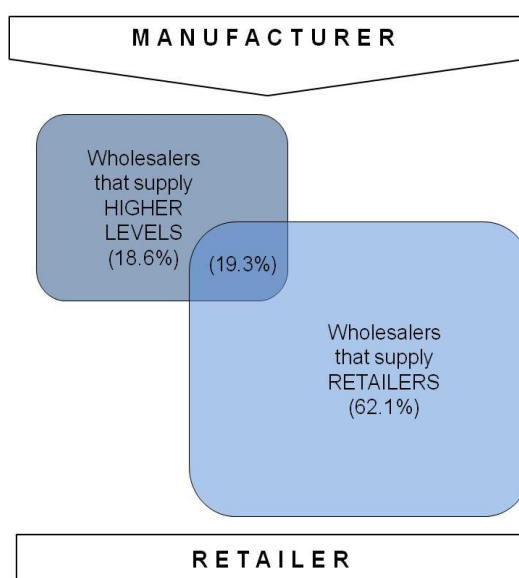
WHOLESALER CHARACTERISTICS: Wholesalers at different levels of the supply chain differed in their number of years of operation and in size, with wholesalers supplying other wholesalers being in business for longer and being larger (median of 9 years and 8 employees) compared to wholesalers that supplied retailers (median of 6 years in business and 5 employees). All wholesalers reported employing a member of staff with a health qualification, the most commonly reported being nurses/midwives (90%), followed by pharmacists (88.3%), and pharmacy assistants (24%). Nearly all wholesalers (99%) reported to have been visited by a pharmaceutical inspector in the past year, although a smaller proportion (92%) were observed to store their antimalarials appropriately (off the floor, in dry areas and out of direct sunlight), or were observed to have an up-to-date license from the National Drug Authority (82%). Three-quarters of all wholesalers interviewed had provided credit facilities to their customers, and only 32% reported delivering antimalarial orders.

% of wholesalers that...

Horizontal bar chart showing, from top to bottom:
- …stored antimalarials in a dry area, out of direct sunlight & off the floor: ~92%
- …employed a member of staff with a health qualification: ~100%
- …reported to have been visited by a pharmaceutical inspector in the past year: ~99%
- …displayed an up-to-date license from the NDA: ~82%
- …provided credit to antimalarial customers in the past 3 months: ~75%
- …delivered antimalarials to customers: ~32%

AVAILABILITY OF ANTIMALARIALS & RDTS: Nearly all wholesalers (99%) had at least one antimalarial in stock at the time of interview, 88% had ACT in stock, and 74% stocked the ACT artemether+lumefantrine (AL, the recommended first line treatment for uncomplicated *Pf* malaria in Uganda). Availability of other antimalarial drugs was comparable to that of ACT, with oral artemisinin monotherapies (AMT) being stocked by 76% of all wholesalers, and non-artemisinin therapies (nAT) by 89% of wholesalers. Half of all wholesalers (52%) stocked non-oral AMTs and RDTs were stocked by less than a fifth (18%) of wholesalers.

% of wholesalers that stocked...

Horizontal bar chart showing, from top to bottom:
- Any antimalarial: ~99%
- ACT: ~88% (with AL segment at ~74%)
- Oral AMT: ~76%
- Non-oral AMT: ~52%
- nAT: ~89%
- RDT: ~18%
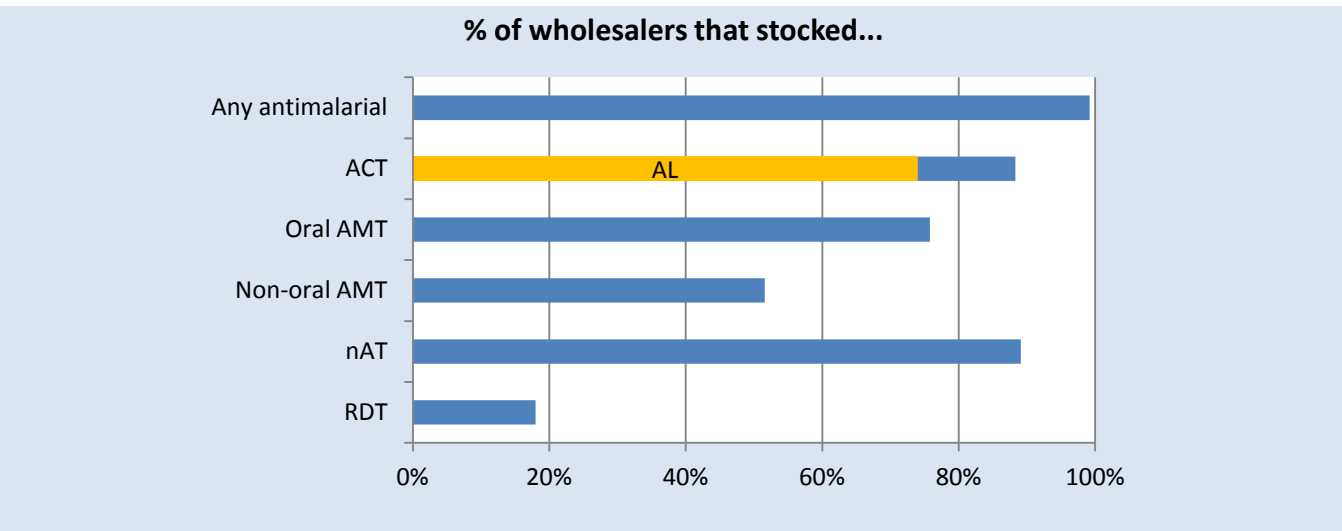
ANTIMALARIAL & RDT SALES VOLUMES: The median number of adult equivalent treatment doses (AETDs) of antimalarials sold the week preceding the survey was greatest for nATs (304.9), followed by ACTs (22.0) and smallest for AMT (15.0). AMT sales volumes were dominated by tablets. These figures reflect the fact that, among wholesalers who sold antimalarials the week before the survey (n=127), more than a third (36%) reported the nAT sulphadoxine-pyrimethamine (SP) to be their top selling antimalarial, followed by other nATs chloroquine (18%) and quinine (12%), while only 10% reported AL, the government-recommended first-line ACT treatment, as their top selling antimalarial. The volume of RDTs flowing down the supply chain was low, with wholesalers reporting a median of 10 RDTs sold in the preceding 7 days.

% of wholesalers who reported the top selling antimalarial to be...
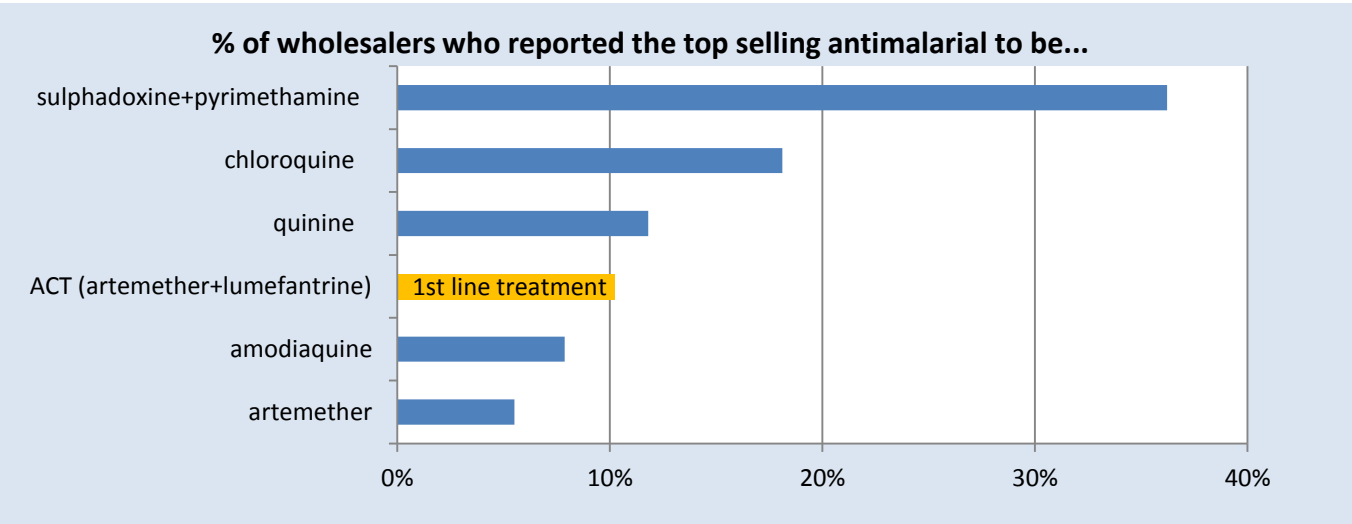
WHOLESALE PURCHASE PRICES: The median wholesale purchase price (i.e. the price paid by wholesalers to purchase stock from their suppliers) per AETD varied across antimalarial drug categories. Overall, AMTs had the highest median purchase price per AETD (US$ 6.34), followed by ACTs (US$ 4.39); while nATs had a lower median purchase price of US$ 1.17. However, median purchase prices were comparable for ACTs and AMTs for similar dosage forms: for tablets the median purchase price was US$ 4.14 for ACT and US$ 5.08 for AMT; and for oral liquids, US$ 12.69 for ACT and US$ 10.15 for AMT. Among wholesalers, the median purchase price for the government recommended first-line treatment, AL (US$ 3.05), was more than 20 times the wholesale purchase price of SP (US$ 0.15); and the median purchase price for the government recommended treatments for severe malaria was US$ 4.61 per AETD for injectable quinine and US$ 9.27 for injectable artemether. The wholesale purchase price for RDTs was much lower than that for ACTs at US$ 0.78 per test.
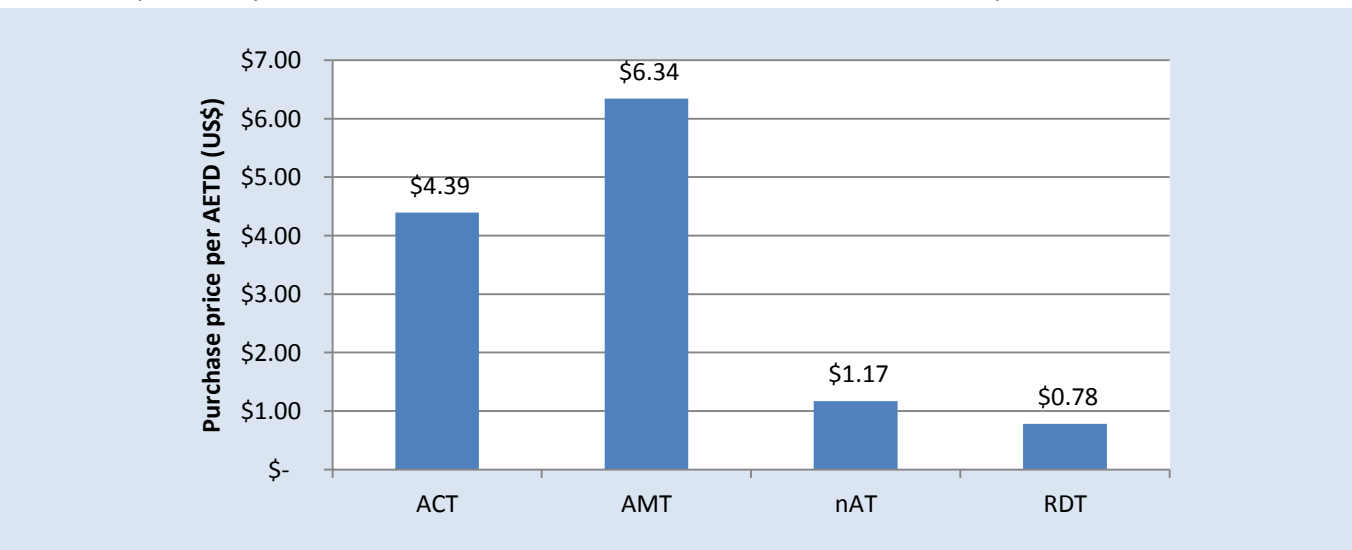
WHOLESALE MARK-UPS FOR ANTIMALARIALS & RDTS: The median mid percent mark-ups were relatively low and consistent across antimalarial categories: 14% on ACTs, 15% on AMTs and 18% on nATs. Wholesale percent mark-ups were also fairly consistent across dosage forms. In absolute terms, mark-ups per AETD were the highest on AMT (US$ 0.94), followed by ACT (US$ 0.59) and nAT (US$ 0.20), corresponding to the differences in purchase prices across drug categories. For similar reasons, variation in absolute mark-up was also seen across dosage forms within a drug category, with injectables tending to have the highest absolute mark-ups, followed by oral liquids and then tablets (except for AMT, where oral liquids were observed to have higher absolute mark-ups than injectables). For example, the median mid absolute mark-up on nAT injectables was US$ 1.02, compared to US$ 0.36 for oral liquids, and US$ 0.06 for tablets. For AL, the median mid percent mark-up was 17% (corresponding to a median mid absolute mark-up of US$ 0.52 per AETD), compared to 23% for SP (corresponding to a median mid absolute mark-up of US$ 0.04 per AETD). For injectable quinine, the median mid percent mark-up was 25% (corresponding to a median mid absolute mark-up of US$ 0.73 per AETD), and 12% (corresponding to a median mid absolute mark-up of US$ 1.00 per AETD) for injectable artemether. For RDTs, the median wholesale percent mark-up was 20%, equivalent to US$ 0.15 in absolute terms.
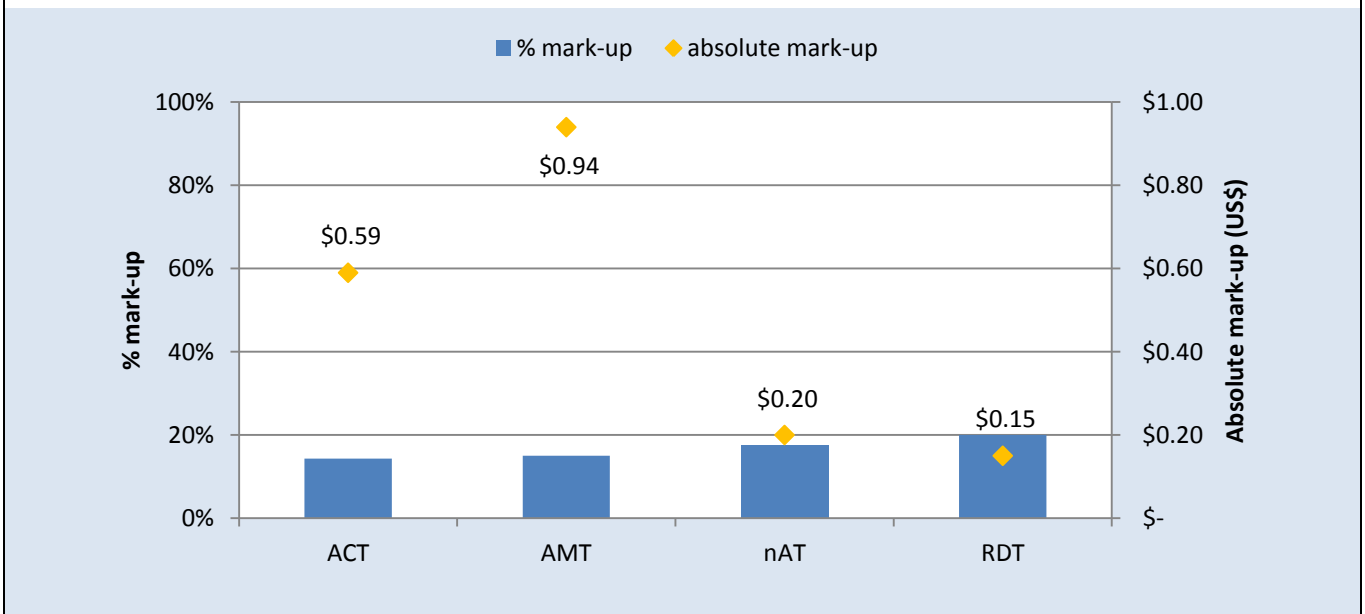
RETAIL PURCHASE PRICES: Similar to the wholesale level, median retail purchase prices (i.e. the price paid by retailers to purchase stock from their suppliers) per AETD varied across antimalarial drug categories. In general, AMTs were observed to have the highest median retail purchase prices per AETD and displayed little variation across retailer categories (ranging from US$ 6.06 at private health facilities and drug stores to US$ 6.43 at pharmacies), while nATs had the lowest median retail purchase prices per AETD and also displayed little variation across retailer categories (ranging from US$ 0.59 at drug stores to US$ 0.79 at pharmacies). ACTs displayed the greatest variation in median retail purchase prices across retailer categories, which ranged from US$ 2.27 in drug stores to US$ 6.39 in pharmacies. Pharmacies tended to have paid higher purchase prices for antimalarials compared to private health facilities and drug stores, although the differences in median purchase prices across retailer categories for AMTs and nATs were small. Pharmacies also tended to have paid similar prices to purchase ACT and AMT tablets (US$ 5.32 and US$ 5.68), but higher prices to purchase ACT oral liquid dosage forms. In private health facilities and drug stores, median purchase prices for ACT tablets and oral liquids were lower than those for AMT tablets and oral liquids. Across retailer categories, injectable nATs were observed to have the highest median retail purchase prices per AETD (ranging from US$ 4.83 at pharmacies to US$ 4.97 at private health facilities and drug stores) compared to other nAT dosage forms. Median retail purchase prices for injectable AMTs were also high (ranging from US$ 9.46 at private health facilities to US$ 11.36 at drug stores), but were similar to those paid for AMTs in oral liquid form (ranging from US$ 6.81 at pharmacies to US$ 11.36 at private health facilities and drug stores). Data were collected by PSI during the ACTwatch Outlet Survey.
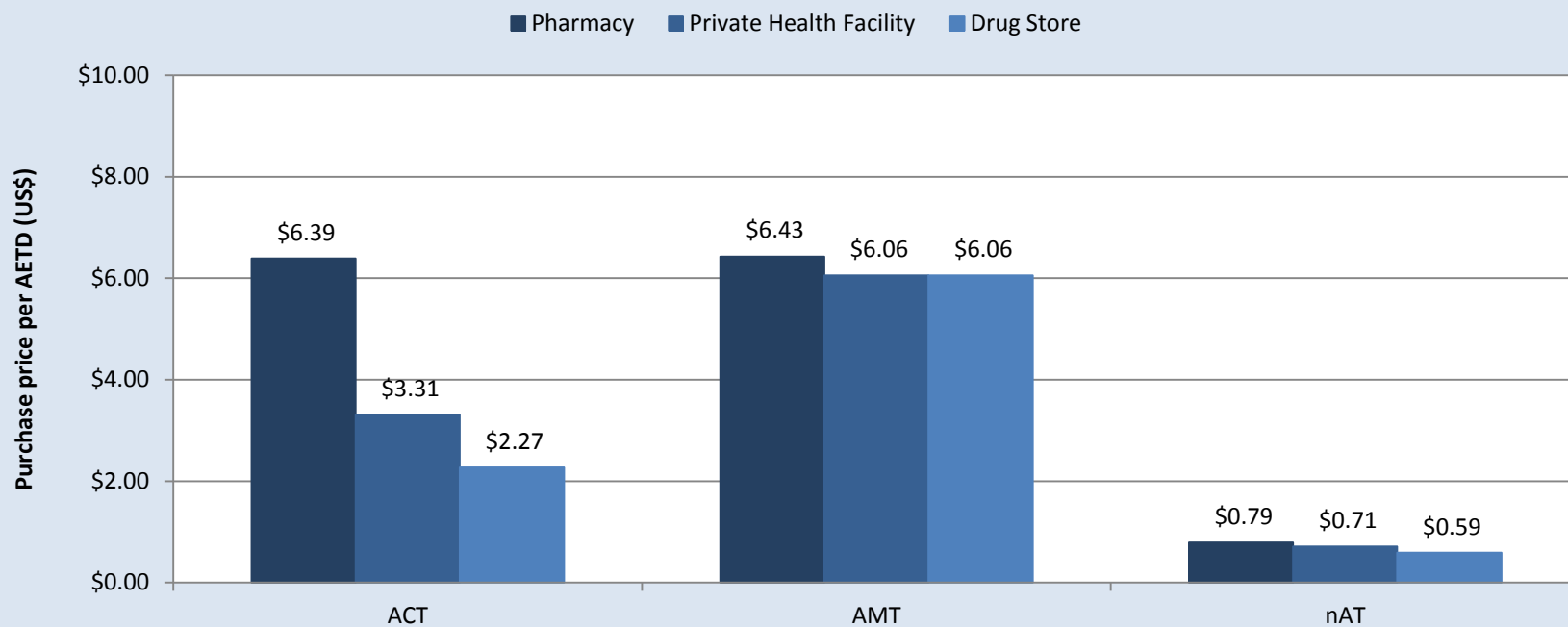
RETAIL MARK-UPS FOR ANTIMALARIALS: Median mid percent mark-ups among retailers tended to be higher compared to those observed among wholesalers. For ACTs, the median mark-up varied little across retailer category from 33% to 46%; for AMT, median mark-up ranged between 33% at drug stores and 60% at private health facilities; and for nAT, between 67% at pharmacies and drug stores, and 88% at private health facilities. Mark-ups above 100% were commonly observed in drug stores and for nATs across all retailer categories. Variation in absolute mark-ups was also observed across antimalarial and retailer categories, corresponding closely with variations in purchase price: mark-ups on ACTs ranged between US$ 0.95 and US$ 2.37; on AMT between US$ 2.84 and US$ 5.00; and on nAT between US$ 0.44 and US$ 0.74. For AL, median mid percent mark-up ranged between 33% (US$ 2.37) at pharmacies and 43% (US$ 1.89) at private health facilities, while the median mid percent mark-up for SP ranged between 100% (US$ 0.47) at pharmacies and 200% (US$ 0.35) at private health facilities. For injectable quinine, median mid percent mark-up ranged between 25% (US$ 1.49) at pharmacies and 150% (US$ 6.16) at private health facilities; and for injectable artemether, median mid percent mark-up ranged between 20% (US$ 3.79) at drug stores and 70% (US$ 8.52) at private health facilities. Data were collected by PSI during the ACTwatch Outlet Survey.
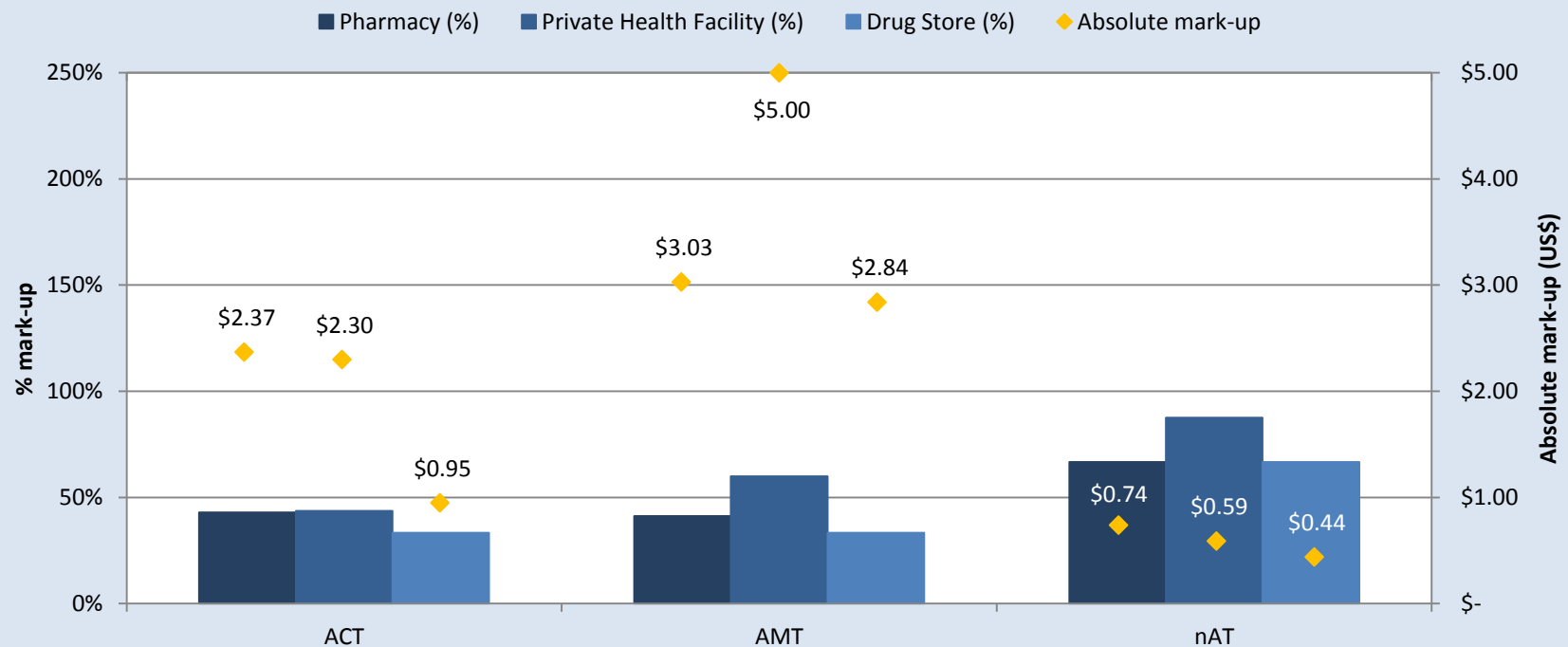
Conclusions

This report has presented a number of important new insights into the private sector market and distribution chain for antimalarial drugs in Uganda. The distribution chain had a pyramid shape comprised of multiple levels, with a relatively broad base and narrow top. While we observed wholesalers to operate over 5 overlapping levels, most antimalarials are likely to go through 3 steps from manufacturer to retailer (or 4 steps from manufacturer to end-user). Although ACTs, and in particular artemether-lumefantrine, the recommended first-line treatment for uncomplicated malaria, were observed to be available in most wholesalers, oral AMTs and nATs were observed to have comparable levels of availability among wholesalers. Furthermore, despite a policy promoting ACTs as the first-line therapy for malaria the volumes of ACTs sold were small, particularly when compared to sales volumes for nATs. This may be partially explained by the large difference in purchase prices between ACTs and nATs, which is likely to shift demand toward cheaper nATs at lower levels of the supply chain and also among consumers, considering that the burden of malaria is disproportionately borne by the poor. [1]

Another worrying observation was that, despite the presence of a ban on oral AMT products that has been in place since 2007, their typical sales volumes among wholesalers were sizeable and comparable to those for WHO-prequalified ACTs. Wholesale percent mark-ups were observed to be consistent both across antimalarial categories and across dosage forms, and tended to be lower than retail-level percent mark-ups on antimalarials. For RDTs, their wholesale purchase prices were also low, in fact lower than the purchase prices for ACTs, AMTs and nATs. They were, however, not widely available among wholesalers and their sales volumes were very low.

