Evidence for Malaria Medicines Policy

ACTwatch 2009
Supply Chain Survey Results
Zambia

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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 6.2 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. The ACTwatch Outlet Survey included a booster sample of public health facilities in the entire district that includes the selected sub-district (ward), consisting of all of the public health facilities in the district that are not in the selected sub-district itself. As there were 44 registered pharmacies in the country at the time of data collection, the booster sample for registered pharmacies included all those that were not already included in the selected sub-districts.

Censused sub-district: Wards 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. Zambia'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 (28 February to 6 May 2009) was 5693.71 Zambia Kwacha (ZMK) to US$1; the average exchange rate during the collection period for retail purchase prices (14 April to 3 July 2009) was 5342.47 Zambia Kwacha (ZMK) 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 6.1 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 (28 February to 6 May 2009) was 5693.71 Zambia Kwacha (ZMK) to US$1; the average exchange rate during the collection period for retail purchase prices (14 April to 3 July 2009) was 5342.47 Zambia Kwacha (ZMK) to US$1 (www.oanda.com).

Rapid-Diagnostic Test (RDT) for malaria: A test used to confirm the presence of malaria parasites in a patient's bloodstream.

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. Zambia'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 defined in Zambia as the ward, which consists of an agglomeration of Census Supervisory Areas that combined hosts a population size of approximately 10,000 to 15,000 inhabitants.

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.
>
> **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
ANC	antenatal clinic
AR	artemether
AS	artesunate
ASMQ	artesunate and mefloquine
CHW	community health worker
CQ	chloroquine
DfID	UK Department for International Development
DHA	dihydroartemisinin
DHA+PP	dihydroartemisinin and piperaquine
IMCI	Integrated Management of Childhood Illness
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
LSHTM	London School of Hygiene & Tropical Medicine
MEC	mutually-exclusive category of wholesalers
MOH	Ministry of Health
MQ	mefloquine
MSL	Medical Stores Limited
nAT	non-artemisinin therapy
NGO	non-governmental organisation
NMCC	National Malaria Control Centre
OS	ACTwatch Outlet Survey
OTC	over-the-counter
Pf	*Plasmodium falciparum*
PMI	US President's Malaria Initiative
POM	prescription only medicine
PPS	probability proportional to size
PRA	Pharmaceutical Regulatory Authority
PSI	Population Services International
RDT	rapid diagnostic test
SFH	Society for Family Health/Zambia
SP	sulphadoxine pyrimethamine
UN	United Nations
WHO	World Health Organization
WS	wholesaler

Executive Summary

Background

In Zambia, 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 (Cambodia, Uganda, Zambia, Nigeria, Benin, Madagascar and the Democratic Republic of Congo). 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 Zambia between February and May 2009.

Methods

The Supply Chain survey was implemented by the London School of Hygiene & Tropical Medicine (LSHTM), with support from the Society for Family Health/Zambia, 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 Zambia's malaria endemic 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/care takers and are therefore relevant to the study of the distribution chain.

Results

STRUCTURE OF THE SUPPLY CHAIN: A total of 57 antimalarial wholesalers were identified, and 43 were successfully interviewed. The maximum number of steps from manufacturers' factory gate to retail outlets was 5 with wholesalers operating across 4 overlapping levels: intermediate-3 (INT 3 WS), intermediate-2 (INT 2 WS), intermediate-1 (INT 1 WS) and terminal (TERMINAL WS) levels (Figure 1). However, less than a fifth of wholesalers were observed to operate at higher levels of the supply chain (i.e. supplying other wholesalers) while all wholesalers, regardless of supply chain level, supplied retailers directly. 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 in Figure 1 from manufacturer to retailer indicates that a few retailers purchased antimalarials directly from manufacturers although this was rare (2.5% of all suppliers mentioned by retailers were local drug manufacturers).

Figure 1: Representation of the antimalarial distribution chain showing interactions between supply chain levels by mutually exclusive wholesaler category