When interpreting the findings of this study, it is important to consider that due to the sensitivity of some of the topics discussed some responses may be affected by social desirability bias, with respondents answering in a way that they think will meet the approval of the interviewer. Also, data for this study were collected in 2009 and changes to the market since then are likely to have occurred, particularly due to the introduction of the AMFm in 2011.

1. Introduction & Objectives

In Uganda, as in many low-income countries, private commercial providers play an important role in the treatment of malaria. To design effective interventions for improved access to accurate diagnosis and effective treatment, there is a need to understand retailers' behaviour and identify the factors that influence their stocking and pricing decisions. Private commercial retailers are the last link in a chain of manufacturers, importers and wholesalers, and their supply sources are likely to have an important influence on the price and quality of malaria treatment that consumers can access. However, there is limited rigorous evidence on the structure and operation of the distribution chain for antimalarial drugs that serves the retail sector.

This study aims to address this gap and constitutes an integral part of the ACTwatch project, a multi-country programme of research being conducted in Uganda, Cambodia, Zambia, Nigeria, Benin, Madagascar and the Democratic Republic of Congo (DRC). The overall goal of ACTwatch is to generate and disseminate evidence to policy makers on artemisinin-based combination therapy (ACT) availability and price in order to inform the development of policies designed to increase rates of access to effective malaria treatment. Along with the Supply Chain Study, the ACTwatch project also includes Outlet and Household Surveys led by PSI and the Program for Accessible Health, Communication and Education (PACE) in Uganda.

The objective of the Supply Chain component of ACTwatch is to document and analyse the supply chain for antimalarials and rapid diagnostic tests (RDTs) for malaria using quantitative (structured survey) and qualitative (in-depth interviews) methods for studying providers operating at each level of the chain. This report presents the results of the structured survey of antimalarial drug wholesalers conducted in Uganda between February and April 2009. In order to provide a complete description of the supply chain for antimalarial drugs, the report also presents retail-level data on antimalarial purchase prices and mark-ups that were collected during the ACTwatch Outlet Survey by PACE Uganda/PSI between March and April 2009.

2. Country Background

Economic Profile
Uganda is a landlocked country in East Africa that shares borders with the Democratic Republic of Congo, Kenya, Rwanda, Sudan and Tanzania. It was one of the first Sub-Saharan African countries to embark on liberalization and pro-market policies in the late 1980s following several decades of political and social upheaval, and since then Uganda has enjoyed many years of economic growth and stability. [2] Annual growth in gross domestic product (GDP) has remained consistently high averaging 7% in the 1990s, but slowing somewhat to 5.8% in 2010 [3]; the per capita GDP in 2009 (current USD) is estimated at $483. [4] The Ugandan economy is heavily dependent on agriculture, which employs over 80% of the workforce; more than 85% of the country's 33.4 million people live in rural areas. [3] Strong economic growth has enabled Uganda to make substantial progress in human development. Most notably, it is on track to meet the 2015 Millennium Development Goal of halving poverty, having reduced the proportion of people living in poverty from 57% in 1992/93 to 31% by 2005/06. [2]

Pharmaceutical Sector
The pharmaceutical sector in Uganda is regulated by the National Drug Authority (NDA), which is responsible for the registration of all products prior to importation and sale; regulating the marketing of pharmaceuticals; licensing of pharmaceutical manufacturers, importers, exporters, wholesalers and retailers; and for quality management and post-marketing surveillance. [5] Pharmacy practice is supervised and regulated by the Pharmaceutical Society of Uganda. There are several local drug manufacturers in Uganda, some producing antimalarials. However, the country still relies heavily on the importation of medicines from

Asia, Western countries, and some other African countries such as Kenya and South Africa. For example, 94% of public sector procurements are imported and only 6% are manufactured locally. [5] The medicines distribution system in the public sector is centralised, with procurement pooled at the national level and organised through the National Medical Stores (NMS), an agency of the Ministry of Health (MOH). The mission sector is also important in Uganda for medicines delivery and treatment, and procurement runs parallel to the public sector, with national level procurement through the Joint Medical Stores (JMS).

Regarding the private pharmaceutical sector, most domestic manufacturers, importers and large wholesalers are located in or near the capital, Kampala. The NDA issues different licenses each for the manufacture, wholesale, and retail of medicines, and permits for import and export. Private pharmaceutical manufacturers must employ two registered pharmacists, while wholesale and retail pharmacies are required to have one registered pharmacist on staff. As pharmacists in Uganda may be employed by a maximum of two separate businesses, the pharmacist may deputise responsibilities to a 'professional auxiliary staff member' (i.e. pharmacy technician, registered/enrolled nurse or midwife with pharmaceutical training) in their absence, two of which must be employed full-time by the business. Drug shops, on the other hand, may be staffed by a pharmacy technician, registered/enrolled nurse or midwife, comprehensive nurse, clinical officer, public health dental assistant or anaesthetic assistant. While drug shops are permitted to only retail a range of over-the-counter (OTC) medicines, known as Class C drugs, prescription-only medicines (POMs), the class of drugs to which antimalarials technically belong, are occasionally sold over-the-counter in both drug shops and retail pharmacies without a prescription. [6, 7] Despite not being authorised to dispense pharmaceuticals, general retail shops, such as grocery stores, dukas, and market stalls, have also been noted as important sources for essential medicines [6]; however, recent studies give a mixed picture regarding the importance of these types of retail outlets for antimalarials, with availability ranging from 0.4% [8] to between 8% and 44%. [9] In order to improve retail level access, ACTs were reclassified as OTC medicines in 2008. [10] There is no regulation of medicine prices or mark-ups. [5]

Health System

In 2007, about 6.3% of GDP was spent on health, of which just over a quarter (26.2%) was public expenditure accounting for 9.8% of total government expenditure in the same year. [4] Of the remaining private expenditure, a significant proportion is financed as out-of-pocket payments; however, the mission and NGO sectors both constitute important sources of health spending in Uganda. [5] Following decentralisation of the health sector in the 1980s, physical infrastructure is relatively well-established and operates across a variety of levels. The MOH provides overall stewardship of the health sector through formulation of national policies, setting of quality targets, mobilisation of resources, and monitoring and evaluating of overall sector performance. Services are delivered by different operational levels: community (village health team, health centre I), parish (health centre II), subcounty (health centre III), county (health centre IV), district (general hospital), regional (referral hospital) and national (referral hospital) levels. Although 71% of the health infrastructure is owned by the public sector, the mission sector and private (for profit) sector also play a role, owning 20% and 9% of health facilities in Uganda in 2006, respectively. [5] User fees are not charged for services received in public facilities, and medicines can also be obtained free of charge; however, poor availability of medicines, increased incidence of unofficial charges, and limited geographical access to free public services have reduced the impact of user fee removal in Uganda. [11, 12]

But despite this public sector dominance with respect to facility ownership, the barriers to access described above have led many to turn to the mission and private sector for health services. Because these sectors do not provide services and drugs free of charge, this has implications for equity of access, particularly as there is no national health insurance scheme and private insurance coverage is low. [12]

Malaria Epidemiology and Control Strategies

In Uganda, malaria is responsible for 30-50% of outpatient visits, 15-20% of admissions, and 9-14% of inpatient deaths. Uganda ranks 6th worldwide in number of malaria cases and 3rd in number of malaria deaths, and the overall malaria-specific mortality is estimated to be between 70,000 and 100,000 child deaths annually in Uganda, a death toll that far exceeds that for HIV/AIDS. [1] In 95% of the country, the malaria epidemiology is stable with perennial transmission at high levels and relatively little seasonal variability. Children-under-five and pregnant women are the most vulnerable groups for infection. The remaining 5% of the country consists of seasonal epidemic-prone areas in the highlands and along the eastern and north-eastern regions bordering Kenya and Sudan respectively. *Plasmodium falciparum* (*Pf*) is the predominant parasite species.

The National Malaria Control Strategy 2005/06-2009/10 focuses on the needs of the most vulnerable groups and includes interventions such as insecticide treated net (ITN) distribution through campaigns and antenatal clinics; indoor residual spraying (IRS) with a focus on low risk and epidemic-prone areas; universal access to ACTs and improved diagnosis; and intermittent preventive treatment (IPT) for pregnant women with sulphadoxine-pyrimethamine (SP). Targets of 85% coverage for each intervention were set for 2010. [13] For ACTs, the aim is to increase access through public and NGO health facilities, the community distribution system for medicines (home-based management of fever) and the private sector. By 2009, 33% of children under five years of age and 44% of pregnant women were sleeping under ITNs, 33% of pregnant women were receiving at least 2 IPT doses, 6% of households had received IRS and 14% of febrile children were promptly treated with an ACT. [1]

National Treatment Policy

In 2004, the National Malaria Control Program (NMCP) adopted artemether-lumefantrine (AL) 20mg/120mg as the first-line treatment for uncomplicated malaria within the formal health sector, and artesunate plus amodiaquine (ASAQ) 50mg/153mg as an alternative first-line. In April 2007, the NMCP changed its treatment policy for Home-Based Management of Fever for Children (HBM) from a locally manufactured SP + chloroquine (CQ) product with the brand name 'HOMAPAK' to AL (see below for roll out plans). Quinine is recommended for treatment of severe malaria and is available at health centre IV and hospitals. According to national policy, consultation and treatment of uncomplicated malaria in all age groups is to be provided in all public health facilities and via community outreach programmes free of charge. Oral artemisinin monotherapies have been banned in Uganda since 2007.

The policy on diagnosis is for all adults and children over the age of five to have confirmed diagnosis through microscopy provided for free in public health facilities. Although Rapid Diagnostic Tests (RDTs) are being introduced through pilots in facilities without microscopy, a national policy document on the use of RDTs is not yet finalised. Microscopy availability is limited to health centre level III (subcounty level) and higher levels. Although the policy is confirmed diagnosis, the necessary capacity is not available in many health centre level III facilities (the ACTwatch Outlet Survey in 2009 found that microscopy testing facilities were available in only 43% of public health facilities[8]), and hence, diagnosis of malaria remains largely clinical.

Antimalarial Treatment Distribution and Delivery

In 2006, Uganda began rollout of AL as first-line treatment, selecting the branded WHO-prequalified drug, Coartem, for distribution in public health facilities. This was followed in 2007 with the introduction of AL at the community level through the HBM programme via volunteer Community Medicine Distributors (CMD), two of which are selected and trained per village and who receive drugs through the existing public sector

distribution chain. First introduced in 10 districts in 2002 using the HOMAPAK combination noted above, the HBM programme was scaled up to cover all districts in Uganda by 2005. [14] Early evaluations of HBM conducted prior to the transition to AL showed that the intervention led to improvements in treatment access and adherence [15, 16], however challenges and questions have arisen since then regarding the sustained of availability of Coartem [10], high attrition rates of volunteer CMDs [14], and the appropriateness of presumptive treatment in low transmission settings in the face rising resistance and a policy environment that favours malaria diagnosis prior to treatment. [17] In 2009, a survey showed that only 18% of households knew of an active CMD in their community, and that only 9% of CMDs had ACTs. [1]

A project piloting a subsidy to increase ACT access through the private sector, particularly through drug shops, was launched in September 2008 in the mainly rural districts of Budaka, Pallisa, Kaliro and Kamuli. The project, run by the Consortium for ACT Private Sector Subsidy, uses Coartem labelled with a green leaf distributed to retail outlets through existing private sector channels and aims for AL to be sold at a consumer price ranging from 200 USH to 800 USH (USD$ 0.10 to US$ 0.38) depending on the dosage. In the first year, approximately 700,000 doses of AL were made available through this project, and early observations showed that availability of subsidised ACTs among drug shops rapidly increased, their affordability rose in the private sector, and drug shops seemed to charge reasonable mark-ups. And after six months following introduction of the ACT subsidy, the number of children receiving treatment had increased and the augmented ACT uptake had eroded the market share of ineffective antimalarials, such as chloroquine. [18] Advocacy in the form of active participation of local government and opinion leaders, and community mobilisation including radio, print and point-of-sale materials were essential to ensure uptake of the subsidised ACTs.

According to results from the ACTwatch Outlet Survey completed in September-October 2008, ACTs were most commonly available among public health facilities (over 80%) and registered pharmacies (over 55%), but much less so among private health facilities (less than 20%) and drug stores (less than 5%). Non-artemisinin therapies (nATs), on the other hand, were carried by more than 85% of all outlet types in Uganda. [8] In terms of treatment seeking behaviour, the ACTwatch Household Survey conducted shortly thereafter in early 2009 showed that only half of all children with fever were treated with an antimalarial, and among those treated, only 36% received an ACT; while the remaining children were most likely to receive an nAT. The same study also showed that private health facilities were the most common sources of these treatments (42%), followed by public health facilities (24%), while 21% of children received an antimalarial that was already in the home; pharmacies were the source for less than 10% of antimalarials to treat children [19] These results reflect the overall importance of the private sector in access to antimalarials in Uganda.

Malaria Financing
External funding is an important source of funding for malaria control in Uganda. Since 2000, a sector wide approach (SWAp), which includes budget support, has been operational in Uganda through which many donors channel their aid. An important source of financing for ACTs in the public sector is from three Global Fund grants (Rounds 2, 4 and 7), totalling US$ 212,100,635 over five years from 2005. The availability of ACTs was somewhat affected in 2008 due to some delays in disbursements from rounds 2 and 4. The grants are used in part to introduce ACTs at health facility levels and at the community level through the HBM policy. In addition, Uganda has received $74.7 million from the President's Malaria Initiative since 2006: $9.5 million (2006), $21.5 million (2007), $21.8 million (2008) and $21.9 million (2009). Of the grant for 2008, $2.5 million was allocated for case management including the procurement of ACTs for the HBM policy and procurement of drugs for severe malaria and pre-referral.

3. Methods

3.1. Scope of the supply chain survey

The Supply Chain structured survey was conducted amongst wholesalers who operated in the private commercial distribution chain that served the antimalarial drug retailers described in the 2009 ACTwatch Outlet Survey report. [8] The term 'private commercial sector distribution chain' refers to any type of supplier (public or private) who served private commercial outlets as well as private suppliers who served public and NGO outlets. This allows any transactions between public, NGO and private commercial sectors to be noted. Public suppliers of public outlets are, however, not included because much more is already known about the structure of the public sector chain compared to that of the private commercial sector. The focus is on suppliers who operate from the point where commodities leave the factory gate or port of entry down to those directly supplying retailers. See Figure 3.1 for a representation of the wholesale supplier interactions that are captured by the Supply Chain survey.

The supply chain survey explored the distribution chain for antimalarials, comprising ACTs, artemisinin monotherapies (AMTs) and nATs, and including all formulations (tablets, syrups, injectables, etc.), whether they are used for inpatient or outpatient care. It excluded complementary products, such as drips, water and syringes. It also explored the availability, sales volumes, and mark-ups on RDTs sold in the distribution chain under study, but excluded microscopy services. The latter were excluded because of the wide range of different products used in providing microscopy services, and the problems in distinguishing those used for malaria diagnosis from those with other purposes.

The structured survey was cross-sectional and collected data on the structure of the private commercial sector supply chain for antimalarial drugs, wholesaler characteristics and business practices, wholesale outlet licensing and inspection, wholesaler knowledge, qualifications and training; and wholesale availability, purchase prices and mark-ups for antimalarials and RDTs. In order to provide a complete description of the supply chain for antimalarial drugs, the report also presents retail-level data on antimalarial purchase prices and mark-ups that were collected during the ACTwatch Outlet Survey by PACE Uganda/PSI between March and April 2009.
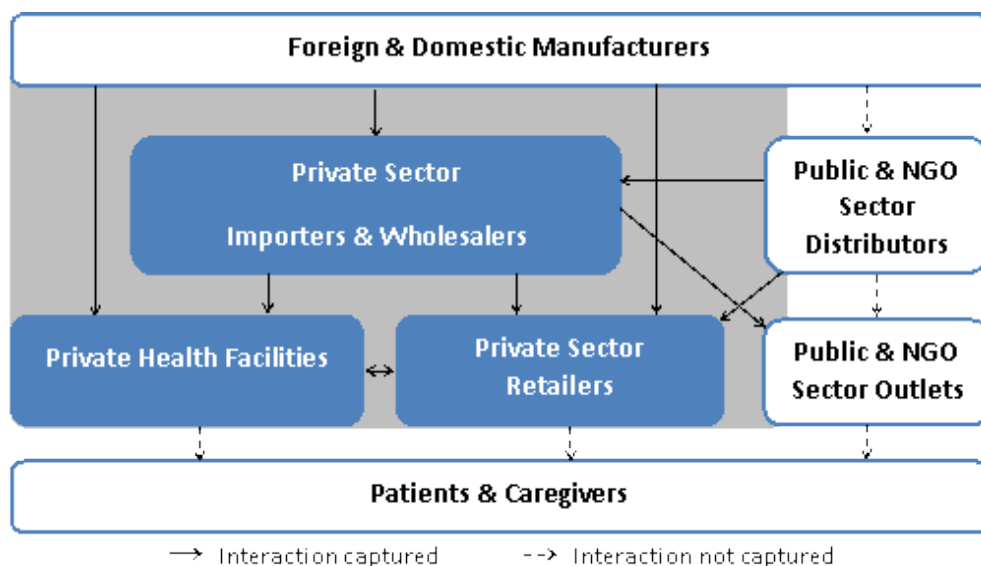

Figure 3.1: Antimalarial wholesale supplier interactions captured by the Supply Chain Study

3.2. Sampling & data collection procedures

3.2.1. Overview of sampling and data collection during the ACTwatch Outlet Survey

For the purpose of the ACTwatch study, Uganda was divided into two strata: one stratum covering areas of high malaria endemicity and another stratum covering areas of prone to malaria epidemics. In each stratum, 19 sub-districts were randomly sampled using a probability proportional to size (PPS) approach through which more populated sub-districts had a higher chance of being selected. Sub-districts were defined as the existing sub-counties, which typically hosts a population size of approximately 10,000 to 15,000 inhabitants; however, in Kampala where the subcounty populations far exceed this approximate size, a smaller sub-division called the parish, was used as the sub-district. In each sub-district, a census of all public and private outlets that had the potential to sell or distribute antimalarials was conducted and outlets that stocked antimalarials at the time of the survey or in the past 3 months were invited to participate in the Outlet Survey (OS). In order to estimate antimalarial availability and price across different outlet types, this sample was supplemented by a booster sample that included all public sector outlets and registered pharmacies operating in the district within which the sampled sub-district was situated. The use of a booster sample is a common procedure across all ACTwatch OS to ensure adequate representation of relatively rare but important antimalarial provider types. All public sector outlets (e.g. health posts, health centres, hospitals) in the entire county which were not in the selected sub-counties/parishes and all registered pharmacies in the entire district that were not in the selected subcounty/parish itself that stocked antimalarials were identified through a census in the relevant districts.

The first OS was conducted in the sampled sub-districts and booster districts by PACE Uganda/PSI between September and October 2008, with a second outlet survey conducted in March and April 2009. The ACTwatch OS collected data on antimalarial drug availability, sales volumes and selling prices, retail outlet and shopkeeper characteristics (antimalarials stocked, other drugs stocked, number of staff, education, health-related qualifications, registration status, GPS co-ordinates) as well as other areas of importance for the Supply Chain Survey, including each retailer's two top supply sources for antimalarials (name, location, provider type, whether they distribute, collect or both) and antimalarial wholesale purchase prices.

3.2.2. Sampling and data collection procedures for the ACTwatch Supply Chain survey

The Supply Chain survey was implemented by LSHTM from February to April 2009, with support from PACE Uganda, shortly after the 2009 OS. All 38 of the OS-sampled sub-districts were used to create a list of all antimalarial wholesale sources mentioned by retailers as their two top antimalarial wholesale sources (termed the "terminal wholesalers") during the OS administered by PACE Uganda/PSI.[1] All these terminal wholesalers were visited and invited to participate in the Supply Chain survey.[2] Wholesalers were eligible to participate if they met the following screening criteria: they had either an antimalarial or RDT in stock at the time of interview, or they reported having stocked either antimalarials or RDTs in the three months prior to interview. During the interview, eligible wholesalers were also asked about their top two supply sources for antimalarials (termed the "intermediate-1" wholesalers). From these data, we created a list of all intermediate-1 wholesalers mentioned. All these intermediate-1 wholesalers were visited and invited to

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[1] Supply sources for outlets that were sampled as part of the outlet survey booster sample were excluded.

[2] There may be horizontal trading within the supply chain, for example if a terminal wholesaler purchases their antimalarial drugs from another wholesaler who has also been identified from the outlet survey as a terminal wholesaler. Where these relationships were identified at the wholesale level the supply chain survey was not administered again to this wholesaler, though the relationship was noted and accounted for in the analysis. However, in the case where horizontal trading is identified at the retail outlet level (for example, a retailer identifies another retailer as the source of their antimalarials), the supply chain survey was administered to the source of supply, even if they have already filled in the outlet survey instrument, because the questions asked were different.

participate in the Supply Chain survey, during which, as at previous levels, they were asked about their top two supply sources for antimalarials (termed the "intermediate-2" wholesalers). This process was repeated until the factory gate or port of entry was reached.

The Supply Chain Survey used an information sheet, a consent form, a provider questionnaire, and antimalarial and RDT inventory sheets. All data collection tools were provided in English, piloted by members of the research team, and further revisions were made to adapt the tools to the specificities of the Ugandan context. Before each interview, trained interviewers sought to speak with the most knowledgeable person about their antimalarial/RDT wholesale business. They informed respondents about the study by providing the information sheet in English. Interviewers stated their name, the institutions involved, aims of the study, nature of questions to be asked and length of the interview. Each respondent was given the opportunity to ask questions at any time before, during and after the interview, and received the contact details of the local research coordinator. Interviewers then invited respondents to participate in the study and obtained oral consent, witnessed by a member of the research team. Interviewers emphasized that individual information was confidential and that no information would be passed on to regulatory authorities or competitors.

The provider questionnaire was used for collecting data on each wholesale business's characteristics and operations and on the wholesalers' top two supply sources for antimalarials and RDTs. Inventory sheets were used for collecting data for each antimalarial/RDT stocked, on brand name, generic name and strengths (for antimalarials), package type and size, recall of volumes sold over the week before the survey, recall of last purchase value and selling and purchase prices.

The Supply Chain component of the ACTwatch study received ethical approval from the Research & Ethics Committee of the Makerere University Faculty of Medicine and the LSHTM ethics review committee.

3.3. Data analysis

3.3.1. Classification of outlets

A challenge in the analysis of wholesalers is their classification into sub-groups, as in practice many operate at several levels of the distribution chain. We have taken 2 approaches:

- To describe the structure of the chain, wholesalers were classified into mutually-exclusive categories (MECs) defined by the levels they supplied. For example, wholesalers supplying retailers only, wholesalers supplying retailers and terminal wholesalers only, and wholesalers supplying intermediate and terminal wholesalers only.

- For analytical purposes, wholesalers were grouped into 2 broader and overlapping categories: one including wholesalers supplying retailers and one for wholesalers supplying wholesalers. Some wholesalers may therefore be included in both analytical categories. This second approach for classifying wholesalers addresses the issues of individual MECs including very few wholesalers. Furthermore, this approach reflects the actual operations of the distribution chain.

In order to get a complete picture of the distribution chain for antimalarial drugs, data relevant to the retail level are also presented for 5 mutually exclusive categories of retailers: pharmacies, private health facilities, drug stores, other private outlet types (e.g. grocery stores, general stores, etc.), and public health facilities. See appendix 6.2 for descriptions of the type of retailers included in these categories.

3.3.2. Calculation of sales volumes

Antimalarial volumes and price data are reported for 5 dosage forms, namely tablets, oral liquids, injectables[3], suppositories and granules, and 3 antimalarial categories[4] namely artemisinin-based combination therapy (ACT), artemisinin monotherapies (AMT) and non-artemisinin therapies (nAT). ACTs were further sub-divided into WHO-prequalified ACT and non-WHO-prequalified ACT.

Antimalarial volumes were calculated on the basis of an adult equivalent treatment dose (AETD). An AETD was defined as the number of milligrams (mg) of an antimalarial drug needed to treat a 60 kg adult (refer to Appendix 6.3 for data used during calculation of AETDs). The number of mg/kg used to calculate one AETD was defined as what was, at the time of the study, recommended for a particular drug combination in the treatment guidelines for uncomplicated malaria in areas of low drug resistance issued by the WHO. Where WHO treatment guidelines did not exist, AETDs were based on product manufacturers' treatment guidelines. In the case of ACTs as the treatment consists of two or more active antimalarial ingredients packaged together (either co-formulated or co-blistered), the strength of the artemisinin-based component was used as the principal ingredient for the AETD calculations. Information collected on both the medicine strength and unit size, as listed on the product packaging, was then used to calculate the number of AETDs contained in each unit. The median number of antimalarial doses reported to have been sold during the week preceding the survey was estimated for each antimalarial category for each wholesaler category. Estimates were calculated by first summing the number of AETDs sold for the different antimalarial categories at each wholesale outlet and then by taking the median across the wholesaler category. Similar estimates were made for RDT sales volumes in each wholesaler category.

For wholesale outlets that stocked antimalarials/RDTs and for which some or all sales volumes were missing, missing values were imputed using the STATA 11 command *mi impute pmm*[5]. For wholesale outlets with no antimalarials of a given category in stock at the time of the survey, sales volumes over the past week were assumed to be null. For wholesale outlets without information about the type of antimalarials stocked (because of refusals to participate in the study or to provide information on the type of antimalarials stocked or because of interrupted interviews), sales volumes were treated as missing. In the case of an outlet not stocking antimalarials, sales volumes were set to zero.

3.3.3. Calculation of purchase prices and mark-ups

Wholesale purchase prices and mark ups were calculated using data collected during the ACTwatch Supply Chain Survey. Because it is common for wholesalers to vary their prices with the volumes they sell, minimum, mid-point and maximum mark-ups were calculated using data on maximum and minimum selling price charged for one unit by wholesalers. The wholesale maximum percentage mark-up was calculated as the difference between the highest wholesale selling price (that is the price of the minimum volume sold wholesale) and the wholesale purchase price, divided by the wholesale purchase price. The wholesale minimum mark-up was calculated as the difference between lowest wholesale selling price (that is the minimum price charged for wholesale sales) and wholesale purchase price, divided by wholesale purchase price. The wholesale percent mid mark-up was calculated as:

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[3] Liquid and powder injectables form a single category.
[4] Antimalarial drugs intended for prophylaxis and drug combinations not used to treat malaria but that contain an ingredient with antimalarial action were excluded from analysis.
[5] A technique used for imputing missing values of one continuous variable whose distribution is skewed. Missing values (e.g. in the case of an outlet stocking antimalarials and with the antimalarial type identified in the audit sheet but for which sales volume data were missing) were imputed using covariates related to provider/outlet and product characteristics. Five imputations were conducted and their mean imputed to the missing values.

[[[(highest selling price)+(lowest selling price)]/2]- (wholesale purchase price)]/(wholesale purchase price)

Retail purchase prices and mark-ups were calculated using price data collected during the 2009 ACTwatch OS. When calculating summary estimates for purchase prices and mark-ups, there was a need to weight outlet survey data to allow for (a) the difference in sampling probabilities due to variation in the size of strata, (b) the oversampling for the booster, and (c) the sampling strategy which involves a census of retail outlets in the sub-districts of varying size selected using PPS. Stratum-specific weights were calculated for each sub-district sampled in the stratum (endemic vs. epidemic-prone areas). Appendix 6.4 provides a detailed description of the calculations performed and weights used.

Retail percentage mark-ups were calculated for each product as the difference between selling price and purchase price, divided by purchase price. For both retail and wholesale observations, absolute mark-ups per AETD were calculated for each product as selling price minus purchase price. Data were collected in local currencies and converted to their US$ equivalent using the average interbank rate during the data collection period.[6]

3.3.4. Summary measures

Indicators are reported using median and inter-quartile range (IQR), which are relevant for describing distributions likely to be skewed. Given that for analytical purposes, wholesalers were classified into overlapping categories (i.e. wholesalers supplying retailers and wholesalers supplying wholesalers), it was not possible to conduct statistical tests of difference between the 2 groups.

4. Results

4.1. Overview of the sample

A total of 295 supply sources were listed by retailers sampled in the 38 selected OS sub-districts, of which 150 (50.8%) were obvious duplicates, two (0.7%) were listed with a general location but without a supplier name, and one private sector retailer listed the government agency, National Medical Stores, as one of its top suppliers of antimalarials. For the remaining 142 supply sources, other uncertainties around supplier business names or locations were clarified by calling suppliers, and in the absence of contact numbers, advice on location was sought from local informants, including PACE staff members and data collectors who had participated in the OS data collection. This process identified 28 (9.5%) additional duplicates, leaving a total of 114 suppliers to form the sample of terminal wholesalers. Out of the 114 terminal level wholesalers, one was ineligible to participate, two could not be located and four had closed down. Among those eligible to participate, one refused and two stopped the interview before completing all sections of the provider questionnaire or the inventory of antimalarials, leaving 104 terminal wholesalers with completed interviews.

All 104 terminal wholesalers who were successfully interviewed were asked about their top two supply sources for antimalarials. From a total of 180 wholesaler mentions, six referred to foreign manufacturers (which are beyond the scope of this study), and the remaining 174 wholesaler mentions referred to 55 unique wholesale businesses, called intermediate-1 wholesalers as they supplied terminal wholesalers, three

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[6] Outlet Survey data collection took place between 16 March and 7 April 2009 and an average exchange rate of 1 US$ to 2113.53 Uganda Shillings during the data collection period was used for the calculation of retail absolute mark-ups. Supply Chain Survey data collection took place between 13 February and 6 April 2009 and an average exchange rate of 1 US$ to 2049.16 Uganda Shillings during the data collection period was used for the calculation of wholesale absolute mark-ups. Historical exchange rates averaged over the specified periods were obtained from http://www.oanda.com/currency/historical-rates.

of which referred to local manufacturers (which are also beyond the scope of this study). Of these 52 eligible intermediate-1 wholesalers, 27 had already been identified at the terminal level (as they also supplied retailers included in the Outlet Survey sample directly), of which two had closed down. As such, an interview was not re-administered to these 27 wholesalers. Of the remaining 25 intermediate-1 wholesalers, interviews were successfully administered to 23 and two refused. From the 48 intermediate-1 wholesalers (the 25 interviewed at terminal level and 23 were newly interviewed), we obtained 84 total mentions for intermediate-2 wholesalers of which 17 were foreign manufacturers, and the remaining 67 mentions referred to 27 unique wholesalers. Three of these were local manufacturers, leaving 24 in total, 23 of which had been identified at previous levels (22 interviews were completed and 1 refused). The one remaining wholesaler newly identified at this level refused to participate. These 22 intermediate-2 wholesalers produced a total of 36 mentions for intermediate-3 wholesalers. A third of these were foreign manufacturers, and the remaining 24 mentions referred to 13 unique wholesalers. Two of these were local manufacturers, and of the 11 remaining intermediate-3 wholesalers, all 11 had already been identified at previous levels (10 interviews completed, 1 refusal). Therefore, no new interviews were conducted at this level. A total of 17 mentions of intermediate-4 wholesalers were gathered and eight of these were foreign manufacturers. Of the remaining nine mentions, six were unique businesses, one of which was a local manufacturer. All five remaining wholesalers had already been identified and successfully interviewed at previous levels. As each of these intermediate-4 wholesalers mentioned manufacturers as their two top antimalarial suppliers, the top of the chain was deemed to have been reached with a total of 142 wholesalers that sold antimalarials identified, with whom 127 interviews were completed, two interviews were partially completed, four refused interview, one was not eligible because it did not stock antimalarials or RDTs at the time of interview or in the preceding three months, two could not be located, and six had closed their business permanently. (Table 4.1)

Table 4.1: Overview of the wholesalers sampled and interviewed

Levels of operation	Initial Sample Size	Number identified at previous level(s)	Number of refusals[1]	Number of duplicates[2]	Number not eligible[3]	Number not interviewed for other reasons[4]	Number not found	Number of interviews conducted[5]
Total	-	-	4	28	1	6	2	129
Terminal	142	-	1	28	1	4	2	106
Intermediate-1	52	27	2	0	0	2	0	23
Intermediate-2	24	23	2	0	0	0	0	0
Intermediate-3	11	11	1	0	0	0	0	0
Intermediate-4[6]	5	5	0	0	0	0	0	0

1: One refusal each at intermediate-2 and intermediate-3 level occurred at previous levels. 2: Wholesalers included in the initial sample and found to be duplicates during data collection. 3: Outlets not stocking antimalarials or RDTs at the time of the interview or in the preceding 3 months. 4: Wholesalers mentioned by respondents at a previous level had closed their business. 5: Partial interviews were conducted with 2 wholesalers at terminal level (i.e. 2 partial and 104 completed interviews). 6: This is the top of the chain, defined as the level at which wholesalers who were reported to supply intermediate-3 wholesalers mentioned only manufacturers as top supply sources for antimalarials. In the ACTwatch protocol, this level was referred to as the primary level where wholesalers who receive supplies directly from manufacturers operated.

4.2. Structure of the private commercial sector distribution chain for antimalarials

- The observed maximum number of steps from manufacturers' factory gate to retail outlet is six: manufacturer → intermediate-4 wholesaler → intermediate-3 wholesaler → intermediate-2 wholesaler → intermediate-1 wholesaler → terminal wholesaler → retailer.

- Among all wholesalers surveyed, regardless of supply chain level, 81.4% were observed to sell directly to retailers, 62.1% sold to retailers only, while 37.9% of all wholesalers also supplied other wholesalers (i.e. horizontal trading).

- While 41.2% of all antimalarial wholesalers were located in Kampala, a much greater proportion of the larger wholesalers supplying other wholesalers were located in Kampala (65.3) than wholesalers supplying retailers (33.9%)

- Of all the wholesalers that stocked antimalarials, one-fifth constituted part of one of the several observed vertically integrated wholesale supply chains, where importers or large pharmaceutical wholesalers typically based in Kampala also owned and/or operated one or more subsidiary wholesalers in regional commercial centres in different parts of the country. In most cases, these subsidiary wholesalers were supplied exclusively by the 'parent' wholesaler located in Kampala.

- In terms of transactions between the public and private sector, no wholesalers reported a public source as one of their two top suppliers of antimalarials; however, one private retailer reported a public source (the National Medical Stores) as one of their two top suppliers of antimalarials (although this is likely erroneous), and 3 public facilities surveyed at outlet level mentioned a private sector source as one of their two top antimalarial suppliers.

- The structure of the private commercial sector distribution chain for antimalarials in Uganda is depicted in Figures 4.2.1 and 4.2.2. In Figure 4.2.1, each red dot represents a mutually exclusive group of wholesalers that are defined by the specific supply chain levels that each wholesaler group serves (these interactions are shown by the array of arrows emanating from each dot). The relative size of each group is shown in the attached percentage. The dashed line from manufacturer to retailer indicates that a few retailers purchased antimalarials directly from manufacturers, although this was rare (0.3% of all suppliers mentioned by retailers were local drug manufacturers). Figure 4.2.2 depicts how wholesalers have been grouped into the overlapping analytical categories used throughout this report, while Table 4.2 shows how these analytical categories have been derived from the mutually exclusive categories depicted in Figure 4.2.1.

Figure 4.2.1: Representation of the antimalarial distribution chain showing interactions between supply chain levels by mutually exclusive wholesaler category
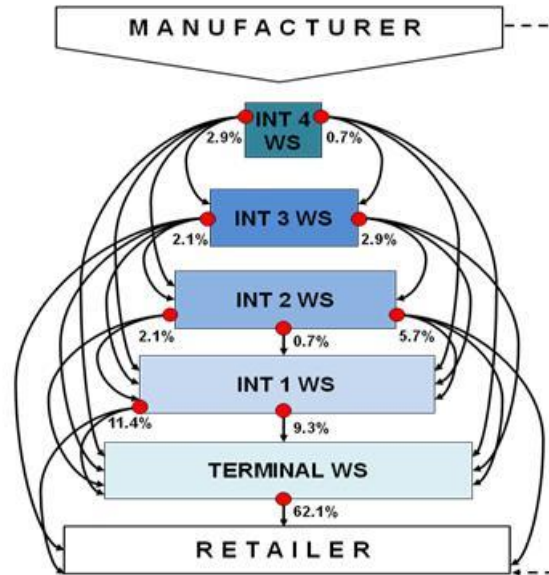
Figure 4.2.2: Representation of the antimalarial distribution chain showing the overlap between wholesaler categories used for analysis

WS: wholesaler; INT: intermediate
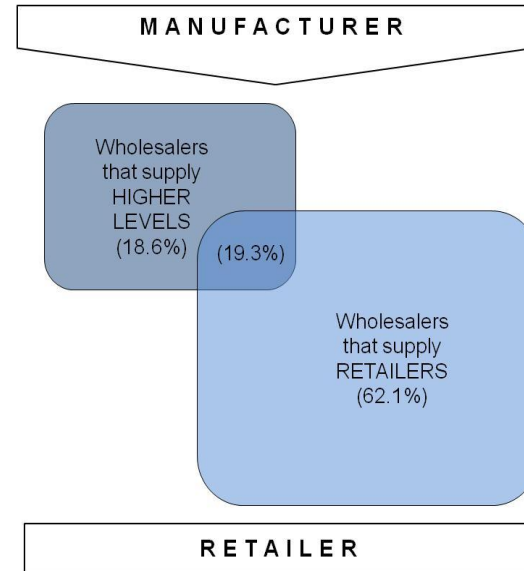
Table 4.2: Defining analytical categories from mutually exclusive wholesaler categories

WHOLESALER CATEGORIES	Total	MUTUALLY EXCLUSIVE CATEGORIES										ANALYTICAL CATEGORIES	
		Supplies int 1	Supplies int 1 & terminal	Supplies int 1, terminal & retailer	Supplies retailer	Supplies terminal	Supplies terminal & retailer	Supplies int 2, int 1 & terminal	Supplies int 2, int 1, terminal & retailer	Supplies int 3, int 1 & terminal	Supplies int 3, int 2, int 1 & terminal	Supply Retailers	Supply Wholesalers
% of WS	100%	0.7%	2.1%	5.7%	62.1%	9.3%	11.4%	2.9%	2.1%	0.7%	2.9%	81.4%	37.9%
(N)	(140)	(1)	(3)	(8)	(87)	(13)	(16)	(4)	(3)	(1)	(4)	(114)	(53)

WS: wholesaler, int: intermediate wholesaler

4.3. Wholesaler characteristics and business practices

4.3.1. Years in operation, outlet size and range of products sold

- Wholesale businesses were of a relatively small size (median of six workers) and had been in operation for a median of eight years. Wholesalers supplying other wholesalers tended to be slightly larger and have been in business for longer (median of eight workers and nine years in operation) than wholesalers supplying retailers (median of five workers and six years in operation).

- More than half of all wholesalers (56.6%) sold other products alongside pharmaceuticals. The most common consumer goods stocked were toiletries (45.7% of all wholesalers), while less than 5% of all wholesalers sold household goods, mobile phone credit, cigarettes or food.

Table 4.3.1: Years in operation, outlet size and range of products sold

CHARACTERISTICS		WHOLESALER CATEGORIES		
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS
Years in operation	**Median**	**8**	**9**	**6**
	IQR	3-11	5-13	3-11
	(N)	(123)	(47)	(99)
Number of people working at outlet	**Median**	**6**	**8**	**5**
	IQR	4-9	5-11	4-8
	(N)	(128)	(48)	(105)
Sells other products in addition to pharmaceuticals[1]	**%**	**56.6**	**53.1**	**54.3**
	(N)	(129)	(49)	(105)

IQR: Inter-quartile Range; 1: other products included toiletries, mobile air time, cigarettes, prepared food, groceries and/or household goods

4.3.2. Wholesalers' customers, delivery activities and credit facilities

Wholesalers mentioned a broad range antimalarial customer types in both private and public sectors. The most frequently mentioned customers were pharmacies and drug stores (92.3%); and private clinics, health centres and dispensaries (92.3%), other drug wholesalers (84.5%) and retail customers (89.2%).

Customer types
- Three wholesalers reported selling antimalarials to government ministries and agencies, such as the Ministry of Defence, the Ministry of Internal Affairs, and the NMS – an agency of the Ministry of Health that manages public sector procurement; one wholesaler reported selling antimalarials to the mission sector procurement agency, the JMS, and also to the national Red Cross; schools were also mentioned as customers by three other wholesalers.
- A higher proportion of wholesalers that supplied retailers (92.4%) reported selling antimalarials directly to retail customers compared to those wholesalers supplying other wholesalers (77.6%).
- Conversely, when compared to wholesalers supplying retailers, a higher proportion of wholesalers that supplied other wholesalers reported selling to private hospitals (79.8% vs. 93.9%), public hospitals (67.3% vs. 81.6%), private clinics, health centres and dispensaries (90.5% vs. 100%), public clinics, health centres and dispensaries (77.1% vs. 87.8%), and to customers in other countries (26.9% vs. 41.7%).
- Nearly a third of all wholesalers interviewed (30.5%) reported selling antimalarials to customers in other countries; the most common countries were Sudan (51.3% of wholesalers), DRC (51.3%), Tanzania (23.1%), Kenya (20.5%), Rwanda (20.5%), Burundi (5.1%) and Somalia (2.5%).

Business practices
- Nearly half (47.9%) of wholesalers supplying other wholesalers reported importing antimalarials, while 16.4% of wholesalers supplying retailers imported antimalarials; and among wholesalers who imported, 43.3% did not sell antimalarials directly to terminal wholesalers.
- 10.2% of all wholesalers identified a manufacturer as one of their two top antimalarial suppliers; however, the proportion was higher among wholesalers supplying other wholesalers compared to those supplying retailers (22.9% vs. 3.9%)
- A third (32.0%) of all wholesalers reported delivering antimalarials to their customers; but half of the wholesalers supplying other wholesalers delivered compared to only a quarter (26.0%) among those supplying retailers.
- Three quarters of all wholesalers interviewed had offered credit to customers in the past three months, offering a median of 30 days credit (IQR 14-30). Although a greater proportion of wholesalers operating at the higher levels of the supply chain (i.e. wholesalers supplying wholesalers) reported providing credit (87.8% vs. 71.2%), the credit terms did not vary widely across supply chain levels.

Table 4.3.2: Wholesalers' Customers, Delivery Activities and Credit facilities

		WHOLESALER CATEGORIES		
ANTIMALARIAL CUSTOMER TYPES		**ALL WHOLESALERS**	**SUPPLY WHOLESALERS**	**SUPPLY RETAILERS**
Retail Customers (e.g. patients, care-takers)	%	**89.2**	**77.6**	**92.4**
	(N)	(129)	(49)	(105)
Retail Outlets				
Pharmacies or drug stores	%	**92.3**	**95.9**	**92.4**
	(N)	(129)	(49)	(105)
General retailers (grocery stores, kiosks, etc.)	%	**73.2**[1]	**70.8**	**73.8**
	(N)	(127)	(48)	(103)
Public clinics, health centres or dispensaries	%	**79.1**	**87.8**	**77.1**
	(N)	(129)	(49)	(105)
Private clinics, health centres or dispensaries	%	**92.3**	**100.0**	**90.5**
	(N)	(129)	(49)	(105)
Public hospitals	%	**69.5**	**81.6**	**67.3**
	(N)	(128)	(49)	(104)
Private hospitals	%	**81.3**	**93.9**	**79.8**
	(N)	(128)	(49)	(104)
Wholesale Outlets				
Drug wholesalers	%	**84.5**	**98.0**[2]	**81.9**
	(N)	(129)	(49)	(105)
General wholesalers	%	**62.8**	**67.4**	**62.9**
	(N)	(129)	(49)	(105)
Customers in Other Countries	%	**30.5**	**41.7**	**26.9**
	(N)	(128)	(48)	(104)
BUSINESS PRACTICES		**ALL WHOLESALERS**	**SUPPLY WHOLESALERS**	**SUPPLY RETAILERS**
Import antimalarial drugs	%	**23.4**	**47.9**	**16.4**
	(N)	(128)	(48)	(104)
Buy directly from antimalarial manufacturers (as one of two top antimalarial suppliers)	%	**10.2**	**22.9**	**3.9**
	(N)	(127)	(48)	(104)
Deliver antimalarials to customers	%	**32.0**	**50.0**	**26.0**
	(N)	(128)	(48)	(104)
Provided credit to customers in the past 3 months	%	**75.0**	**87.8**	**71.2**
	(N)	(128)	(49)	(104)
Most common terms of credit offered in the past 3 months (number of days)	**Median**	**30**	**30**	**30**
	IQR	14-30	30-30	14-30
	(N)	(93)	(43)	(71)

1: Some wholesalers interviewed may have understood the question asked to mean customers for 'any medicines' and not specifically antimalarials, or perhaps customers that buy 'any medicines for the management of malaria', which may include antipyretics, vitamins, etc. that are commonly sold by general retailers. 2: One of the 49 wholesalers in this category reported that they did not supply drug wholesalers; however, during the supply chain survey, a wholesale respondent identified this particular wholesaler as one of their top two supply sources for antimalarials. To remain consistent across indicators, we have chosen to report this indicator as 98.0% rather than 100.0% based on the information reported by respondents.

4.4. Licensing & inspection

A high proportion of wholesalers were observed to have a license from the National Drug Authority while possession of retail licenses and import licenses was lower. Nearly all (99.2%) wholesalers interviewed reported that they had been visited by a pharmaceutical inspector in the past year.

- Among all wholesalers interviewed, 82.8% reported having a wholesale pharmacy license.
- Two-thirds (66.4%) of all wholesalers interviewed reported having a retail pharmacy license, although a higher proportion of wholesalers supplying retailers (71.4%) reported having a retail license compared to wholesalers supplying other wholesalers (54.2%); 8 wholesalers also reported having a Class C license from the National Drug Authority, which is typically obtained by drug shops and permits the retail of selected over-the-counter medicines (however, not antimalarials).
- Any up-to-date license from the National Drug Authority (wholesale or retail) was observed in 82.8% of all wholesalers interviewed. A higher proportion of wholesalers operating at higher levels of the supply chain (i.e. wholesalers supplying wholesalers) were observed to have an up-to-date license compared to wholesalers supplying retailers (91.7% vs. 81.0%).
- Possession of a pharmacy import license was reported by more wholesalers operating at higher levels of the supply chain (i.e. wholesalers supplying wholesalers) compared to those supplying retailers (40.4% vs. 16.4%); these figures were similar to the number of wholesalers who reported importing antimalarials: 47.9% of wholesalers supplying wholesalers vs. 16.4% of wholesalers supplying retailers.
- However, the percentage of wholesalers that reported selling antimalarials directly to retail customers (89.2%) was higher than the percentage of wholesalers that reported having the required license to do so (66.4%).

Table 4.4: Licensing & Inspection

REGISTRATION STATUS		WHOLESALER CATEGORIES		
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS
Reported having a license allowing wholesale of pharmaceuticals	%	82.8	95.8	81.0
	(N)	(128)	(48)	(105)
Reported having a license allowing retail of pharmaceuticals	%	66.4	54.2	71.4
	(N)	(128)	(48)	(105)
Reported having an import license	%	20.6	40.4	16.4
	(N)	(126)	(47)	(104)
Reported having a exporter license	%	7.1	12.7	7.7
	(N)	(127)	(47)	(104)
Reported having a manufacturer license	%	1.6	4.2	1.9
	(N)	(128)	(48)	(105)
Any up-to-date license from the National Drug Authority was observed[1]	%	82.0	91.7	81.0
	(N)	(128)	(48)	(105)
An up-to-date wholesaler license from the National Drug Authority was observed	%	63.3	79.2	61.0
	(N)	(128)	(48)	(105)
An general business or trading license was observed[2]	%	75.8	70.8	79.1
	(N)	(128)	(48)	(105)
Reported they had been visited by a pharmaceutical inspector in the past year	%	99.2	100.0	99.0
	(N)	(123)	(48)	(100)

1: This license may be either a retail or wholesale pharmacy license, but not a Class C license intended solely for the retail of specific OTC drugs, not including antimalarials; this includes wholesalers who had a recently valid pharmacy license (i.e. Expired Nov or Dec 2008) as licences for 2009 were still being processed by the authorities at the time of data collection; 2: The trading license is a general business license required for all companies; only a date of issue is listed on the certificate and no expiry date.

4.5. Knowledge, qualifications and training

All wholesalers surveyed employed at least one staff member with health-related qualifications and most correctly identified the government-recommended first line treatment for uncomplicated malaria. However, fewer wholesalers believed ACTs to be the most effective antimalarial treatment.

- Most wholesalers (86.7%) were able to correctly identify AL as the government recommended first-line treatment for uncomplicated *Pf* malaria; however, a greater proportion of wholesalers operating at higher levels of the supply chain were able to do so compared to those supplying retailers (93.8% vs. 83.8%).
- Despite this, the percentage of wholesalers identifying an ACT as the most effective medication for treating uncomplicated malaria was somewhat lower (40.2% for children and 52.8% for adults). AL was most commonly mentioned as the most effective antimalarial among all wholesalers (34.7% for children and 39.4% for adults); while 18.9% of wholesalers mentioned an AMT, artemether, for the treatment of malaria in both adults and children, and was the second most commonly mentioned 'most effective' antimalarial. Among all wholesalers, the third and fourth most commonly mentioned as 'most effective' for the treatment of malaria in children were SP (15.0%) and CQ (13.4%).
- All wholesalers reported employing staff with health qualifications. The most commonly reported health qualifications were nurses/midwives (89.8%), followed by pharmacists (88.3%), and pharmacy assistants (24.2%).
- The percentage of wholesalers who indicated that staff had participated in in-service training related to malaria treatment in the past two years was low (15.0% of all wholesalers interviewed).

Table 4.5: Wholesalers' knowledge, qualifications and training

HEALTH QUALIFICATIONS, TRAINING AND KNOWLEDGE		WHOLESALER CATEGORIES		
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS
Employ a member of staff with health qualifications[1]	%	100.0	100.0	100.0
	(N)	(128)	(48)	(105)
Employ staff who participated in in-service training related to malaria treatment in the past 2 years	%	15.0	14.6	14.4
	(N)	(127)	(48)	(104)
Identify any ACT as the most effective medication for treating uncomplicated *Pf* malaria in adults	%	52.8	62.5	48.1
	(N)	(127)	(48)	(104)
Identify any ACT as the most effective medication for treating uncomplicated *Pf* malaria in children	%	40.2	50.0	37.5
	(N)	(127)	(48)	(104)
Correctly identify the government recommended first line treatment for uncomplicated *Pf* malaria	%	86.7	93.8	83.8
	(N)	(128)	(48)	(105)

1: Health qualifications included pharmacist, pharmacy technician, pharmacy assistant, medical doctor, nurse, midwife, clinical officer, nursing assistant

4.6. Storage of antimalarial drugs

Most wholesalers were observed to follow good medicines storage practices, including storage in dry areas out of direct sunlight and off the floor.

- All wholesalers were observed to store antimalarials in a dry area; almost all of whom were observed to keep them out of direct sunlight (97.6%) or off the floor (94.4%).
- 92.1% of all wholesalers met each of the specified conditions for good storage of antimalarials (in a dry area, out of direct sunlight and off the floor); however, more wholesalers supplying other wholesalers were observed to comply with all conditions compared to those supplying retailers (95.7% vs. 91.3%).

Table 4.6: Wholesalers' storage practices

STORAGE		WHOLESALER CATEGORIES		
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS
Store antimalarials in a dry area	%	100.0	100.0	100.0
	(N)	(126)	(47)	(103)
Store antimalarials out of direct sunlight	%	97.6	97.9	98.1
	(N)	(126)	(47)	(103)
Store antimalarials off the floor	%	94.4	97.9	93.2
	(N)	(126)	(47)	(103)
Store antimalarials in a dry area, out of direct sunlight & off the floor	%	92.1	95.7	91.3
	(N)	(126)	(47)	(103)

4.7. Availability of antimalarials & RDTs

More than three-quarters of all wholesalers surveyed (88.3%) had an ACT in stock at the time of interview, and a similar proportion (83.3%) of all wholesalers reported having had at least one ACT in stock throughout the three month period prior to interview. Oral AMTs were stocked by a similar proportion of wholesalers (75.8%), while less than a fifth (18.0%) stock RDTs.

- Nearly all wholesalers surveyed (99.2%) had at least one antimalarial in stock at the time of interview.
- A higher proportion of wholesalers had non-WHO-prequalified ACTs in stock (75.0%) than WHO-prequalified ACTs (52.3%).
- AL, the recommended first-line treatment for uncomplicated *Pf* malaria, was stocked by 74.0% of all wholesalers; however, it was only the third most frequently observed antimalarial, accounting for 13.0% of all antimalarial products stocked by wholesalers and 53.9% of all ACTs stocked; of all the AL products observed, 45.4% were WHO-prequalified brands.
- The second most frequently observed ACT stocked by wholesalers after AL was dihydroartemisinin piperaquine, accounting for 5.3% of all antimalarial products stocked by wholesalers and 22.3% of all ACTs stocked.
- Oral AMTs were stocked by 75.8% of all wholesalers, and non-oral AMTs by 51.6% of all wholesalers.
- The two most frequently observed antimalarials were artemether (an AMT), followed by quinine (19.2% and 18.4% of all products stocked by wholesalers, respectively). SP accounted for 10.6% of all products stocked by wholesalers, and chloroquine, 9.1%. More than half (55%) of the artemether products, 72% of the quinine products and virtually all of the SP (98%) and chloroquine (97%) products stocked by wholesalers were oral formulations, with the remainder in injectable dosage form.
- RDTs were stocked by less than a fifth (18.0%) of all wholesalers at the time of interview; however, a higher proportion of wholesalers operating at higher levels of the supply chain (i.e. wholesalers supplying wholesalers) were observed to have RDTs in stock compared to wholesalers supplying retailers (32.0% vs. 17.1%).

Table 4.7: Antimalarial & RDT availability

AVAILABILITY		WHOLESALER CATEGORIES		
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS
Had antimalarials in stock	%	99.2	96.0	99.0
	(N)	(128)	(50)	(105)
Had ACT in stock	%	88.3	92.0	86.7
	(N)	(128)	(50)	(105)
Always had at least one ACT in stock over the past 3 months	%	83.3	87.5	82.5
	(N)	(126)	(48)	(103)
Had WHO-prequalified ACT in stock	%	52.3	50.0	54.3
	(N)	(128)	(50)	(105)
Had non-WHO-prequalified ACT in stock	%	75.0	80.0	74.3
	(N)	(128)	(50)	(105)
Had oral AMT in stock	%	75.8	72.0	79.0
	(N)	(128)	(50)	(105)
Had non-oral AMT in stock	%	51.6	50.0	53.3
	(N)	(128)	(50)	(105)
Had nAT in stock	%	89.1	78.0	92.4
	(N)	(128)	(50)	(105)
Had RDT in stock	%	18.0	32.0	17.1
	(N)	(128)	(50)	(105)

4.8.   Sales volumes of antimalarials and RDTs

Typical sales volumes were greatest for non-artemisinin therapies, followed by ACTs, and smallest for AMT. AMT sales volumes were dominated by tablets. More than a third of all wholesalers reported SP as their top selling antimalarial, while the government recommended first-line treatment, AL, was the top selling antimalarial for only a tenth of all wholesalers.

Among all wholesalers (n=127; Table 4.8.1)
- The median number of adult equivalent treatment doses (AETDs) sold the week preceding the survey was 22.0 (IQR 4.8-94.4) for ACTs and 15.0 (IQR 2.3-34.8) for AMT, but much higher for nATs: 304.9 (IQR 52.1-1523.7).
- Most wholesalers (83.6%) reported selling an ACT during the week preceding the survey; this figure was 79.7% for AMTs and 87.5% for nATs.
- Across the different antimalarial drug categories, more AETDs were sold as tablets than any other dosage form, particularly for AMTs where the median sales volume for tablets was 7.7 AETDs (IQR 0.0-18.8) and 0.0 AETDs for oral liquid and injectable dosage forms. However, relatively high median volumes of oral liquid nATs were sold by wholesalers. The volumes of granule and suppository dosage forms sold were very low: median sales volumes among all wholesalers stocking any antimalarial across all antimalarial categories were 0 (IQR 0-0). See Appendix 6.1 for additional tables on sales volumes of suppository and granule dosage forms.
- Only 10.2% reported the recommended first line treatment for uncomplicated malaria, AL, to be their top selling antimalarial, while higher proportions of wholesalers reported SP (36.2%), CQ (18.1%) and quinine (11.8%) to be their top selling antimalarial.[7]
- However, compared to wholesalers supplying retailers, a higher proportion of wholesalers supplying other wholesalers (18.8%) reported AL to be their top selling antimalarial drug, second only to SP, the top-selling antimalarial of 22.9% of these wholesalers. Following behind was chloroquine (14.6%) and an AMT, artemether, reported by 12.5% of wholesalers supplying wholesalers as their top selling antimalarial.

Among wholesalers stocking the corresponding product category (Table 4.8.2)
- Considering only wholesalers who stocked ACT (n=113), the median ACT sales volumes sold the week preceding the survey was 30.0 (IQR 10.0-99.9). The median sales volume of WHO-prequalified ACTs among the 108 wholesalers stocking them (10.0 AETDs, IQR 5.0-40.0) was about half the observed sales volume of non-WHO-prequalified ACTs (18.3 AETDs, IQR 5.4-85.8) among the 96 wholesalers who stocked them. Among wholesalers supplying other wholesalers, non-WHO-prequalified ACTs were even more dominant (median of 50.7 AETDs, n=40; compared with 20.0 for WHO-prequalified ACTs, n=25).
- Considering only wholesalers who stocked nAT (n=114), the median nAT sales volumes in the past week were 372.7 AETDs (IQR 125.0-2092.8).
- Of wholesalers stocking AMT (n=103), their median AMT sales volumes were 20.5 AETDs (IQR 10.1-62.5). AMT tablets were stocked by 92 wholesaler who sold a median volume of 13.8 AETDs (IQR 6.3-26.9) the week preceding the survey; AMT injectables were stocked by 65 wholesaler who sold a median volume of 8.3 AETDs (IQR 2.4-30.0); and only 29 wholesalers stocked AMT oral liquid products and sold a median volume of 1.6 AETDs (IQR 0.6-6.3).
- RDTs were not commonly stocked by wholesalers. Among those who did stock RDTs (n=22), the volume of tests sold varied widely both within and across supply chain levels. Among those who stocked RDTs, the median number of tests sold during the week preceding the survey was 15 (IQR 2.5-50.5) among wholesalers supplying wholesalers, while wholesalers supplying retailers sold a median 8.5 tests (IQR 0-50).

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[7]The analysis of the top selling antimalarials used sales volumes data collected for each antimalarial in stock at the time of the survey: in each outlet and for each antimalarial stocked, wholesalers were asked to recall the quantity they had sold during the week preceding the survey

Table 4.8.1: Median number of AETDs & RDTs sold during the week preceding the survey (all wholesalers)

ANTIMALARIAL TYPE[1] Formulation[2]			WHOLESALER CATEGORIES		
			ALL WHOLESALERS N=127[3]	SUPPLY WHOLESALERS N=48	SUPPLY RETAILERS N=104
All ACT	All	**Median**	**22.0**	**58.8**	**18.9**
		IQR	4.8-94.4	15.8-343.6	4.0-57.1
	Tablet	**Median**	**21.9**	**56.4**	**18.1**
		IQR	4.0-86.7	14.3-295.1	3.7-56.2
	Oral liquid	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-2.3	0.0-0.0
WHO-prequalified ACT	All products were tablets	**Median**	**2.0**	**1.0**	**2.0**
		IQR	0.0-10.0	0.0-20.0	0.0-10.0
Non-WHO-prequalified ACT	All	**Median**	**9.8**	**30.9**	**8.9**
		IQR	0.0-46.5	3.3-216.0	0.0-37.7
	Tablet	**Median**	**9.4**	**24.5**	**8.7**
		IQR	0.0-44.4	1.0-194.4	0.0-36.8
	Oral liquid	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-2.3	0.0-0.0
AMT	All	**Median**	**15.0**	**21.6**	**14.1**
		IQR	2.3-34.8	12.5-125.8	1.9-32.3
	Tablet	**Median**	**7.7**	**12.8**	**7.7**
		IQR	0.0-18.8	0.0-25.1	0.0-18.3
	Oral liquid	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.9	0.0-0.0
	Injectable	**Median**	**0.0**	**0.0**	**0.2**
		IQR	0.0-9.5	0.0-20.0	0.0-8.2
nAT	All	**Median**	**304.9**	**236.2**	**350.7**
		IQR	52.1-1523.7	25.8-3822.6	109.1-1828.3
	Tablet	**Median**	**203.8**	**122.0**	**244.4**
		IQR	10.3-1053.9	0.0-3642.9	69.4-1348.4
	Oral liquid	**Median**	**28.8**	**32.5**	**32.3**
		IQR	3.6-78.8	0.0-77.2	10.2-81.1
	Injectable	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0
			ALL WHOLESALERS N=126	SUPPLY WHOLESALERS N=46	SUPPLY RETAILERS N=104
RDT[4] (units)		**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria; 2 The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesaler and retailers stocked suppositories or granules, and so few of these product types were observed during the audit, these dosage forms have been excluded from the tables here, but are provided in the appendix as supplemental tables. 3 For antimalarials: there were a total of 127wholesalers with antimalarial sales volumes (reported or imputed or set as null if did not stock). Note on imputation process for antimalarial sales volumes: during the study, 142 wholesalers were identified, of which 127 were interviewed and 4 refused (Table 1). Out of the 127 interviewed, 1 did not stock antimalarials at the time of the survey, so their sales volumes were set as zero for all antimalarial categories. The volumes for 14 wholesalers were set as missing for all antimalarial categories: 6 businesses had closed down, 2 wholesalers could not be located, 4 refused and had antimalarials in stock, and 2 reported stocking antimalarials but no audit sheet information was recorded. Overall, there were a total of 1326 antimalarials audited, of which 45 (3.4%) had missing sales volumes that were imputed using the mi impute pmm command. 4 For RDTs, 105 wholesalers reported that they did not stock RDTs, 3 did not know if they stocked RDTs at any point in the three months prior to interview, and 24 reported stocking RDT from whom inventory data were collected from 23 wholesalers on 25 observed products. Of these, information on sales volume was not provided for 3 products from 3 different wholesalers; however imputation was not performed as there were too few observations to reliably perform linear regression. Sales volumes were set as missing for the 1 wholesaler who reported stocking RDTs but from whom inventory data were not collected. Therefore for RDTs, median sales volumes at the level supplying retail outlets are estimated based on the sample of 22 products from 20 wholesalers for which volumes were not missing.

Table 4.8.2: Median number of AETDs & RDTs sold during the week preceding the survey (among wholesalers stocking corresponding antimalarial drug category/RDT at the time of the survey)

ANTIMALARIAL TYPE[1] Formulation[2]			WHOLESALER CATEGORIES[3]		
			ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS
All ACT	All	**Median**	**30.0**	**74.0**	**23.0**
		IQR	10.0-99.9	21.2-344.8	8.9-60.4
		(n)	(113)	(46)	(91)
	Tablet	**Median**	**31.2**	**84.4**	**25.5**
		IQR	11.7-97.8	25.2-344.4	10.4-72.4
		(n)	(108)	(43)	(88)
	Oral liquid	**Median**	**1.7**	**3.8**	**1.5**
		IQR	0.4-4.3	1.1-7.5	0.4-3.8
		(n)	(36)	(19)	(29)
WHO-prequalified ACT	All products were tablets	**Median**	**10.0**	**20.0**	**10.0**
		IQR	5.0-40.0	10.0-50.0	5.0-30.0
		(n)	(67)	(25)	(57)
Non-WHO-prequalified ACT	All	**Median**	**18.3**	**50.7**	**15.2**
		IQR	5.4-85.8	9.3-243.4	5.0-48.8
		(n)	(96)	(40)	(78)
	Tablet	**Median**	**20.0**	**64.4**	**16.3**
		IQR	8.6-82.1	18.3-236.1	6.2-54.4
		(n)	(89)	(36)	(73)
	Oral liquid	**Median**	**1.7**	**3.8**	**1.5**
		IQR	0.4-4.3	1.1-7.5	0.4-3.8
		(n)	(36)	(19)	(29)
AMT	All	**Median**	**20.5**	**28.4**	**18.9**
		IQR	10.1-62.5	15.6-150.0	8.6-34.8
		(n)	(103)	(41)	(85)
	Tablet	**Median**	**13.8**	**18.5**	**12.5**
		IQR	6.3-26.9	10.8-43.8	5.6-22.1
		(n)	(92)	(34)	(78)
	Oral liquid	**Median**	**1.6**	**1.6**	**1.6**
		IQR	0.6-6.3	1.3-6.3	0.6-6.3
		(n)	(29)	(15)	(23)
	Injectable	**Median**	**8.3**	**20.0**	**7.1**
		IQR	2.4-30.0	5.9-147.9	2.3-23.8
		(n)	(65)	(24)	(56)
nAT	All	**Median**	**372.7**	**750.5**	**441.0**
		IQR	125.0-2092.8	81.2-4306.3	142.4-2092.8
		(n)	(114)	(39)	(97)
	Tablet	**Median**	**404.8**	**688.1**	**420.0**
		IQR	111.4-1546.8	119.0-6000.0	111.9-1738.1
		(n)	(105)	(35)	(91)
	Oral liquid	**Median**	**33.9**	**47.6**	**33.7**
		IQR	16.5-85.8	31.7-158.4	16.5-99.2
		(n)	(106)	(33)	(94)
	Injectable	**Median**	**22.0**	**238.1**	**20.2**
		IQR	4.8-119.0	19.0-1190.5	4.8-95.2
		(n)	(58)	(14)	(55)
RDT (units)		**Median**	**10**	**15**	**8.5**
		IQR	0-25	2.5-50.5	0-50
		(n)	(22)	(16)	(18)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesaler and retailers stocked suppositories or granules, and so few of these product types were observed during the audit, these dosage forms have been excluded from the tables here, but are provided in the appendix as supplemental tables. 3 (n) is the number of wholesalers at a given level who stocked antimalarials for corresponding drug category or who stocked RDT.

4.9. Purchase price of antimalarials and RDTs

Purchase price is the price paid by businesses (i.e. wholesalers or outlets) for their most recent purchase of an antimalarial product from their suppliers, and is reported in terms of the median price (in US dollars) per AETD. Because of the varied nature of wholesaler transactions (e.g. wholesalers may vary their price; antimalarials may pass through a number of wholesalers before reaching an outlet), wholesale purchase prices are indicative of the purchase prices paid by wholesalers in general, rather than at specific levels of the supply chain. Retail purchase prices, however, reflect the antimalarial purchase prices paid by specific outlet types to their suppliers.

Among all wholesalers, the median wholesale purchase price per AETD ranged from US$ 1.17 (IQR 0.22-3.95) for nATs, to US$ 4.39 (IQR 2.44-7.56) for ACTs, and US$ 6.34 (IQR 4.68-9.76) for AMTs. Considering only oral dosage forms, median wholesale purchase prices were comparable for ACTs and AMTs for tablets (US$ 4.14 for ACTs vs. US$ 5.08 for AMT) and oral liquids (US$ 12.69 for ACTs vs. US$ 10.15 for AMTs). The median purchase price for RDTs at wholesale level was US$ 0.78 per test.

- Across different wholesale levels of the supply chain, purchase prices tended to be similar; however, the median purchase price for WHO-prequalified ACTs was observed to be lower among wholesalers supplying retailers (US$ 3.12, IQR 2.34-7.32) than those supplying other wholesalers (US$ 4.76, IQR 2.34-7.56). This was because a higher proportion of ACT products stocked by wholesalers supplying other wholesalers was Coartem (62% vs. 42% among wholesalers supplying retailers), which is the originator brand of AL, with a higher median purchase price than other brands of WHO-prequalified AL.

- Across different retail outlet types, the median retail purchase price per AETD for ACTs ranged from US$ 2.27 (IQR 0.71-3.79) in drug stores to US$ 6.39 (IQR 4.15-7.57) in pharmacies; for AMTs from US$ 6.06 (IQR 3.03-10.22) in private health facilities to US$ 6.43 (IQR 4.54-9.73) in pharmacies; and for nATs from US$ 0.09 (IQR 0.00-0.50) in other private outlets, such as grocery stores, to US$ 0.79 (IQR 0.30-2.98) in pharmacies. Pharmacies tended to have paid higher purchase prices for ACTs than other outlet types. For example, the median purchase price of WHO-prequalified ACT paid by pharmacies was US$ 7.10, compared to US$ 3.08 in private health facilities and US$ 3.79 in drug stores. Public health facilities did not typically pay for their antimalarial purchases; however in a few instances, some public health facilities reported having paid to purchase AMTs and nATs.

- Examining the effect of subsidised ACTs on retail purchase price in drug stores, the median price per AETD for all ACTs fell from US$ 2.27 (IQR 0.71-3.79) to US$ 0.47 (IQR 0.24-2.84) when observations from sub-districts participating in the pilot programme are included (described in section 2 above), and from US$ 3.79 (IQR 2.37-4.73) to US$ 0.26 (IQR 0.19-1.80) for WHO-prequalified ACTs.

- For AL, the first-line treatment for uncomplicated *Pf* malaria, the median purchase price per AETD at wholesale level was US$ 4.29 (IQR 1.81-7.81) among wholesalers supplying other wholesalers, and US$ 3.17 (IQR 1.95-7.81) among wholesalers supplying retailers. At retail level, the median purchase price was US$ 7.10 (IQR 3.08-8.52) at pharmacies, US$ 3.08 (IQR 2.13-5.27) at private health facilities, and US$ 2.27 (IQR 1.80-3.79) at drug stores.

- For SP, the antimalarial with the highest number of AETDs distributed, the median purchase price per AETD was US$ 0.33 (IQR 0.14-0.71) at pharmacies, US$ 0.13 (IQR 0.08-0.28) at private health facilities, US$ 0.12 (IQR 0.06-0.24) at drug stores, and US$ 0.09 (IQR 0.00-0.11) at other private outlets, such as grocery stores; at the wholesale level, the median purchase price was US$ 0.15 (IQR 0.10-0.40).

- Regarding the recommended treatments for severe *Pf* malaria, the median purchase price per AETD for injectable quinine at wholesale level was US$ 4.61 (IQR 3.79-8.20); and at retail level, US$ 4.97 (IQR 3.89-8.45) at pharmacies, US$ 4.97 (IQR 2.98-7.95) at private health facilities, and US$ 4.97 (IQR 3.97-6.96) at drug stores. For injectable artemether, the median purchase price per AETD at wholesale level was US$ 9.27 (IQR 7.03-11.22); and at retail level, US$ 10.22 (IQR 6.81-11.36) at pharmacies, US$ 9.46 (IQR 4.09-14.19) at private health facilities, and US$ 11.36 (IQR 5.52-19.30) at drug stores.

- Median purchase prices per AETD for tablets were lower compared to oral liquids across all antimalarial types and for both wholesalers and retailers. Injectables tended to have the highest purchase prices, except for AMTs where oral liquids were observed to have higher purchase prices than injectables at wholesale level.
- In several cases, the median price retailers paid to purchase antimalarials were observed to be lower than the prices paid by wholesalers, particularly among drug stores and private health facilities; while the reasons for this are not immediately clear, this may be the effect of differences in the restocking practices at different levels of the supply chain combined with exchange rate volatility, or preferences of different retailer types to stock a product mix different to wholesalers (e.g. drug stores may prefer to stock more generic than branded products.)
- Where RDTs were stocked, wholesalers at all levels of supply chain reported purchasing 1 RDT unit at US$ 0.78 (IQR 0.73-0.88) (data were not collected on retailer purchase prices for RDTs).

Table 4.9.1 Purchase price per AETD/RDT (US$), wholesale level

ANTIMALARIAL TYPE[1] Formulation[2]			WHOLESALER CATEGORIES		
			ALL WHOLESALERS N=127	SUPPLY WHOLESALERS N=48	SUPPLY RETAILERS N=104
All ACT	All	Median	4.39	4.39	4.39
		IQR	2.44-7.56	2.20-7.56	2.44-7.56
		(n)	(277)	(115)	(234)
	Tablet	Median	4.14	4.20	4.20
		IQR	2.17-5.86	1.95-5.86	2.20-5.86
		(n)	(232)	(94)	(196)
	Oral liquid	Median	12.69	11.84	13.01
		IQR	7.81-13.29	7.81-13.01	8.13-14.18
		(n)	(38)	(20)	(32)
WHO-prequalified ACT	All products were tablets	Median	3.15	4.76	3.12
		IQR	2.27-7.44	2.34-7.56	2.34-7.32
		(n)	(84)	(30)	(73)
Non WHO-prequalified ACT	All	Median	4.53	4.39	4.67
		IQR	2.44-7.56	2.20-7.32	3.42-7.81
		(n)	(193)	(85)	(161)
	Tablet	Median	4.36	4.20	4.39
		IQR	1.95-5.61	1.76-4.94	2.20-5.76
		(n)	(148)	(64)	(123)
	Oral liquid	Median	12.69	11.84	13.01
		IQR	7.81-13.29	7.81-13.01	8.13-14.18
		(n)	(38)	(20)	(32)
AMT	All	Median	6.34	6.49	6.30
		IQR	4.68-9.76	4.68-9.56	4.68-9.76
		(n)	(293)	(110)	(254)
	Tablet	Median	5.08	4.84	5.08
		IQR	3.90-6.25	3.90-6.25	3.90-6.17
		(n)	(162)	(61)	(140)
	Oral liquid	Median	10.15	10.54	10.15
		IQR	9.37-14.05	9.68-14.05	9.37-14.31
		(n)	(27)	(14)	(22)
	Injectable	Median	9.27	8.39	9.37
		IQR	7.03-11.22	6.34-10.71	7.32-11.22
		(n)	(103)	(35)	(91)
nAT	All	Median	1.17	1.17	1.17
		IQR	0.22-3.95	0.22-3.90	0.22-4.10
		(n)	(621)	(182)	(570)
	Tablet	Median	0.22	0.22	0.22
		IQR	0.13-1.74	0.13-1.74	0.13-1.74
		(n)	(299)	(89)	(272)
	Oral liquid	Median	1.32	1.35	1.32
		IQR	0.61-5.30	0.65-5.38	0.61-5.33
		(n)	(253)	(72)	(232)
	Injectable	Median	4.61	4.00	4.61
		IQR	3.69-8.20	3.07-7.17	3.69-8.20
		(n)	(66)	(19)	(63)
RDT (per unit)		Median	0.78	0.78	0.78
		IQR	(0.73-0.88)	(0.73-0.88)	(0.73-0.88)
		(n)	(19)	(15)	(15)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesaler and retailers stocked suppositories or granules, and so few of these product types were observed during the audit, these dosage forms have been excluded from the tables here.

Table 4.9.2 Purchase price per AETD (US$), retail level

ANTIMALARIAL TYPE[1] Formulation[2]			RETAILER CATEGORIES[3]				
			PHARMACIES N=87	PRIVATE HEALTH FACILITIES N=176	DRUG STORES N=352	OTHER PRIVATE OUTLETS[4] N=9	PUBLIC HEALTH FACILITIES N=198
All ACT[5]	All	**Median**	**6.39**	**3.31**	**2.27**	**-**	**0.00**
		IQR	4.15-7.57	2.13-4.52	0.71-3.79	-	0.00-0.00
		(n)	(243)	(69)	(52)	-	(233)
	Tablet	**Median**	**5.32**	**3.31**	**2.27**	**-**	**0.00**
		IQR	3.41-7.10	2.13-4.52	0.71-3.79	-	0.00-0.00
		(n)	(205)	(63)	(49)	-	(233)
	Oral liquid	**Median**	**12.62**	**8.20**	**2.31**	**-**	**-**
		IQR	12.62-12.62	0.00-9.46	0.00-2.31	-	-
		(n)	(30)	(5)	(3)	-	-
WHO-prequalified ACT[5]	All products were tablets	**Median**	**7.10**	**3.08**	**3.79**	**-**	**0.00**
		IQR	4.73-7.33	0.00-7.45	2.37-4.73	-	0.00-0.00
		(n)	(82)	(13)	(11)	-	(225)
Non WHO-prequalified ACT[5]	All	**Median**	**5.32**	**3.46**	**2.13**	**-**	**0.00**
		IQR	3.99-8.20	2.13-4.52	0.47-3.79	-	0.00-0.00
		(n)	(161)	(56)	(41)	-	(8)
	Tablet	**Median**	**4.52**	**3.41**	**2.13**	**-**	**0.00**
		IQR	3.09-5.68	2.13-4.36	0.47-3.79	-	0.00-0.00
		(n)	(123)	(50)	(38)	-	(8)
	Oral liquid	**Median**	**12.62**	**8.20**	**2.31**	**-**	**-**
		IQR	12.62-12.62	0.00-9.46	0.00-2.31	-	-
		(n)	(30)	(5)	(3)	-	-
AMT	All	**Median**	**6.43**	**6.06**	**6.06**	**-**	**6.06**
		IQR	4.54-9.73	3.03-10.22	4.16-7.57	-	6.06-11.36
		(n)	(213)	(89)	(40)	-	(3)
	Tablet	**Median**	**5.68**	**5.30**	**4.92**	**-**	**6.06**
		IQR	4.02-7.27	3.03-6.81	3.79-6.06	-	6.06-6.06
		(n)	(119)	(53)	(31)	-	(1)
	Oral liquid	**Median**	**6.81**	**11.36**	**11.36**	**-**	**-**
		IQR	6.81-9.84	0.00-11.36	11.36-11.36	-	-
		(n)	(20)	(6)	(3)	-	-
	Injectable	**Median**	**10.22**	**9.46**	**11.36**	**-**	**11.36**
		IQR	6.81-11.36	4.09-14.19	5.52-19.30	-	11.36-11.36
		(n)	(71)	(30)	(6)	-	(2)
nAT	All	**Median**	**0.79**	**0.71**	**0.59**	**0.09**	**0.00**
		IQR	0.30-2.98	0.14-2.44	0.14-1.99	0.00-0.50	0.00-0.07
		(n)	(526)	(735)	(1369)	(14)	(347)
	Tablet	**Median**	**0.33**	**0.21**	**0.21**	**0.09**	**0.00**
		IQR	0.17-0.89	0.09-0.80	0.08-0.89	0.00-0.20	0.00-0.06
		(n)	(277)	(412)	(775)	(12)	(181)
	Oral liquid	**Median**	**1.70**	**2.13**	**1.70**	**3.91**	**4.40**
		IQR	0.79-4.15	0.79-4.40	0.63-4.40	3.91-3.91	3.35-4.89
		(n)	(191)	(215)	(513)	(1)	(10)
	Injectable	**Median**	**4.83**	**4.97**	**4.97**	**3.97**	**0.00**
		IQR	3.48-8.45	2.84-7.95	3.53-6.96	3.97-3.97	0.00-0.00
		(n)	(58)	(108)	(81)	(1)	(156)

Table 4.9.3 Purchase price per AETD (US$), retail level INCLUDING subsidised ACT products

ANTIMALARIAL TYPE[1] Formulation[2]			RETAILER CATEGORIES[3]				
			PHARMACIES N=87	PRIVATE HEALTH FACILITIES N=176	DRUG STORES N=352	OTHER PRIVATE OUTLETS[4] N=9	PUBLIC HEALTH FACILITIES N=198
All ACT[5]	All	**Median**	**6.12**	**3.31**	**0.47**	-	**0.00**
		IQR	3.73-7.57	2.13-4.52	0.24-2.84	-	0.00-0.00
		(n)	(248)	(69)	(65)	-	(233)
	Tablet	**Median**	**5.32**	**3.31**	**0.47**	-	**0.00**
		IQR	3.08-7.10	2.13-4.52	0.24-3.19	-	0.00-0.00
		(n)	(210)	(63)	(62)	-	(233)
	Oral liquid	**Median**	**12.62**	**8.20**	**2.31**	-	-
		IQR	12.62-12.62	0.00-9.46	0.00-2.31	-	-
		(n)	(30)	(5)	(3)	-	-
WHO-prequalified ACT[5]	All products were tablets	**Median**	**7.10**	**3.08**	**0.26**	-	**0.00**
		IQR	3.08-7.24	0.00-7.45	0.19-1.80	-	0.00-0.00
		(n)	(87)	(13)	(24)	-	(225)
Non WHO-prequalified ACT[5]	All	**Median**	**5.32**	**3.46**	**2.13**	-	**0.00**
		IQR	3.99-8.20	2.13-4.52	0.47-3.79	-	0.00-0.00
		(n)	(161)	(56)	(41)	-	(8)
	Tablet	**Median**	**4.52**	**3.41**	**2.13**	-	**0.00**
		IQR	3.09-5.68	2.13-4.36	0.47-3.79	-	0.00-0.00
		(n)	(123)	(50)	(38)	-	(8)
	Oral liquid	**Median**	**12.62**	**8.20**	**2.31**	-	-
		IQR	12.62-12.62	0.00-9.46	0.00-2.31	-	-
		(n)	(30)	(5)	(3)	-	-

4.10. Price mark-ups on antimalarials and RDTs

4.10.1. Percent Mark-Ups on Antimalarials and RDTs

In general, the percentage mark-up is calculated as the difference between the selling price and the purchase price, divided by the purchase price. It captures both the costs of doing business and profit to the seller. Because wholesalers vary their prices, minimum, maximum and mid mark-ups were calculated using data on minimum and maximum selling price charged for one unit by wholesalers. The wholesale percent mid mark-up was calculated as the difference between the average wholesale selling price (i.e. the mid-point between the maximum and minimum wholesale selling price) and wholesale purchase price, divided by wholesale purchase price. The retail percent mark-up was calculated using the retail selling price and purchase price collected during the ACTwatch Outlet Survey.[8]

At wholesale level, percent mark-ups were relatively low and consistent both across antimalarial categories and dosage forms, ranging from 14% on ACTs, to 15% on AMTs and 18% on nATs. Percent mark-ups among retailers tended to be higher than at wholesale level, and mark-ups above 100% were commonly observed in drug stores and for nATs across all retailer categories.

- Wholesale-level median mid percent mark-ups did not vary much across antimalarial categories or dosage forms: they ranged from 14.3% for ACTs to 17.6% for nATs; and across dosage forms from 15.4% for tablets to 20.0% for oral liquids and injectables.
- Wholesalers reported varying their mark-up on 42.1% of all observed products depending on the volume being purchased (based on the 1194 observations where mark-up data were obtained), with similar percentages varying mark-ups across different levels of the supply chain. The difference between the highest and lowest median mark-ups was generally less than 5%, except for nATs, where the difference between highest and lowest mark-ups was 13% for oral liquids.
- Among wholesalers, median mid percent mark-ups were observed to be slightly higher among wholesalers supplying retailers than those supplying other wholesalers (except for AMTs where percent mark-ups were similar across wholesale supply chain levels).
- Retail median percent mark-ups were observed to be generally higher than those for wholesalers, ranging from 33.3%-87.5% across outlet types and antimalarial categories.
- It was rare for public health facilities to report taking payments for antimalarials, and the percent mark-ups added were relatively low, ranging from 15.0% to 32.5%.
- Across different retail outlet types, the median percent mark-up on ACT ranged between 33.3% (IQR 20.0-100.0) in drug stores and 43.6% (IQR 15.4-76.5) in private health facilities; on AMT between 33.3% (IQR 25.0-126.4) at drug stores and 60.0% (IQR 25.0-114.3) at private health facilities; on nAT between 66.7% (IQR 33.3-150.0) at drug stores and 87.5% (IQR 38.9-250.9) at private health facilities. Pharmacies, private health facilities and drug stores were observed to apply higher percent mark-ups for non-WHO-prequalified ACT tablets than prequalified ACT tablets.
- In drug stores, median percent mark-ups for ACTs were generally higher when observations from sub-districts participating in the subsidised ACT pilot programme are included (described in section 2 above); for example, the median mark-up on WHO-prequalified ACT was 42.9% (IQR 33.3-100.0) when subsidised ACTs are included, and 31.6% (IQR 12.5-50.0) when excluded.
- For AL, the first-line treatment for uncomplicated *Pf* malaria, the median retail percent mark-up was 33.3% (IQR 23.1-50.0) at pharmacies, 42.9% (IQR 25.0-75.0) at private health facilities, and 33.3% (IQR 20.0-100.0) at drug stores; at wholesale levels, the median mid percent mark-up was 11.3% (IQR 5.7-25.0) among those supplying wholesalers, and 14.3% (IQR 7.2-25.0) among those supplying retailers.
- For SP, the antimalarial with the highest number of AETDs distributed, the median retail percent mark-up was 100.0% (IQR 66.7-350.0) at pharmacies, 200.0% (IQR 68.0-525.0) at private health facilities, and 177.8% (IQR 66.7-455.6) at drug stores; at wholesale levels, the median mid percent mark-up was 12.9% (IQR 6.7-25.0) among wholesalers supplying wholesalers, and 23.1% (IQR 9.1-45.8) among wholesalers supplying retailers.

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[8] Negative % mark-ups were recorded in several cases, for which there are several possible explanations: (1) data collection errors (e.g. antimalarials bought in relatively large pack sizes and sold by the tablet were sometimes subject to errors); (2) some businesses may have sold products at lower prices than at which they were bought to deal with slow moving products or because the purchase price has increased and the business was still selling the 'old' product at the 'old' price.

- Regarding the recommended treatments for severe *Pf* malaria, the median percent mark-up for injectable quinine at wholesale level was 25.0% (IQR 20.0-30.0); and at retail level, 25.0% (IQR 17.6-50.0) at pharmacies, 150.0% (IQR 60-828.5) at private health facilities, and 87.5% (IQR 42.9-150.0) at drug stores. For injectable artemether, the median percent mark-up per AETD at wholesale level was 11.8% (IQR 6.3-22.7); and at retail level, 40.0% (IQR 31.3-66.7) at pharmacies, 70.0% (IQR 33.3-122.2) at private health facilities, and 20.0% (IQR -17.6-50.0) at drug stores.
- The wholesale median mid percent mark-up on RDTs was 26.7% (IQR 20.0-33.3) among wholesalers supplying other wholesalers, and 17.6% (IQR 17.6-17.6) among those supplying retailers.

Table 4.10.1.1: Percent price mark-ups on antimalarials and RDTs, wholesale level (%)

ANTIMALARIAL TYPE[1] Formulation[2]			WHOLESALER CATEGORIES								
			ALL WHOLESALERS N=127			SUPPLY WHOLESALERS N=48			SUPPLY RETAILERS N=104		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
All ACT	All	**Median**	**14.3**	**11.1**	**16.7**	**10.7**	**8.6**	**12.5**	**13.6**	**11.1**	**15.4**
		IQR	7.1-25.0	5.9-20.0	8.1-28.6	5.4-24.0	4.2-18.2	6.3-28.6	6.7-25.0	5.4-18.8	7.5-26.3
		(n)		(277)			(115)			(234)	
	Tablet	**Median**	**14.3**	**11.1**	**16.7**	**10.2**	**8.2**	**12.5**	**14.1**	**11.1**	**16.3**
		IQR	7.1-25.0	5.9-20.0	8.3-28.6	5.4-22.7	3.8-16.7	6.3-27.3	7.1-25.0	5.9-19.4	7.9-26.7
		(n)		(232)			(94)			(196)	
	Oral liquid	**Median**	**14.8**	**11.1**	**15.6**	**14.6**	**11.1**	**14.6**	**9.7**	**7.9**	**9.7**
		IQR	6.7-22.2	5.0-18.2	6.7-30.0	5.3-27.3	5.1-17.9	5.3-39.4	5.3-18.2	5.0-17.2	5.3-19.1
		(n)		(38)			(20)			(32)	
WHO-prequalified ACT	All products were tablets	**Median**	**14.8**	**11.1**	**16.7**	**9.5**	**6.9**	**11.3**	**14.3**	**11.1**	**16.7**
		IQR	7.5-25.8	6.1-18.5	8.0-29.3	4.5-22.2	3.2-16.7	4.5-26.7	7.1-25.0	5.9-18.2	7.5-27.9
		(n)		(84)			(30)			(73)	
Non WHO-prequalified ACT	All	**Median**	**14.3**	**11.1**	**16.7**	**11.4**	**10.0**	**12.5**	**13.3**	**10.2**	**15.4**
		IQR	6.7-25.0	5.7-22.2	8.1-28.6	5.7-24.0	5.0-18.2	6.3-28.6	6.7-25.0	5.4-20.0	7.6-25.0
		(n)		(193)			(85)			(161)	
	Tablet	**Median**	**13.6**	**11.1**	**16.3**	**11.1**	**8.6**	**12.5**	**13.3**	**11.1**	**16.0**
		IQR	7.1-25.0	5.9-22.4	8.3-28.6	5.7-22.8	4.2-17.0	6.3-27.6	7.1-25.0	5.9-21.2	8.1-26.3
		(n)		(148)			(64)			(123)	
	Oral liquid	**Median**	**14.8**	**11.1**	**15.6**	**14.6**	**11.1**	**14.6**	**9.7**	**7.9**	**9.7**
		IQR	6.7-22.2	5.0-18.2	6.7-30.0	5.3-27.3	5.1-17.9	5.3-39.4	5.3-18.2	5.0-17.2	5.3-19.1
		(n)		(38)			(20)			(32)	

ANTIMALARIAL TYPE[1] Formulation[2]			WHOLESALER CATEGORIES								
			ALL WHOLESALERS N=127			SUPPLY WHOLESALERS N=48			SUPPLY RETAILERS N=104		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
AMT	All	Median	15.0	11.1	16.7	14.7	11.1	16.7	14.4	11.1	15.4
		IQR	7.5-28.6	6.3-22.4	8.3-33.3	6.7-28.6	5.3-20.0	7.7-33.3	7.5-25.0	6.3-22.7	8.3-30.4
		(n)		(293)			(110)			(254)	
	Tablet	Median	15.4	12.5	17.2	14.7	10.0	16.7	15.2	12.5	16.7
		IQR	7.7-29.8	6.7-23.1	7.9-33.3	5.8-29.3	4.9-16.7	7.1-33.3	7.7-29.2	6.9-25.0	8.1-33.3
		(n)		(162)			(61)			(140)	
	Oral liquid	Median	15.4	11.1	16.7	15.2	11.1	16.0	14.7	11.1	16.0
		IQR	8.3-29.2	6.7-23.1	10.3-33.3	8.9-22.2	7.1-16.7	11.1-33.3	7.3-23.1	6.7-23.1	9.1-23.1
		(n)		(27)			(14)			(22)	
	Injectable	Median	11.8	9.5	12.5	13.8	12.2	16.7	11.1	9.4	12.5
		IQR	6.3-22.7	5.9-20.0	7.1-25.0	5.7-28.6	5.3-25.7	7.1-28.6	6.4-20.0	5.9-20.0	7.1-23.1
		(n)		(103)			(35)			(91)	
nAT	All	Median	17.6	12.5	20.0	10.6	7.1	12.5	17.6	13.0	20.0
		IQR	8.6-35.1	6.3-25.0	10.0-44.4	5.6-25.0	4.3-18.8	5.9-31.6	8.7-35.0	6.3-25.0	10.2-42.9
		(n)		(623)			(182)			(572)	
	Tablet	Median	15.4	12.5	17.2	9.4	7.1	11.8	15.4	12.5	17.6
		IQR	6.7-35.0	6.2-25.0	7.1-38.2	4.8-18.8	4.0-16.7	5.9-25.0	7.0-35.0	6.3-25.0	7.1-40.0
		(n)		(300)			(89)			(273)	
	Oral liquid	Median	20.0	12.5	25.0	11.1	6.5	14.3	20.0	12.5	25.0
		IQR	9.4-38.9	6.3-25.0	11.1-50.0	5.6-29.3	4.8-20.0	5.9-39.2	9.4-38.9	6.3-25.0	11.1-50.0
		(n)		(254)			(72)			(233)	
	Injectable	Median	20.0	17.3	25.0	16.9	15.4	16.9	20.0	17.6	25.0
		IQR	11.1-29.2	8.1-25.0	12.5-33.3	6.8-30.0	5.4-30.0	8.1-33.3	11.3-29.2	8.6-25.0	12.5-33.3
		(n)		(66)			(19)			(63)	
RDT (per unit)		Median	20.0	17.6	20.0	26.7	20.0	33.3	17.6	17.6	17.6
		IQR	10.0-44.4	6.7-40.0	11.1-44.4	10.0-44.4	6.7-44.4	11.1-50.0	10.0-38.9	6.7-38.9	11.1-38.9
		(n)		(19)			(15)			(15)	

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesaler and retailers stocked suppositories or granules, and so few of these product types were observed during the audit, these dosage forms have been excluded from the tables here.

Table 4.10.1.2: Percent price mark-ups on antimalarials, retail level (%)

ANTIMALARIAL TYPE[1] Formulation[2]			RETAILER CATEGORIES[3]				
			PHARMACIES N=89	PRIVATE HEALTH FACILITIES N=173	DRUG STORES N=349	OTHER PRIVATE OUTLETS[4] N=9	PUBLIC HEALTH FACILITIES N=197
All ACT[5]	All	**Median**	**42.9**	**43.6**	**33.3**	**-**	**0.0**
		IQR	23.1-52.5	15.4-76.5	20.0-100.0	-	0.0-0.0
		(n)	(240)	(61)	(48)	-	(230)
	Tablet	**Median**	**42.9**	**42.9**	**40.0**	**-**	**0.0**
		IQR	23.1-60.0	11.1-76.5	25.0-100.0	-	0.0-0.0
		(n)	(202)	(56)	(47)	-	(230)
	Oral liquid	**Median**	**50.0**	**53.8**	**9.1**	**-**	**-**
		IQR	25.0-50.0	33.3-66.7	9.1-9.1	-	-
		(n)	(30)	(4)	(1)	-	-
WHO-prequalified ACT[5]	All products were tablets	**Median**	**33.3**	**25.0**	**31.6**	**-**	**0.0**
		IQR	13.9-33.3	-55.6-38.5	12.5-50.0	-	0.0-0.0
		(n)	(81)	(10)	(10)	-	(222)
Non WHO-prequalified ACT[5]	All	**Median**	**50.0**	**53.8**	**33.3**	**-**	**0.0**
		IQR	26.3-76.5	20.0-84.6	25.0-140.0	-	0.0-0.0
		(n)	(159)	(51)	(38)	-	(8)
	Tablet	**Median**	**50.0**	**50.0**	**42.9**	**-**	**0.0**
		IQR	28.6-76.5	15.4-84.6	25.0-140.0	-	0.0-0.0
		(n)	(121)	(46)	(37)	-	(8)
	Oral liquid	**Median**	**25.0**	**33.3**	**9.1**	**-**	**-**
		IQR	25.0-50.0	33.3-66.7	9.1-9.1	-	-
		(n)	(30)	(4)	(1)	-	-
AMT	All	**Median**	**41.2**	**60.0**	**33.3**	**-**	**15.0**
		IQR	25.0-56.3	25.0-114.3	25.0-126.4	-	15.0-32.5
		(n)	(210)	(84)	(38)	-	(3)
	Tablet	**Median**	**41.2**	**60.0**	**42.9**	**-**	**15.0**
		IQR	20.0-50.0	25.0-114.3	25.0-138.1	-	15.0-15.0
		(n)	(119)	(51)	(29)	-	(1)
	Oral liquid	**Median**	**55.6**	**33.3**	**33.3**	**-**	**-**
		IQR	50.0-55.6	33.3-36.4	33.3-33.3	-	-
		(n)	(20)	(5)	(3)	-	-
	Injectable	**Median**	**40.0**	**70.0**	**20.0**	**-**	**32.5**
		IQR	31.3-66.7	33.3-122.2	-17.6-50.0	-	32.5-32.5
		(n)	(68)	(28)	(6)	-	(2)
nAT	All	**Median**	**66.7**	**87.5**	**66.7**	**259.0**	**0.0**
		IQR	42.9-100.0	38.9-250.9	33.3-150.0	25.0-16566.7	0.0-15.0
		(n)	(515)	(716)	(1354)	(15)	(338)
	Tablet	**Median**	**66.7**	**100.0**	**100.0**	**1400.0**	**0.0**
		IQR	50.0-233.3	50.0-455.6	50.0-300.0	25.0-16566.7	0.0-20.5
		(n)	(267)	(404)	(768)	(13)	(177)
	Oral liquid	**Median**	**66.7**	**50.0**	**42.9**	**12.5**	**25.0**
		IQR	42.9-92.3	25.0-87.5	25.0-66.7	12.5-12.5	15.0-38.9
		(n)	(191)	(208)	(507)	(1)	(10)
	Injectable	**Median**	**25.0**	**150.0**	**87.5**	**25.0**	**0.0**
		IQR	17.6-50.0	50.0-828.6	42.9-150.0	25.0-25.0	0.0-0.0
		(n)	(57)	(104)	(79)	(1)	(151)

Table 4.10.1.3: Percent price mark-ups on antimalarials, retail level, INCLUDING subsidised ACT products (%)

ANTIMALARIAL TYPE[1] Formulation[2]			PHARMACIES N=89	PRIVATE HEALTH FACILITIES N=173	DRUG STORES N=349	OTHER PRIVATE OUTLETS[4] N=9	PUBLIC HEALTH FACILITIES N=197
All ACT[5]	All	Median	42.9	43.6	42.9	-	0.0
		IQR	23.1-52.5	15.4-76.5	31.6-100.0	-	0.0-0.0
		(n)	(245)	(61)	(61)	-	(230)
	Tablet	Median	42.9	42.9	42.9	-	0.0
		IQR	23.1-60.0	11.1-76.5	33.3-100.0	-	0.0-0.0
		(n)	(207)	(56)	(60)	-	(230)
	Oral liquid	Median	50.0	53.8	9.1	-	-
		IQR	25.0-50.0	33.3-66.7	9.1-9.1	-	-
		(n)	(30)	(4)	(1)	-	-
WHO-prequalified ACT[5]	All products were tablets	Median	33.3	25.0	42.9	-	0.0
		IQR	13.9-36.4	-55.6-38.5	33.3-100.0	-	0.0-0.0
		(n)	(86)	(10)	(23)	-	(222)
Non WHO-prequalified ACT[5]	All	Median	50.0	53.8	33.3	-	0.0
		IQR	26.3-76.5	20.0-84.6	25.0-140.0	-	0.0-0.0
		(n)	(159)	(51)	(38)	-	(8)
	Tablet	Median	50.0	50.0	42.9	-	0.0
		IQR	28.6-76.5	15.4-84.6	25.0-140.0	-	0.0-0.0
		(n)	(121)	(46)	(37)	-	(8)
	Oral liquid	Median	50.0	53.8	9.1	-	-
		IQR	25.0-50.0	33.3-66.7	9.1-9.1	-	-
		(n)	(30)	(4)	(1)	-	-

4.10.2. Absolute mark-ups on antimalarials and RDTs (US$)

In general, the absolute mark-up is calculated as the difference between the selling price and the purchase price per AETD and is reported in US dollars. It captures both the costs of doing business and profit to the seller. Because wholesalers vary their prices, minimum, maximum and mid mark-ups were calculated using data on minimum and maximum selling price charged per AETD by wholesalers. The wholesale absolute mid mark-up was calculated as the difference between the average wholesale selling price (i.e. the mid-point between the maximum and minimum wholesale selling price) and wholesale purchase price. The retail absolute mark-up was calculated using the retail selling price and purchase price collected during the ACTwatch Outlet Survey. Data were collected in local currencies and converted to their US$ equivalent using the average interbank rate for the duration of the fieldwork period.

- The wholesale median mid absolute mark-up was US$ 0.59 (IQR 0.24-1.20) on ACT, US$ 0.49 (IQR 0.24-0.85) on WHO-prequalified ACT, US$ 0.61 (IQR 0.27-1.37) on non-WHO-prequalified ACT, US$ 0.94 (IQR 0.39-1.80) on AMT and US$ 0.20 (IQR 0.05-0.59) on nAT.
- Wholesalers supplying retailers tended to apply higher absolute mark-ups than those supplying other wholesalers. This is because wholesalers supplying retailers tended to apply higher percent mark-ups (as noted above in section 4.10.1), as purchase prices tended to be similar across different chain levels of.
- As noted in section 4.10.1, it was common for wholesalers to vary percent mark-ups applied depending on volumes purchased, and percent mark-ups applied by wholesalers supplying retailers tended to be higher than by those supplying other wholesalers. Absolute mark-ups mirrored these patterns; however as expected, the magnitude of the observed differences between median high and low absolute mark-ups was a function of purchase price (i.e. higher purchase price led to greater differences between median high and low absolute mark-ups).
- Across different retail outlet types, the median absolute mark-up on ACTs ranged between US$ 0.95 (IQR 0.47-2.65) at drug stores and US$ 2.37 (IQR 1.18-3.79) at pharmacies; on AMTs between US$ 2.84 (IQR 1.51-5.07) at drug stores and US$ 5.00 (IQR 2.27-8.52) at private health facilities; and on nATs between US$ 0.44 (IQR 0.21-1.22) at drug stores and US0.74 (IQR 0.34-1.42) at pharmacies.
- Pharmacies and private health facilities tended to have higher absolute mark-ups for antimalarials compared to drug stores, as drug stores stocked relatively cheaper products, fewer injectable products, more generic – rather than originator – products (e.g. among ACTs, Lonart vs. Coartem), and in the case of nATs, more locally manufactured products.
- In drug stores, absolute price mark-ups for ACTs were generally lower when observations from sub-districts participating in the subsidised ACT pilot programme are included (described in section 2 above); for example, the median absolute price mark-up on WHO-prequalified ACT was US$ 0.19 (IQR 0.09-0.25) when subsidised ACTs are included, and US$ 0.95 (IQR 0.47-1.42) when excluded.
- For AL, the first-line treatment for uncomplicated *Pf* malaria, the median absolute retail mark-up was US$ 2.37 (IQR 1.04-3.79) at pharmacies, US$ 1.89 (IQR 0.95-3.31) at private health facilities, and US$ 0.95 (IQR 0.47-2.78) at drug stores; at the wholesale level, the overall median absolute mark-up was US$ 0.52 (IQR 0.24-1.22); however for tablets, wholesalers supplying retailers applied a higher median mid absolute mark-up (US$ 0.48, IQR 0.24-0.88) than those supplying other wholesalers (US$ 0.24, IQR 0.18-0.61).
- For SP, the antimalarial with the highest number of AETDs distributed, the median absolute retail mark-up was US$ 0.47 (IQR 0.39-0.71) at pharmacies, US$ 0.35 (IQR 0.21-0.60) at private health facilities, and US$ 0.24 (IQR 0.14-0.38) at drug stores; at the wholesale level, median mid absolute mark-up was US$ 0.04 (IQR 0.01-0.13).
- Regarding the recommended treatments for severe *Pf* malaria, the median absolute mark-up per AETD for injectable quinine at wholesale level was US$ 0.73 (IQR 0.73-0.73); and at retail level, US$ 1.49 (IQR 1.49-2.48) at pharmacies, US$ 6.16 (IQR 2.98-14.11) at private health facilities, and US$ 4.97 (IQR 2.98-6.96) at drug stores. For injectable artemether, the median absolute mark-up per AETD at wholesale level was US$ 1.00 (IQR 0.50-1.95); and at retail level, US$ 4.54 (IQR 2.84-5.68) at pharmacies, US$ 8.52 (IQR 3.89-12.49) at private health facilities, and US$ 3.79 (IQR -0.97-4.54) at drug stores.
- The median wholesale mid mark-up on RDTs was US$ 0.19 (IQR 0.07-0.24) among wholesalers supplying other wholesalers, and US$ 0.15 (IQR 0.07-0.24) among wholesalers supplying retailers.

Table 4.10.2.1: Absolute price mark ups on antimalarials and RDTs, wholesale level (US$)

ANTIMALARIAL TYPE[1] Formulation[2]			WHOLESALER CATEGORIES								
			ALL WHOLESALERS N=127			SUPPLY WHOLESALERS N=48			SUPPLY RETAILERS N=104		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
All ACT	All	**Median**	**0.59**	**0.49**	**0.65**	**0.44**	**0.32**	**0.49**	**0.55**	**0.49**	**0.65**
		IQR	0.24-1.20	0.24-0.98	0.27-1.37	0.22-1.10	0.15-0.78	0.24-1.22	0.24-1.17	0.24-0.98	0.27-1.30
		(n)		(277)			(115)			(234)	
	Tablet	**Median**	**0.49**	**0.34**	**0.55**	**0.32**	**0.24**	**0.34**	**0.49**	**0.31**	**0.55**
		IQR	0.24-0.98	0.24-0.77	0.24-1.17	0.20-0.78	0.15-0.59	0.24-0.98	0.24-1.00	0.24-0.75	0.24-1.17
		(n)		(232)			(94)			(196)	
	Oral liquid	**Median**	**1.24**	**1.07**	**1.30**	**1.30**	**0.98**	**1.30**	**0.93**	**0.82**	**1.10**
		IQR	0.65-2.60	0.65-2.60	0.65-3.25	0.65-2.93	0.65-2.60	0.65-3.60	0.65-2.60	0.65-2.28	0.65-2.60
		(n)		(38)			(20)			(32)	
WHO-prequalified ACT	All products were tablets	**Median**	**0.49**	**0.24**	**0.49**	**0.31**	**0.24**	**0.41**	**0.49**	**0.24**	**0.49**
		IQR	0.24-0.85	0.24-0.59	0.24-0.98	0.20-0.73	0.12-0.49	0.24-0.78	0.24-0.85	0.24-0.49	0.24-0.98
		(n)		(84)			(30)			(73)	
Non WHO-prequalified ACT	All	**Median**	**0.61**	**0.49**	**0.73**	**0.44**	**0.39**	**0.49**	**0.65**	**0.49**	**0.73**
		IQR	0.27-1.37	0.24-1.17	0.27-1.46	0.24-1.20	0.16-0.93	0.24-1.32	0.27-1.22	0.24-1.17	0.27-1.46
		(n)		(193)			(85)			(161)	
	Tablet	**Median**	**0.49**	**0.34**	**0.55**	**0.32**	**0.27**	**0.34**	**0.49**	**0.34**	**0.59**
		IQR	0.24-1.10	0.24-0.91	0.26-1.20	0.20-0.84	0.15-0.66	0.24-1.03	0.24-1.10	0.24-0.93	0.24-1.22
		(n)		(148)			(64)			(123)	
	Oral liquid	**Median**	**1.24**	**1.07**	**1.30**	**1.30**	**0.98**	**1.30**	**0.93**	**0.82**	**1.10**
		IQR	0.65-2.60	0.65-2.60	0.65-3.25	0.65-2.93	0.65-2.60	0.65-3.60	0.65-2.60	0.65-2.28	0.65-2.60
		(n)		(38)			(20)			(32)	

ANTIMALARIAL TYPE[1] Formulation[2]			WHOLESALER CATEGORIES								
			ALL WHOLESALERS N=127			SUPPLY WHOLESALERS N=48			SUPPLY RETAILERS N=104		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
AMT	All	**Median**	**0.94**	**0.70**	**1.17**	**0.89**	**0.67**	**1.17**	**0.84**	**0.68**	**0.99**
		IQR (n)	0.39-1.80	0.39-1.46	0.39-2.01	0.37-1.76	0.31-1.41	0.39-2.01	0.39-1.67	0.39-1.46	0.39-1.95
				(293)			(110)			(254)	
	Tablet	**Median**	**0.76**	**0.55**	**0.78**	**0.59**	**0.39**	**0.73**	**0.72**	**0.52**	**0.78**
		IQR (n)	0.39-1.56	0.39-1.17	0.39-1.95	0.31-1.34	0.24-0.98	0.39-1.80	0.39-1.56	0.39-1.17	0.39-1.87
				(162)			(61)			(140)	
	Oral liquid	**Median**	**1.48**	**1.09**	**1.56**	**1.56**	**1.20**	**1.56**	**1.33**	**1.02**	**1.56**
		IQR (n)	0.86-3.12	0.78-2.34	0.94-3.90	1.17-2.73	0.78-1.56	1.56-3.12	0.78-3.12	0.47-2.34	0.78-3.12
				(27)			(14)			(22)	
	Injectable	**Median**	**1.00**	**0.82**	**1.17**	**1.17**	**1.17**	**1.17**	**1.00**	**0.80**	**1.17**
		IQR (n)	0.50-1.95	0.39-1.76	0.67-2.01	0.39-2.01	0.39-2.01	0.40-2.68	0.50-1.95	0.34-1.76	0.67-1.95
				(103)			(35)			(91)	
nAT	All	**Median**	**0.20**	**0.15**	**0.24**	**0.13**	**0.08**	**0.15**	**0.20**	**0.15**	**0.23**
		IQR (n)	0.05-0.59	0.04-0.41	0.06-0.70	0.03-0.37	0.02-0.31	0.04-0.44	0.05-0.59	0.04-0.44	0.06-0.72
				(620)			(182)			(569)	
	Tablet	**Median**	**0.06**	**0.05**	**0.07**	**0.04**	**0.03**	**0.05**	**0.07**	**0.05**	**0.07**
		IQR (n)	0.02-0.20	0.02-0.16	0.02-0.24	0.01-0.15	0.01-0.10	0.01-0.20	0.02-0.20	0.02-0.16	0.02-0.22
				(298)			(89)			(271)	
	Oral liquid	**Median**	**0.36**	**0.29**	**0.44**	**0.23**	**0.15**	**0.31**	**0.34**	**0.26**	**0.44**
		IQR (n)	0.15-0.65	0.12-0.54	0.16-0.88	0.11-0.55	0.08-0.31	0.15-0.65	0.15-0.63	0.12-0.56	0.16-0.88
				(253)			(72)			(232)	
	Injectable	**Median**	**1.02**	**1.02**	**1.18**	**0.82**	**0.67**	**1.02**	**1.02**	**1.02**	**1.23**
		IQR (n)	0.51-2.05	0.51-2.05	0.51-2.05	0.26-1.54	0.20-1.54	0.31-2.05	0.51-2.05	0.51-2.05	0.67-2.05
				(66)			(19)			(63)	
RDT (per unit)		**Median**	**0.15**	**0.15**	**0.15**	**0.19**	**0.15**	**0.23**	**0.15**	**0.15**	**0.15**
		IQR (n)	0.07-0.24	0.05-0.24	0.10-0.29	0.07-0.24	0.05-0.24	0.10-0.29	0.07-0.24	0.05-0.24	0.10-0.24
				(19)			(15)			(15)	

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesaler and retailers stocked suppositories or granules, and so few of these product types were observed during the audit, these dosage forms have been excluded from the tables here.

Table 4.10.2.2: Absolute price mark ups on antimalarials, retail level (US$)

ANTIMALARIAL TYPE[1] Formulation[2]			RETAILER CATEGORIES[3]				
			PHARMACIES N=87	PRIVATE HEALTH FACILITIES N=176	DRUG STORES N=351	OTHER PRIVATE OUTLETS[4] N=9	PUBLIC HEALTH FACILITIES N=197
All ACT[5]	All	**Median**	**2.37**	**2.30**	**0.95**	-	**0.00**
		IQR	1.18-3.79	0.95-3.73	0.47-2.65	-	0.00-0.00
		(n)	(240)	(68)	(52)	-	(232)
	Tablet	**Median**	**2.13**	**1.89**	**0.95**	-	**0.00**
		IQR	1.06-3.46	0.83-3.41	0.47-2.65	-	0.00-0.00
		(n)	(202)	(62)	(49)	-	(232)
	Oral liquid	**Median**	**6.31**	**4.42**	**0.21**	-	-
		IQR	3.79-6.31	3.15-10.09	0.21-10.09	-	-
		(n)	(30)	(5)	(3)	-	-
WHO-prequalified ACT[5]	All products were tablets	**Median**	**1.42**	**1.18**	**0.95**	-	**0.00**
		IQR	0.95-2.37	0.47-1.89	0.47-1.42	-	0.00-0.00
		(n)	(81)	(13)	(11)	-	(224)
Non WHO-prequalified ACT[5]	All	**Median**	**3.19**	**2.60**	**0.95**	-	**0.00**
		IQR	1.86-3.79	1.06-4.26	0.24-2.78	-	0.00-0.00
		(n)	(159)	(55)	(41)	-	(8)
	Tablet	**Median**	**2.66**	**2.30**	**0.95**	-	**0.00**
		IQR	1.42-3.78	0.95-3.46	0.47-2.78	-	0.00-0.00
		(n)	(121)	(49)	(38)	-	(8)
	Oral liquid	**Median**	**6.31**	**4.42**	**0.21**	-	-
		IQR	3.79-6.31	3.15-10.09	0.21-10.09	-	-
		(n)	(30)	(5)	(3)	-	-
AMT	All	**Median**	**3.03**	**5.00**	**2.84**	-	**0.91**
		IQR	1.67-4.54	2.27-8.52	1.51-5.07	-	0.91-3.69
		(n)	(211)	(88)	(40)	-	(3)
	Tablet	**Median**	**1.95**	**3.41**	**1.95**	-	**0.91**
		IQR	1.66-3.03	1.51-5.92	1.51-5.30	-	0.91-0.91
		(n)	(119)	(53)	(31)	-	(1)
	Oral liquid	**Median**	**3.79**	**5.30**	**3.79**	-	-
		IQR	3.79-4.54	3.79-12.11	3.79-3.79	-	-
		(n)	(20)	(6)	(3)	-	-
	Injectable	**Median**	**4.54**	**8.52**	**3.79**	-	**3.69**
		IQR	2.84-5.68	3.89-12.49	-0.97-4.54	-	3.69-3.69
		(n)	(69)	(29)	(6)	-	(2)
nAT	All	**Median**	**0.74**	**0.59**	**0.44**	**0.24**	**0.00**
		IQR	0.34-1.42	0.23-1.66	0.21-1.22	0.14-0.42	0.00-0.19
		(n)	(516)	(728)	(1365)	(14)	(345)
	Tablet	**Median**	**0.47**	**0.34**	**0.26**	**0.21**	**0.00**
		IQR	0.18-0.95	0.18-0.62	0.13-0.51	0.14-0.42	0.00-0.17
		(n)	(267)	(410)	(775)	(12)	(180)
	Oral liquid	**Median**	**1.14**	**1.18**	**0.74**	**0.49**	**0.71**
		IQR	0.71-1.95	0.52-1.69	0.47-1.47	0.49-0.49	0.66-1.22
		(n)	(191)	(214)	(511)	(1)	(10)
	Injectable	**Median**	**1.49**	**6.16**	**4.47**	**0.99**	**0.00**
		IQR	1.14-2.48	2.98-14.11	1.99-5.96	0.99-0.99	0.00-0.00
		(n)	(58)	(104)	(79)	(1)	(155)

Table 4.10.2.3: Absolute price mark-ups on antimalarials, retail level INCLUDING subsidised ACT products (US$)

ANTIMALARIAL TYPE[1] Formulation[2]			RETAILER CATEGORIES[3]				
			PHARMACIES N=87	PRIVATE HEALTH FACILITIES N=176	DRUG STORES N=351	OTHER PRIVATE OUTLETS[4] N=9	PUBLIC HEALTH FACILITIES N=197
All ACT[5]	All	Median	2.37	2.30	0.25	-	0.00
		IQR	1.18-3.79	0.95-3.73	0.11-1.14	-	0.00-0.00
		(n)	(245)	(68)	(65)	-	(232)
	Tablet	Median	2.13	1.89	0.25	-	0.00
		IQR	1.04-3.46	0.83-3.41	0.11-1.14	-	0.00-0.00
		(n)	(207)	(62)	(62)	-	(232)
	Oral liquid	Median	6.31	4.42	0.21	-	-
		IQR	3.79-6.31	3.15-10.09	0.21-10.09	-	-
		(n)	(30)	(5)	(3)	-	-
WHO-prequalified ACT[5]	All products were tablets	Median	1.38	1.18	0.19	-	0.00
		IQR	0.71-2.37	0.47-1.89	0.09-0.25	-	0.00-0.00
		(n)	(86)	(13)	(24)	-	(224)
Non WHO-prequalified ACT[5]	All	Median	3.19	2.60	0.95	-	0.00
		IQR	1.86-3.79	1.06-4.26	0.24-2.78	-	0.00-0.00
		(n)	(159)	(55)	(41)	-	(8)
	Tablet	Median	2.66	2.30	0.95	-	0.00
		IQR	1.42-3.78	0.95-3.46	0.47-2.78	-	0.00-0.00
		(n)	(121)	(49)	(38)	-	(8)
	Oral liquid	Median	6.31	4.42	0.21	-	-
		IQR	3.79-6.31	3.15-10.09	0.21-10.09	-	-
		(n)	(30)	(5)	(3)	-	-

5. Discussion

Supply Chain Structure and Wholesaler Characteristics

Broad-based pyramidal structure of private sector distribution chain with many levels: The private commercial sector distribution chain for antimalarials had a pyramidal shape with a very broad base (i.e. there were many distributors at the lower level of the chain supplying retailers and other outlet types). The majority of wholesalers (81.4%) identified in Uganda supplied antimalarials to retailers, and of these, 62.1% supplied retailers only. However, 37.9% of all wholesalers identified supplied antimalarials to retailers and other wholesalers, operating across five overlapping levels of the supply chain (intermediate-4, intermediate-3, intermediate-2, intermediate-1 and terminal wholesalers).

Most antimalarials pass through three steps from manufacturer to retailer: As such, the maximum number of steps from manufacturers' factory gate to retailers could be as high as six (manufacturer → intermediate-4 wholesaler → intermediate-3 wholesaler → intermediate-2 wholesaler → intermediate-1 wholesaler → terminal wholesaler → retailer). However, the likely number of steps in the antimalarial supply chain was less than six since most wholesalers were observed to sell directly to retailers. As of those supplying retailers, only a small percentage (3.9%) were observed to purchase antimalarials directly from manufacturers as one of their two top suppliers, most antimalarials were likely to pass through three steps from manufacturer to retailer (manufacturer → intermediate wholesaler → terminal wholesaler → retailer).

Multiple factors influence the distribution chain structure: Uganda's domestic pharmaceutical industry is relatively well developed, and produces a wide range of antimalarial products. However, until 2006, local manufacturers did not produce ACTs, and at the time of this survey, no local manufacturers were producing an ACT that was WHO-prequalified. [20-22] This availability of domestically manufactured antimalarials likely causes many wholesalers to source some supplies domestically, which is supported by our observation of the low number of wholesalers who reported importing antimalarials (23.7%). Buying domestically has additional advantages, such as avoiding the expensive and lengthy bureaucratic requirements of developing business relationships with foreign manufacturers and also the high transaction costs of importing, such as fees charged by the NDA in order to import foreign medicines and the length of time to process the necessary documentation (unpublished data from in-depth interviews conducted with wholesalers in Uganda).

The tendency to procure locally produced goods is also supported by data from the ACTwatch Outlet Survey which showed that more than a third of all antimalarial products observed during the survey were manufactured in Uganda (37%), while 30% originated from India, 10% from China and 7% from Kenya, however in terms of volume, products imported from India and China dominate the market. [23] As in other East African countries, many pharmaceutical wholesale businesses are owned and/or operated by individuals who may be identified ethnically as South Asian – much of which is the legacy of migration that began during British rule in Uganda – and this cultural link between Uganda and India may have facilitated the penetration of Indian antimalarial products into Uganda's market. [24] The hub of pharmaceutical manufacturing and wholesaling in Uganda is based in and around Kampala, as are the major ports of Entebbe (air and inland marine) and Jinja (inland marine). One of the country's best roads connects Kampala to the land border with Kenya, which is another important foreign source of antimalarials. However, many parts of the country, particularly in the north, are difficult to access by road; so despite Uganda's relatively small land area, regional distribution hubs exist in the major commercial cities across the country. Several instances of vertically integrated wholesale supply chains were noted where importers or large pharmaceutical wholesalers based in Kampala also owned and/or operated one or more subsidiary

wholesalers in these regional distribution hubs. Horizontal trading among wholesalers was common in Kampala, and similar practices have been observed in other settings. [25]

Transactions between public and private sectors were limited: Only one private outlet reported the National Medical Stores, the government's procurement agency, as one of their two top suppliers of antimalarials – and this is likely to have been an error. However, three public facilities mentioned a private sector source as one of their two top antimalarial suppliers, which may reflect some of the problems with the public sector supply chain issues noted in other studies. [26]

Wholesaler characteristics: Wholesale businesses were small with a median of six workers. Wholesalers operating at higher levels of the chain tended to be only slightly larger than those that supplied retailers (median of eight vs. five workers, respectively). Wholesale pharmacies are required to have a registered pharmacist on staff who may deputise responsibilities to a professional auxiliary staff member, of which two must be employed by the wholesaler. Therefore, up to half of the employees in a typical wholesale business are mandated by regulations. As regulations stipulate that a pharmacist may be employed by a maximum of two businesses, this presents a potential barrier to entering the wholesale and retail market. Our observation that wholesalers had been in operation for a median of eight years may reflect this. Only 56.6% of all wholesalers were observed to sell other products in addition to pharmaceuticals, but these tended to be related products, such as toiletries (46.7% of all wholesalers). Products such as household goods, mobile phone credit, cigarettes and food were not commonly sold by wholesalers (all less than 5%).

Business practices within the supply chain: Despite not being very different in size, business practices between wholesalers supplying other wholesalers (i.e. intermediate wholesalers) tended to be more characteristic of much larger businesses compared to wholesalers supplying retailers (i.e. terminal wholesalers). A higher proportion of intermediate wholesalers reported importing antimalarials (47.9% vs. 16.4%), buying directly from manufacturers (22.9% vs. 3.9%), delivering to customers (50.0% vs. 26.0%), having customers in other countries (41.7% vs. 26.9%), providing credit (87.8% vs. 71.2%), and having a broader range of customers. This could be by virtue of location, as most intermediate wholesalers were located in Kampala where the intensity of competition may provide greater incentive to offer more value added services to customers, differentiate themselves from other wholesalers, and engage with markets further afield.

Licensing and Inspection
Many wholesalers did not display up-to-date licenses: Despite our observation that virtually all wholesalers reported having been visited by an inspector from the National Drug Authority at least once in the 12 months preceding the interview, only 82.0% of wholesalers were observed to have an up-to-date license, which must be renewed annually and prominently displayed on the premises. Up-to-date licenses in this instance included both valid wholesale and retail licenses from the NDA because the bottom-up approach used for this study was designed to identify de facto wholesalers (i.e. businesses that sell to other businesses); as such, it was expected that some retail outlets, such as grocery stores that should not be retailing antimalarials, would purchase antimalarial stock from retail drug outlets, such as pharmacies or drug stores. Another requirement to operate both wholesale and retail businesses is to have a registered pharmacist on staff. Similar to licenses, 88.3% of all wholesalers reported employing a pharmacist.

Wholesaler knowledge

Awareness of AL as first-line treatment is high among wholesalers, but many did not identify AL as the most effective treatment for uncomplicated malaria: As Uganda adopted ACTs as first-line treatment policy in 2004, it may explain why most (86.7%) of the wholesalers interviewed were able to correctly identify AL as the government recommended treatment for uncomplicated *Pf* malaria. However, the percentage of wholesalers identifying AL, or any other ACT, as the most effective treatment for uncomplicated malaria in both children (40.2%) and adults (50.0%) was much lower. This may have implications for ACT availability at subsequent levels of the supply chain as supplier preferences and recommendations may influence customer choices. These gaps related to ACT acceptance may be partially due to a lack of targeted interventions to change wholesaler knowledge, attitudes and behaviours. In this study, only 15.0% of wholesalers reported employing a staff member who had participated in some form of in-service training related to malaria treatment in the two years prior to interview.

Availability

ACT availability was relatively high: Most of the wholesalers surveyed (88.3%) had an ACT in stock at the time of interview, and a similar number (83.3%) reported always having at least one ACT in stock throughout the three month period prior to interview. Just over half of all wholesalers (52.3%) had a WHO-prequalified ACT in stock at the time of interview, while non-WHO-prequalified ACTs were stocked by more wholesalers (75.0%). The recommended first-line treatment for uncomplicated malaria, AL, was stocked by 74.0% of all wholesalers but only accounted for 13.0% of all antimalarial products stocked by wholesalers and 53.9% of all ACTs stocked. The second most frequently observed ACT stocked by wholesalers after AL was dihydroartemisinin piperaquine, which accounted for 5.3% of all antimalarial products stocked by wholesalers and 22.3% of all ACTs stocked. Although local production of ACTs began several years ago in 2006, many wholesalers were observed to stock a non-WHO-prequalified AL product manufactured in India (Lonart), which has a lower purchase price than the brand of AL recommended by the government, Coartem. This was also the case at the retail level. Preference for AL over the locally produced ACT, an ASAQ combination listed as the alternative recommended first line treatment for uncomplicated malarial, may also partly be due to perceived undesirable side effects associated with amodiaquine among consumers. [27]

Oral AMT and nAT availability was also relatively high: The number of wholesalers that stocked nATs (89.1%) and oral AMTs (75.8%) was comparable to that for ACTs (88.3%). In addition, the two most frequently observed antimalarials stocked by wholesalers were artemether (an AMT), followed by quinine (an nAT) (19.2% and 18.4% of all products stocked by wholesalers, respectively), while SP accounted for 10.6%, and chloroquine for 9.1%. More than half (55%) of the artemether products, 72% of the quinine products and virtually all of the SP (98%) and chloroquine (97%) products stocked by wholesalers were oral formulations, with the remainder in injectable dosage form.

RDT availability was low: RDTs were stocked by only a few wholesalers, despite their recommended use in the case management of fevers: 32.0% of wholesalers supplying other wholesalers, and 17.1% of those supplying retailers.

Sales Volumes

ACTs are being sold by wholesalers in much smaller quantities than nATs: A range of different indicators related to sales volumes demonstrated that only small volumes of ACTs were sold by wholesalers, and sales volumes were much lower than for nATs. Among all wholesalers who sold any antimalarial the week before the survey, the median number of AETDs sold was 22.1 (IQR 4.6-95.0) for ACTs, which is less than a tenth of the median sales volumes of nATs (310.0 AETDs, IQR 68.9-1578.5). These high volumes of nATs are driven by

sales of SP, which was reported by 37.8% of all wholesalers to be their top selling antimalarial, followed by CQ (15.0%) and quinine (12.6%); while AL, for comparison, was the top selling antimalarial among only 10.2% of wholesalers. At retail level, the ACTwatch Outlet Survey observed a similar pattern where SP accounted for approximately 40% of total antimalarial volumes sold in pharmacies, private health facilities and drug stores. [8] The dominance of SP, CQ and other nATs at all levels of the private sector commercial supply chain could be due to familiarity. Prior to adoption of AL in the malaria treatment guidelines, CQ+SP was the recommended first-line treatment. Also, a CQ+SP combination was the product used at the introduction of the Home-Based Management of Fever programme. This intervention used volunteer Community Medicine Distributors to educate caretakers on malaria treatment as well as distribute the treatment itself. This familiarity of other older regimens may also be reflected in our observation that, although knowledge of ACTs as the recommended treatment for malaria is generally high, most wholesalers still believe other drugs to be more effective treatments. As we discuss later, the much lower price of these older antimalarials compared to ACTs is also another likely driver of demand, particularly as the burden of malaria disproportionately falls on Uganda's poor and numerous rural population. [1]

Volumes of oral AMTs sold among wholesalers are comparable to ACT volumes: Among all wholesalers, median sales volumes of AMTs were comparable to ACT sales volumes (AMTs: 15.0, IQR 1.9-37.8, ACTs: 22.1, IQR 4.6-95.0). Furthermore, despite a ban on oral AMTs having been in place since 2007, AMT tablets were still stocked by greater numbers of wholesalers than WHO-prequalified ACTs (92 vs. 67 of 128 wholesalers), and sold in volumes that exceeded those for WHO-prequalified ACTs (7.7 AETDs in the past 7 days, IQR 0.0-18.8 vs. 1.0 AETDs, IQR 0.0-10.0).

Volumes of RDT sold are low: Of the few wholesalers that were observed to have them in stock (18% of all wholesalers), the median number of tests sold during the week preceding the interview was low: 10 tests (IQR 0-25).

Price and Mark-ups
Purchase prices for nAT were much lower than for ACT and AMT: At wholesale level, the median purchase prices for ACT and oral and injectable AMT were many times greater than that for nAT. To demonstrate, the median purchase price for nAT was US$ 1.17 (IQR 0.22-3.95) compared to US$ 4.39 (IQR 2.44-7.56) for ACT, US$ 5.08 (IQR 3.90-6.25) for AMT tablets and US$ 9.27 (IQR 7.03-11.22) for AMT injectables. A similar pattern was observed at retail level. For example in drug stores, the median purchase price was US$ 2.27 (IQR 0.71-3.79) for ACT, US$ 4.92 (IQR 3.79-6.06) for AMT tablets, and US$ 11.36 (IQR 5.52-19.30) for AMT injectables; while the median purchase price for nAT was much lower at US$ 0.59 (IQR 0.14-1.99). This partly reflects the large variety of cheap, domestically manufactured nATs that were readily available at retail level.

As the sampling strategy used for this study included two rural sub-districts participating in the subsidised ACT pilot programme [18], we are able to comment on the possible effect that this intervention may have on the purchase prices and mark-ups on WHO-prequalified ACTs. It is important to note that all of the subsidised products encountered were found in drug shops located in the two sampled sub-districts (as intended by design), and that the these products accounted for a large proportion of all WHO-prequalified products surveyed in the entire national survey (and an even greater proportion once observations were weighted to account for variations in sampling probability due to the sampling design). Once these products were taken into account, the median purchase price for ACTs in drug stores was considerably lower, bringing the median purchase price for all ACTs very much closer to that of nATs (i.e. for all ACT including subsidised

products: US$ 0.47 [IQR 0.24-2.84] vs. nAT: US$ 0.59 [IQR 0.14-1.99]), and the median price for WHO-prequalified ACT tablets much closer to that of nAT tablets (i.e. for WHO-prequalified ACT tablets including subsidised products: US$ 0.26 [IQR 0.19-1.80] vs. nAT tablets: US$ 0.21 [IQR 0.08-0.89]). This is encouraging as it suggests that subsidies for ACTs could have the desired effect of reducing end-user prices for quality effective antimalarials in drug stores to a level where they can compete with less effective medicines on price, so long as wholesalers and retailers do not reduce the value of the subsidy passed onto the consumer through excessive mark-ups (see below for additional discussion on mark-ups).

Purchase prices for ACTs and AMTs are comparable at wholesale level for the same dosage forms: For tablets, the median wholesale purchase price per AETD was US$ 4.14 [IQR 2.17-5.86) for ACTs and US$ 5.08 [IQR 3.90-6.25) for AMTs; and for oral liquid dosage forms, median purchase prices were US$ 12.69 [IQR 7.81-13.29) for ACTs and US$ 10.15 [IQR 9.37-14.05) for AMTs. This pattern was not observed at retail level among private health facilities and drug stores, where median purchase prices for ACTs tended to be lower than those for AMTs; however among retail pharmacies, the median purchase prices paid for ACT and AMT tablets was similar (US$ 5.32 vs. US$ 5.68, respectively), while the median purchase price paid for ACT oral liquids was nearly twice of that paid for AMT oral liquids (US$ 12.62 vs. US$ 6.81, respectively).

Wholesaler mark-ups were lower than retailer mark-ups: Wholesaler median mid percent mark-ups were relatively low and consistent across antimalarial categories (14% on ACTs, 15% on AMTs and 18% on nATs), while retail level median mid percent mark-ups were higher, but also fairly consistent across outlet types (ACTs: 43%-44%, AMTs: 33%-60%, nAT: 67%-88%). This observed consistency could be a reflection of the competitiveness in the wholesale market in Uganda. At wholesale level, this may also be reflected in our finding that wholesalers tended to be clustered in the same locations (i.e. in certain districts in Kampala and other major regional commercial centres). At retail level, the public and NGO/mission sectors are also important sources of antimalarial treatment and distribute antimalarials free of charge. This may exert additional pressure on private sector retailers to keep margins low.

Wholesale median mid absolute mark-ups were also relatively low, but varied considerably by antimalarial type (ACT: US$ 0.68, AMT: US$ 1.09, nAT: US$ 0.24), corresponding to the differences in purchase prices across drug categories. When taking into account observations from the two sub-districts where the ACT subsidy programme was being piloted, the additional observations did not have much effect on percentage mark-up: for WHO-prequalified ACT, the median mark-up increased from 31.6% when subsidy products were excluded to 42.9% when included; compared to 66.7% for nATs. This translated to median absolute mark-ups of US$ 0.95 when subsidised products are excluded and US$ 0.19 when included, compared to US$0.44 for nATs, indicating that – despite the reduced purchase prices resulting from the subsidy noted above – a smaller absolute margin from the sale of each subsidised ACT compared to nAT still potentially presents wholesalers and retailers with a disincentive to sell the subsidised product. This may partly be the result of retailers adhering to the recommended retail price printed on the subsidised product, restraining the upper limit of observed mark-ups.

Large disparities in price and mark-up between AL and SP: The median purchase price per AETD at wholesale level for AL (intermediate wholesalers: US$ 4.97, IQR 2.09-9.04; terminal wholesalers: US$ 3.67, IQR 2.26-9.04) was at least 20 times the wholesale-level median purchase price for SP (US$ 0.17, IQR 0.12-0.46). At retail level, similar differences in prices between the two antimalarials were also observed. With respect to observed median mid percent mark-ups, these did not differ greatly at wholesale level (AL: 17% vs. SP: 23%); however at retail level, there were large differences. For example, at pharmacies, the median percent mark-

up for AL was 33% (corresponding to an absolute mark-up of US$ 2.79), while for SP, the median percent mark-up was 100% (corresponding to an absolute mark-up of US$ 0.56). The low price of SP and its high demand likely allow retailers to apply high percent mark-ups on this antimalarial; and although the margin gained is relatively small, the high volumes being sold indicate that this product is an important revenue generator for retailers and wholesalers alike.

Conclusion
This report has presented a number of important new insights into the private sector market and distribution chain for antimalarial drugs in Uganda. The distribution chain had a pyramid shape comprised of multiple levels, with a relatively broad base and narrow top. While we observed wholesalers to operate over 5 overlapping levels, most antimalarials are likely to go through 3 steps from manufacturer to retailer (or 4 steps from manufacturer to end-user). Although ACTs, and in particular AL, the recommended first-line treatment for uncomplicated malaria, were observed to be available in most wholesalers, oral AMTs and nATs were observed to have comparable levels of availability among wholesalers. Furthermore, despite a policy promoting ACTs as the first-line therapy for malaria the volumes of ACTs sold were small, particularly when compared to sales volumes for nATs. This may be partially explained by the large difference in purchase prices between ACTs and nATs, which is likely to shift demand toward cheaper nATs at lower levels of the supply chain and also among consumers, considering that the burden of malaria is disproportionately borne by the poor. [1]

Another worrying observation was that, despite the presence of a ban on oral AMT products that has been in place since 2007, their typical sales volumes among wholesalers were sizeable and comparable to those for WHO-prequalified ACTs. Wholesale percent mark-ups were observed to be consistent both across antimalarial categories and across dosage forms, and tended to be lower than retail-level percent mark-ups on antimalarials. For RDTs, their wholesale purchase prices were also low, in fact lower than the purchase prices for ACTs, AMTs and nATs. They were, however, not widely available among wholesalers and sales volumes were very low.

When interpreting the findings of this study, it is important to consider that due to the sensitivity of some of the topics discussed some responses may be affected by social desirability bias, with respondents answering in a way that they think will meet the approval of the interviewer. Also, data for this study were collected in 2009 and changes to the market since then are likely to have occurred, particularly due to the introduction of the AMFm in 2011.

6. Appendices

6.1. Supplemental tables for median number of suppository and granule AETDs sold

Table 4.8.1a: Median number of AETDs sold during the week preceding the survey (all wholesalers, suppositories and granules only)

ANTIMALARIAL TYPE[1] Formulation[2]			WHOLESALER CATEGORIES		
			ALL WHOLESALERS N=128[3]	SUPPLY WHOLESALERS N=48	SUPPLY RETAILERS N=105
All ACT	All	**Median**	**22.0**	**58.8**	**18.9**
		IQR	4.8-94.4	15.8-343.6	4.0-57.1
	Suppository	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0
	Granule	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0
Non-WHO prequalified ACT	All	**Median**	**9.8**	**30.9**	**8.9**
		IQR	0.0-46.5	3.3-216.0	0.0-37.7
	Suppository	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0
	Granule	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0
AMT	All	**Median**	**15.0**	**21.6**	**14.1**
		IQR	2.3-34.8	12.5-125.8	1.9-32.3
	Suppository	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0
	Granule	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0
nAT	All	**Median**	**304.9**	**236.2**	**350.7**
		IQR	52.1-1523.7	25.8-3822.6	109.1-1828.3
	Suppository	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0
	Granule	**Median**	**0.0**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0	0.0-0.0

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria; 2 The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesaler and retailers stocked suppositories or granules, and so few of these product types were observed during the audit, these dosage forms have been separated from the tables for other dosage forms provided in the main text. 3 For antimalarials: there were a total of 128 wholesalers with antimalarial sales volumes (reported or imputed or set as null if did not stock). Note on imputation process for antimalarial sales volumes: during the study, 140 wholesalers were identified, of which 127 were interviewed and 4 refused (Table 1). Out of the 127 interviewed, 1 did not stock antimalarials at the time of the survey, so their sales volumes were set as zero for all antimalarial categories. The volumes for 14 wholesalers were set as missing for all antimalarial categories: 6 businesses had closed down, 2 wholesalers could not be located, 4 refused and had antimalarials in stock, and 2 reported stocking antimalarials but no audit sheet information was recorded. Overall, there were a total of 1326 antimalarials audited, of which 45 (3.4%) had missing sales volumes that were imputed using the mi impute pmm command.

Table 4.8.2a: Median number of AETDs sold during the week preceding the survey (among wholesalers stocking corresponding antimalarial drug category/RDT at the time of the survey, suppositories and granules only)

ANTIMALARIAL TYPE[1] Formulation			WHOLESALER CATEGORIES[3]		
			ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS
All ACT	All	**Median**	**30.0**	**74.0**	**25.2**
		IQR	10.0-102.7	21.2-344.8	8.9-88.2
		(n)	(113)	(46)	(91)
	Suppository	**Median**	**250.0**	**250.0**	**-**
		IQR	250.0-250.0	250.0-250.0	-
		(n)	(1)	(1)	-
	Granule	**Median**	**0.6**	**19.4**	**0.4**
		IQR	0.1-1.3	1.3-37.5	0.0-0.8
		(n)	(8)	(2)	(6)
Non-WHO-prequalified ACT	All	**Median**	**19.2**	**50.6**	**15.9**
		IQR	5.4-91.6	9.3-243.4	5.0-54.4
		(n)	(96)	(40)	(78)
	Suppository	**Median**	**250.0**	**250.0**	**-**
		IQR	250.0-250.0	250.0-250.0	-
		(n)	(1)	(1)	-
	Granule	**Median**	**0.6**	**19.4**	**0.4**
		IQR	0.1-1.3	1.3-37.5	0.0-0.8
		(n)	(8)	(2)	(6)
AMT	All	**Median**	**21.3**	**34.8**	**18.9**
		IQR	10.9-75.0	16.5-200.5	8.6-37.3
		(n)	(103)	(41)	(85)
	Suppository	**Median**	**9.4**	**18.8**	**0.0**
		IQR	0.0-18.8	18.8-18.8	0.0-0.0
		(n)	(2)	(1)	(1)
	Granule	**Median**	**-**	**-**	**-**
		IQR	-	-	-
		(n)	-	-	-
nAT	All	**Median**	**398.3**	**477.9**	**441.0**
		IQR	122.8-2092.8	81.2-4306.3	157.0-2092.8
		(n)	(114)	(39)	(97)
	Suppository	**Median**	**131.0**	**115.5**	**131.0**
		IQR	100.0-166.7	100.0-131.0	100.0-166.7
		(n)	(3)	(2)	(3)
	Granule	**Median**	**-**	**-**	**-**
		IQR	-	-	-
		(n)	-	-	-

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesaler and retailers stocked suppositories or granules, and so few of these product types were observed during the audit, these dosage forms have been separated from the tables for other dosage forms provided in the main text. 3 (n) is the number of wholesalers at a given level who stocked antimalarials for corresponding drug category.

6.2. Range of health and non-health retail outlets selling antimalarials in Uganda

Public Health Facilities	N	Description
National / Regional referral hospital	3	These government-run facilities provide free prescription medicines, medical consultations and diagnoses. They are staffed by qualified health practitioners.
District hospital	8	Parish-level facilities provide preventive and curative health services to outpatients. In addition to these services, sub-county facilities provide some inpatient care such as maternity, and in theory have laboratory services available. County-level health centres provide the same services as HC III, but are also equipped for emergency surgery procedures, including blood transfusion.
Health centre IV: County	49	
Health centre III: Sub-county	198	District hospitals offer services available in HC IV, in addition to assistance to community-based care programmes and in-service training for staff. Regional referral hospitals have provision for specialist inpatient and outpatient services such ENT, dentistry, radiology and intensive care wards. In addition to these facilities, the 2 national referral hospitals are involved in teaching medical students and conducting research (UMOH, 2005).
Health centre II: Parish	267	

Community medicine distributors	N	Description
Community medicine distributor	90	Provide free non-prescription medicines, including ACTs under the Home-Based Management of Fever (HBMF) program.

Private not-for-profit facilities	N	Description
Non-Governmental Organization (NGO) and Missionary hospital	11	These facilities provide prescription medicine at a nominal price following medical consultation or diagnosis. They are usually staffed with qualified health practitioners, though some smaller clinics run by NGOs have less well-qualified staff.

Private for-profit facilities	N	Description
Private clinic / domiciliary / midwife	208	These for-profit facilities are staffed by qualified health practitioners and generally include a consultation / examination room. They are licensed by the Ministry of Health (MOH), the Uganda Medical and Dental Practitioners Association, and/or the Nurses and Midwives Council.

These outlets sell prescription-only, licensed, and over-the-counter medicines at a commercial rate, and in accordance with the laws on licensed pharmacies and/or licensed drug sellers.

An unknown proportion of these outlets are not registered by the Ministry of Health. |

Pharmacies	N	Description
Pharmacy	97	Licensed and highly regulated by the National Drug Authority (NDA), pharmacies sell prescription medicines at a commercial rate. Their staff must include at least one qualified pharmacist, and many of the other staff are also qualified health practitioners. They sell all classes of medicines, including class A (narcotics), which are restricted to prescription-only sale by a registered pharmacist or licensed pharmacy.

Drug Stores	N	Description
Drug store	398	These outlets are smaller than pharmacies, and typically stock a smaller range of medicines. In theory they are licensed by the NDA, although an unknown proportion of these outlets are not registered. Drug stores sell class C (non-prescription but licensed) medicines and over-the-counter medicines at a commercial rate. NDA-licensed drug stores are staffed by qualified health dispensers or practitioners (e.g. enrolled nurses, clinical officers).

General Retailers	N	Description
Grocery stores / Dukas / General merchandise stores	3,747	Businesses/points of sale that sell fast moving consumer goods (e.g. food, household products), in addition to some medicines (most often antipyretics). Drugs sold at these locations are not regulated.
Kiosks	180	
Other	8	This category includes a small number of traditional healers (3) and mobile shops/hawkers (5) that were enumerated.

6.3. Calculating AETDs: antimalarial treatment and equivalent adult treatment dose

Antimalarial Category	Dose used for calculating 1 AETD (mg to treat a 60kg adult)	Generic product used for AETD mg dose value for combination therapies	Notes	Source
Amodiaquine	1800mg			WHO Use of Antimalarials, 2001
Amodiaquine-Sulfadoxine-Pyrimethamine	1800mg	Amodiaquine		WHO Model Formulary, 2008
Arteether	1050mg			WHO Use of Antimalarials, 2001
Artemether	960mg			WHO Use of Antimalarials, 2001
Artemether-Lumefantrine	480mg	Artemether		WHO Model Formulary, 2008
Artemisinin-Naphthoquine	2400mg	Artemisinin	Manufacturer Guidelines for this product are 1000mg Artemisinin in a single dose. Such a short ACT regimen is highly suspect. This treatment dose is based upon the WHO Artemisinin-MQ recommendation of a total dose of 40mg/kg.	WHO Use of Antimalarials, 2001
Artemisinin-Piperaquine	576mg	Artemisinin	Treatment dose based on Artemisinin-Piperaquine-Primaquine value, below.	As below
Artemisinin-Piperaquine-Primaquine	576mg	Artemisinin		Tangpukdee, N. et al. 2008. Efficacy of *Artequick* versus artesunate-mefloquine in the treatment of acute uncomplicated falciparum malaria in Thailand. The Southeast Asian Journal of Tropical Medicine and Public Health. 39(1): 1-8 http://imsear.hellis.org/handle/123456789/33676
Artesunate	960mg			WHO Use of Antimalarials, 2001
Artesunate-Amodiaquine	600mg	Artesunate		Manufacturer Guidelines (*Winthrop/Coarsucam – Sanofi Aventis*)
Artesunate-Halofantrine	600mg	Artesunate	Relatively uncommon combination; dosing information is difficult to find and the value here is based on the Artesunate-Amodiaquine, Artesunate-SP, and Artesunate-Mefloquine values.	-

Antimalarial Category	Dose used for calculating 1 AETD (mg to treat a 60kg adult)	Generic product used for AETD mg dose value for combination therapies	Notes	Source
Artesunate-Lumefantrine	600mg	Artesunate	Relatively uncommon combination; dosing information is difficult to find and the value here is based on the Artesunate-Amodiaquine, Artesunate-SP, and Artesunate-Mefloquine values.	-
Artesunate-Mefloquine	600mg	Artesunate		Manufacturer Guidelines (*Artequin Adult – Mepha*)
Artesunate-Piperaquine	600mg	Artesunate	Relatively uncommon combination; dosing information is difficult to find and the value here is based on the Artesunate-Amodiaquine, Artesunate-SP, and Artesunate-Mefloquine values.	-
Artesunate-Pyronaridine	600mg	Artesunate	Relatively uncommon combination; dosing information is difficult to find and the value here is based on the Artesunate-Amodiaquine, Artesunate-SP, and Artesunate-Mefloquine values.	-
Artesunate-Sulfadoxine-Pyrimethamine	600mg	Artesunate		Manufacturer Guidelines (*Co-arinate – Dafra*)
Atovaquone-Proguanil	3000mg	Atovaquone		Manufacturer Guidelines (*Malanil – GSK*)
Chloroquine	1500mg			WHO Model Formulary, 2008
Chloroquine-Sulfadoxine-Pyrimethamine	1500mg	Chloroquine		WHO Model Formulary, 2008
Chlorproguanil-Dapsone	360mg	Chlorproguanil		Manufacturer Guidelines (*LapDap – GSK*)
Dihydroartemisinin	480mg			Manufacturer Guidelines (*Cotecxin – Holleypharm; MALUether – Euromedi*)

Antimalarial Category	Dose used for calculating 1 AETD (mg to treat a 60kg adult)	Generic product used for AETD mg dose value for combination therapies	Notes	Source
Dihydroartemisinin-Amodiaquine	360mg	Dihydroartemisinin	Relatively uncommon combination; dosing information is difficult to find and the value here is based on the most common Dihydroartemisinin-combinations with sources listed below.	-
Dihydroartemisinin-Halofantrine	360mg	Dihydroartemisinin	Relatively uncommon combination; dosing information is difficult to find and the value here is based on the most common Dihydroartemisinin-combinations with sources listed below.	-
Dihydroartemisinin-Lumefantrine	360mg	Dihydroartemisinin	Relatively uncommon combination; dosing information is difficult to find and the value here is based on the most common Dihydroartemisinin-combinations with sources listed below.	-
Dihydroartemisinin-Piperaquine	360mg	Dihydroartemisinin		Manufacturer Guidelines (*Duo-cotecxin – Holleypharm*)
Dihydroartemisinin-Piperaquine-Trimethoprim	256mg	Dihydroartemisinin		Manufacturer Guidelines (*Artecxin – Medicare Pharma; Artecom – Ctonghe*)
Dihydroartemisinin-Pyronaridine	360mg	Dihydroartemisinin	Relatively uncommon combination; dosing information is difficult to find and the value here is based on the most common Dihydroartemisinin-combinations with sources listed below.	-
Dihydroartemisinin-Sulfadoxine-Pyrimethamine	360mg	Dihydroartemisinin		Manufacturer Guidelines (*Dalasin – Adams Pharma*)
Dihydroartemisinin-Mefloquine	360mg	Dihydroartemisinin		Manufacturer Guidelines (*Meflodisin – Adams Pharma*)
Halofantrine	1500mg		This dose is for halofantrine hydrochloride as the strength is normally reported in this manner. The total dose for halofantrine base is 1398 mg.	Manufacturer Guidelines (*Halfan – GSK*)

Antimalarial Category	Dose used for calculating 1 AETD (mg to treat a 60kg adult)	Generic product used for AETD mg dose value for combination therapies	Notes	Source
Hydroxychloroquine	2000mg			Manufacturer Guidelines (*Plaquenil – Sanofi Aventis)*
Mefloquine	1000mg			WHO Use of Antimalarials, 2001
Mefloquine-Sulfadoxine-Pyrimethamine	1000mg	Mefloquine		WHO Use of Antimalarials, 2001
Primaquine	45mg		This dose is for the gametocytocidal treatment of P. falciparum.	WHO Model Formulary, 2008
Quinacrine	2212mg		Recommendations for malaria treatment are very dated. This value is the treatment regimen for giardiasis, which has also been used in the treatment for malaria.	Gardner, T. B. and Hill, D. R. 2001. Treatment of Giardiasis. Clinical Microbiology Reviews. 14(1): 114-128 http://cmr.asm.org/cgi/content/full/14/1/114#T2
Quinimax	10500mg			Manufacturer Guidelines (*Quinimax – Sanofi Aventis)*
Quinine	12600mg		This dose is for quinine sulphate, a salt, as quinine strengths are normally reported for salts. The total dose for quinine base based on 24mg/kg is 10080mg for a 60kg adult.	WHO Model Formulary, 2008
Quinine-Sulfadoxine-Pyrimethamine	12600mg	Quinine	This dose is for quinine sulphate, a salt, as quinine strengths are normally reported for salts. The total dose for quinine base based on 24mg/kg is 10080mg for a 60kg adult.	WHO Model Formulary, 2008
Sulfadoxine-Pyrimethamine	1500mg	Sulfadoxine		WHO Model Formulary, 2008

6.4. Rationale & method to calculate weights and how to use weights to calculate indicators

Study design

During the 2009 ACTwatch Outlet Survey in Uganda, stratification based on malaria endemicity allowed for two appropriate domains for the outlet survey, high endemicity and low endemicity. A one-stage probability proportional to size (PPS) technique was then used to select 19 clusters (sub-counties) within each domain, with the sub-county population as the measure of size. As a result of this approach, 3 sub-counties were randomly selected from Kampala district. The smallest of these sub-counties had a population of 240,624 and so in all three cases a Parish was further randomly selected (by SRS) from each of the selected sub-counties in Kampala. The three parishes were the administrative unit in which the census of outlets was conducted.

Booster Sample

A booster sample of public health facilities (PHFs) comprised all PHFs in the county in which a selected sub-county fell. For the booster sample, PHFs included referral hospitals, health centers, and health posts, but excluded Community Medicine Distributers. A booster sample of Part-one Pharmacies (POPs) comprised all POPs in the district in which a selected sub-county fell. No booster sample was conducted for the 3 parishes in Kampala district.

A note on county and district boundaries

During fieldwork the counties and districts visited for the booster sample occasionally differed from those defined in the 2002 census in terms of the sub-counties included by their boundaries. In each case, these 'new' counties and districts matched those listed in the 2006 Health Facility Inventory in terms of the sub-counties included by their boundaries. In such instances, county and district population totals were calculated based on the 'new' boundaries and the sub-counties they include, using sub-county population data from the 2002 census. These 'new' population totals match the areas visited by interviewers based on the list of sub-counties in the dataset. Note that this problem did not occur at the sub-county level and thus the original sampling method and all non-booster weighting is unaffected by any county and district-level boundary changes.

Weighting approach

Weights were calculated differently for PHFs, POPs, and other outlet types, and were specific to analysis type, but generally involved the inverse of the selection probability and corresponding population size. We used sub-county populations for non-PHFs non-POPs, and for analysis involving only the non-booster sample (i.e. estimation of volumes for all outlet types). County populations were used for PHF outlet types, and district populations for POP outlet types, where analysis included the booster sample (i.e. availability and price). Although coded on the field questionnaire as PHFs, Community Medicine Distributors were absent from the booster sample and thus weighted throughout as a non-PHF outlet type. A correction factor was included in the weighting formula for booster outlets. This allowed us to account for potentially different approaches taken to reach outlets in the larger booster areas (counties and districts as opposed to sub-counties). Weights were not scaled. This was partly for convenience, but also driven by the key indicators being proportions and medians, which are invariant under scaling. In analysis the weights indicate the probability of selection, and are invoked using the `pweight` command in *Stata*.

The weight calculations are summarized as follows:

Availability and Price analysis (excluding Kampala):

i. All PHFs enumerated in a county;

$$Weight_i = \frac{\text{Stratum Population}}{\text{Number of counties visited in stratum} \times \text{County Population}} \times \frac{\text{Number of PHFs listed in sample frame for county}}{\text{Number of PHFs visited in the county}}$$

where the number of counties visited is 19 for high endemicity and 16 for low endemicity.

ii. All POPs enumerated in a district;

$$Weight_i = \frac{\text{Stratum Population}}{\text{Number of districts visited in stratum} \times \text{District Population}} \times \frac{\text{Number of POPs listed in sample frame for district}}{\text{Number of POPs visited in the district}}$$

where the number of districts visited is 19 for high endemicity and 15 for low endemicity.

iii. Non-PHF non-POP outlets (including Community Medicine Distributors) enumerated in a selected sub-county;

$$Weight_i = \frac{\text{Stratum Population}}{19 \times \text{SubCounty Population}}$$

Volumes analysis (excluding Kampala):
All outlets enumerated in a selected sub-county (non-booster sample);

$$Weight_i = \frac{\text{Stratum Population}}{19 \times \text{SubCounty Population}}$$

Availability, Price, and Volumes analysis for 3 Parishes in Kampala:
All outlets enumerated in the 3 parishes falling in Kampala district;

$$Weight_i = \frac{\text{Stratum Population}}{19 \times \text{SubCounty Population}} \times \frac{\text{Number of Parishes in selected SubCounty}}{1}$$

where the number of parishes is 19 for Kawmepe sub-county, 21 for Makindye sub-county, and 23 for Nakawa sub-county.

Data provided for weight estimation

    i. Population size at sub-county level for the malaria endemic areas with strata specified accordingly (*Ref: Uganda National Census Frame, 2002*)

    ii. A list of the selected sub-counties in the two strata

    iii. List of PHFs (referral hospitals, health centers, and health posts) at Parish level, with sub-county, county and district names also indicated
(*Ref: Health Facility Inventory, October 2006, Uganda MoH*)

    iv. List of registered pharmacies (POPs) by district, dated 2009

Tables

The tables on the following pages list the population figures and sampling frame PHF and POP counts used to calculate weights. The four tables presented are:

6.4.1. PHF weights by county for availability & price estimates (excludes Kampala)
6.4.2. POP weights by district for availability & price estimates (excludes Kampala)
6.4.3. Non-PHF non-POP weights by sub-county for availability & price estimates (includes Kampala)
6.4.4. All non-booster outlet weights by sub-county for volume estimates (includes Kampala)

Note on Table 6.4.2: Boundary differences for booster districts between the 2002 census, and the 2009 List of Registered Pharmacies by District and areas covered by fieldwork, are highlighted under the column marked *District*. For example, in the 2002 census the counties of Ibanda and Kazo are contained within Mbarara district. In the 2009 list, and for fieldwork purposes, they are autonomous districts. The *District Population* is that which represents the areas covered by fieldwork, and will differ from those given in the 2002 census.

Note on Tables 6.4.3 and 6.4.4: It is clear from the formulas above that the weights in Tables 3 and 4 are identical. Both tables are presented here for the sake of completeness when talking about weights for different analysis types.

Table 6.4.1: PHF weights by county for availability and price estimates (excludes Kampala)

County	Stratum (High / Low Endemicity)	Strata Population	County Population	Total PHFs in County (Sample frame)	Number of PHFs visited	Weight (Availability and Price)
Nakaseke	High	16,033,410	137,278	16	19	5.18
Masaka Municipal	High	16,033,410	67,768	7	5	17.43
Kassanda	High	16,033,410	201,052	14	11	5.34
Mukono	High	16,033,410	257,857	19	21	2.96
Kyotera	High	16,033,410	140,580	21	15	8.40
Bukooli North	High	16,033,410	116,843	15	7	15.48
Kigulu	High	16,033,410	235,866	22	21	3.75
Bugabula	High	16,033,410	230,870	19	12	5.79
Bukedea	High	16,033,410	122,433	7	7	6.89
Budaka	High	16,033,410	136,489	11	9	7.56
West Budama North	High	16,033,410	107,163	15	11	10.74
Kole	High	16,033,410	165,922	9	7	6.54
Koboko	High	16,033,410	129,148	8	5	10.45
Kilak	High	16,033,410	119,430	17	10	12.01
Moroto	High	16,033,410	163,047	14	9	8.05
Aruu	High	16,033,410	142,320	14	10	8.30
Igara	High	16,033,410	205,671	18	21	3.52
Busongora	High	16,033,410	276,841	41	28	4.46
Kibale	High	16,033,410	155,935	14	12	6.31
Busiro	Low	7,770,989	365,306	32	26	1.64
Kyadondo	Low	7,770,989	542,682	27	23	1.05
Bubulo	Low	7,770,989	262,566	14	15	1.73
Bungokho	Low	7,770,989	261,440	11	15	1.36
Budadiri	Low	7,770,989	185,819	19	10	4.97
Lamwo	Low	7,770,989	115,345	17	11	6.51
Bugahya	Low	7,770,989	198,833	22	16	3.36
Ndorwa	Low	7,770,989	153,595	31	27	3.63
Bunyangabu	Low	7,770,989	127,062	14	14	3.82
Bugangaizi	Low	7,770,989	108,357	11	9	5.48
Bufumbira	Low	7,770,989	220,312	28	28	2.20
Ibanda	Low	7,770,989	198,635	32	29	2.70
Kazo	Low	7,770,989	111,589	17	17	4.35
Rwampara	Low	7,770,989	131,962	18	20	3.31
Kinkiizi	Low	7,770,989	204,732	24	24	2.37
Kyaka	Low	7,770,989	110,925	13	11	5.17

Table 6.4.2: POP weights by district for availability and price estimates (excludes Kampala)

District	Stratum (High / Low Endemicity)	Strata Population	District Population	Total POPs in District (Sample frame)	Number of POPs visited	Weight (Availability and Price)
Luwero	High	16,033,410	478,595	1	1	1.76
Masaka	High	16,033,410	770,662	10	4	2.74
Mubende	High	16,033,410	689,530	4	4	1.22
Mukono	High	16,033,410	795,393	8	6	1.41
Rakai	High	16,033,410	470,365	3	2	2.69
Bugiri	High	16,033,410	412,395	0	0	-
Igana	High	16,033,410	708,690	4	5	0.95
Kamuli	High	16,033,410	722,090	3	2	1.75
Kumi	High	16,033,410	122,433	0	0	-
Pallisa	High	16,033,410	136,489	0	0	-
Tororo	High	16,033,410	536,888	3	1	4.72
Apac	High	16,033,410	683,993	0	0	-
Arua	High	16,033,410	833,928	6	7	0.87
Gulu	High	16,033,410	458,967	6	3	3.68
Lira	High	16,033,410	741,240	10	8	1.42
Pader	High	16,033,410	326,338	0	0	-
Bushenyi	High	16,033,410	754,219	1	1	1.12
Kasese	High	16,033,410	523,033	2	3	1.08
Kamwenge	High	16,033,410	263,730	0	1	3.20
Wakiso	Low	7,770,989	907,988	21	10	1.20
Mbale (Bubutu)	Low	7,770,989		10	0	-
Mbale (Busiu)	Low	7,770,989	718,239	10	4	1.80
Sironko	Low	7,770,989	283,092	0	1	1.83
Kitgum	Low	7,770,989	282,375	1	2	0.92
Hoima	Low	7,770,989	343,618	6	6	1.51
Kabale	Low	7,770,989	458,318	3	3	1.13
Kabarole	Low	7,770,989	356,914	8	7	1.66
Kibaale	Low	7,770,989	405,882	1	2	0.64
Kisoro	Low	7,770,989	220,312	1	0	-
Mbarara (Ibanda)	Low	7,770,989	198,635	1	2	1.30
Mbarara (Kazo)	Low	7,770,989		0	0	-
Mbarara	Low	7,770,989	777,132	20	8	1.66
Kanungu	Low	7,770,989	204,732	0	0	-
Kyenjojo	Low	7,770,989	377,171	2	1	2.75

Table 6.4.3: Non-PHF non-POP weights by sub-county for availability and price estimates
(Includes Kampala – refer to weighting section above for details of Kampala-specific weighting)

Sub-county	Stratum (High / Low Endemicity)	Strata Population	Sub-county Population	Weight (Availability and Price)
Kikamulo	High	16,033,410	22,078	38.22
Nyendo/Senyange	High	16,033,410	29,562	28.55
Kassanda	High	16,033,410	58,828	14.34
Nama	High	16,033,410	33,004	25.57
Kalisizo	High	16,033,410	27,847	30.30
Kapyanga	High	16,033,410	42,553	19.83
Namungalwe	High	16,033,410	28,061	30.07
Balawoli	High	16,033,410	35,000	24.11
Kachumbala	High	16,033,410	36,767	22.95
Naboa	High	16,033,410	17,337	48.67
Nagongera	High	16,033,410	28,907	29.19
Alito	High	16,033,410	50,549	16.69
Kuluba	High	16,033,410	18,030	46.80
Lamogi	High	16,033,410	25,426	33.19
Apala	High	16,033,410	30,605	27.57
Puranga	High	16,033,410	14,396	58.62
Nyabubare	High	16,033,410	35,111	24.03
Maliba	High	16,033,410	37,204	22.68
Kahunge	High	16,033,410	50,622	16.67
Bwaise II (**Kampala**)	Low	7,770,989	262,165	29.64
Bukasa (**Kampala**)	Low	7,770,989	303,171	28.33
Kiwatule (**Kampala**)	Low	7,770,989	240,624	39.09
Ssisa	Low	7,770,989	45,624	8.96
Nabweru	Low	7,770,989	104,400	3.92
Bubutu	Low	7,770,989	38,928	10.51
Busiu	Low	7,770,989	25,746	15.89
Buyobo	Low	7,770,989	18,028	22.69
Palabek Gem	Low	7,770,989	12,639	32.36
Buhanika	Low	7,770,989	20,050	20.40
Kaharo	Low	7,770,989	17,974	22.76
Buheesi	Low	7,770,989	32,600	12.55
Nalweyo	Low	7,770,989	20,756	19.71
Muramba	Low	7,770,989	28,189	14.51
Nyamarebe	Low	7,770,989	20,685	19.77
Buremba	Low	7,770,989	27,324	14.97
Rugando	Low	7,770,989	22,802	17.94
Kanyantorogo	Low	7,770,989	16,643	24.57
Kyegegwa	Low	7,770,989	25,111	16.29

Table 6.4.4: All non-booster outlet weights by sub-county for volume estimates
(Includes Kampala – refer to weighting section above for details of Kampala-specific weighting)

Sub-county	Stratum (High / Low Endemicity)	Strata Population	Sub-county Population	Weight (Availability and Price)
Kikamulo	High	16,033,410	22,078	38.22
Nyendo/Senyange	High	16,033,410	29,562	28.55
Kassanda	High	16,033,410	58,828	14.34
Nama	High	16,033,410	33,004	25.57
Kalisizo	High	16,033,410	27,847	30.30
Kapyanga	High	16,033,410	42,553	19.83
Namungalwe	High	16,033,410	28,061	30.07
Balawoli	High	16,033,410	35,000	24.11
Kachumbala	High	16,033,410	36,767	22.95
Naboa	High	16,033,410	17,337	48.67
Nagongera	High	16,033,410	28,907	29.19
Alito	High	16,033,410	50,549	16.69
Kuluba	High	16,033,410	18,030	46.80
Lamogi	High	16,033,410	25,426	33.19
Apala	High	16,033,410	30,605	27.57
Puranga	High	16,033,410	14,396	58.62
Nyabubare	High	16,033,410	35,111	24.03
Maliba	High	16,033,410	37,204	22.68
Kahunge	High	16,033,410	50,622	16.67
Bwaise II (**Kampala**)	Low	7,770,989	262,165	29.64
Bukasa (**Kampala**)	Low	7,770,989	303,171	28.33
Kiwatule (**Kampala**)	Low	7,770,989	240,624	39.09
Ssisa	Low	7,770,989	45,624	8.96
Nabweru	Low	7,770,989	104,400	3.92
Bubutu	Low	7,770,989	38,928	10.51
Busiu	Low	7,770,989	25,746	15.89
Buyobo	Low	7,770,989	18,028	22.69
Palabek Gem	Low	7,770,989	12,639	32.36
Buhanika	Low	7,770,989	20,050	20.40
Kaharo	Low	7,770,989	17,974	22.76
Buheesi	Low	7,770,989	32,600	12.55
Nalweyo	Low	7,770,989	20,756	19.71
Muramba	Low	7,770,989	28,189	14.51
Nyamarebe	Low	7,770,989	20,685	19.77
Buremba	Low	7,770,989	27,324	14.97
Rugando	Low	7,770,989	22,802	17.94
Kanyantorogo	Low	7,770,989	16,643	24.57
Kyegegwa	Low	7,770,989	25,111	16.29

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