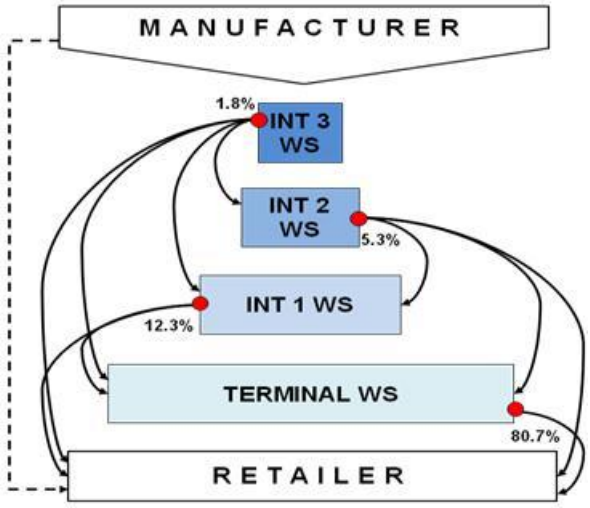
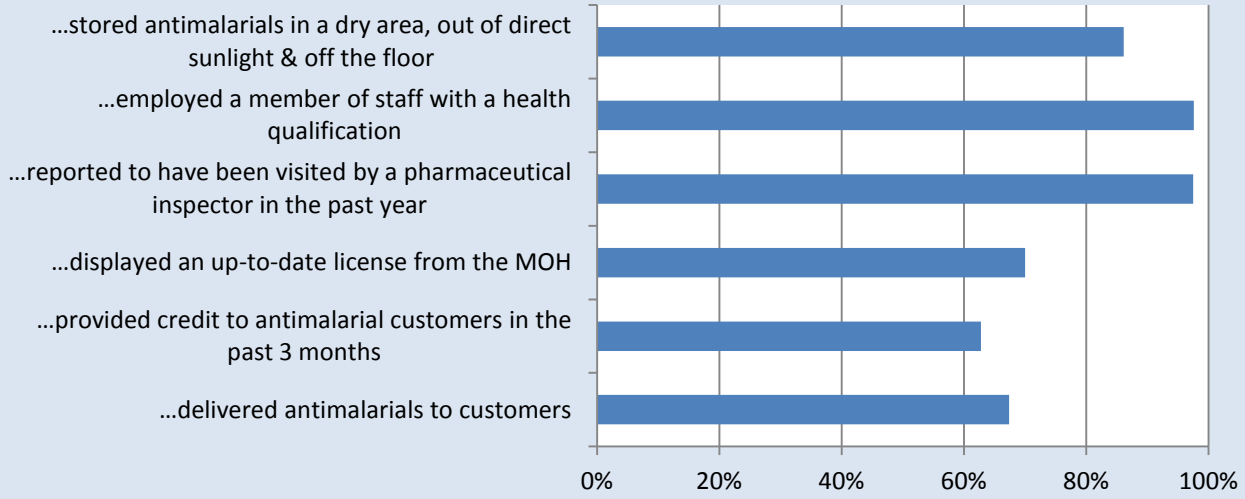


Figure 2: Representation of the antimalarial distribution chain showing the overlap between wholesaler categories used for analysis

Note: WS: wholesaler; INT: intermediate

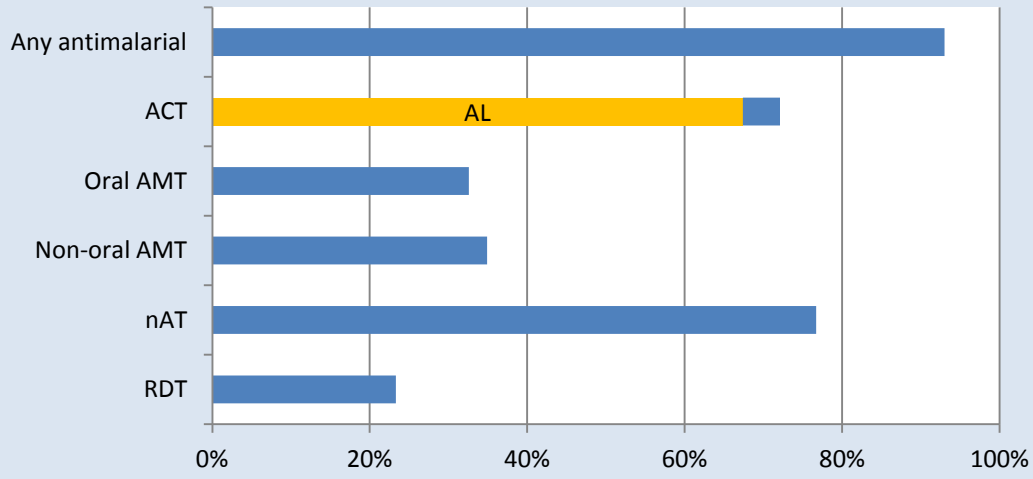
WHOLESALER CHARACTERISTICS: Wholesalers had been in operation for a median of 9 years. Their businesses ranged in size, with wholesalers that supplied retailers being smaller than those supplying other wholesalers (median of 8 workers compared to 20 workers). Nearly all wholesalers (98%) reported employing a member of staff with a health qualification, the most commonly reported being a pharmacist (91%) and a pharmacy technologist (79%). Most wholesalers (86%) stored antimalarials appropriately (off the floor, in dry areas and out of direct sunlight), and a high proportion (98%) reported having been visited by a pharmaceutical inspector in the 12 months preceding the interview. However, a smaller proportion of wholesalers (70%) were observed to have any up-to-date license from the Ministry of Health. Two-thirds of wholesalers delivered antimalarial orders to their customers and more than 60% offered their customers credit facilities.

% of wholesalers that...



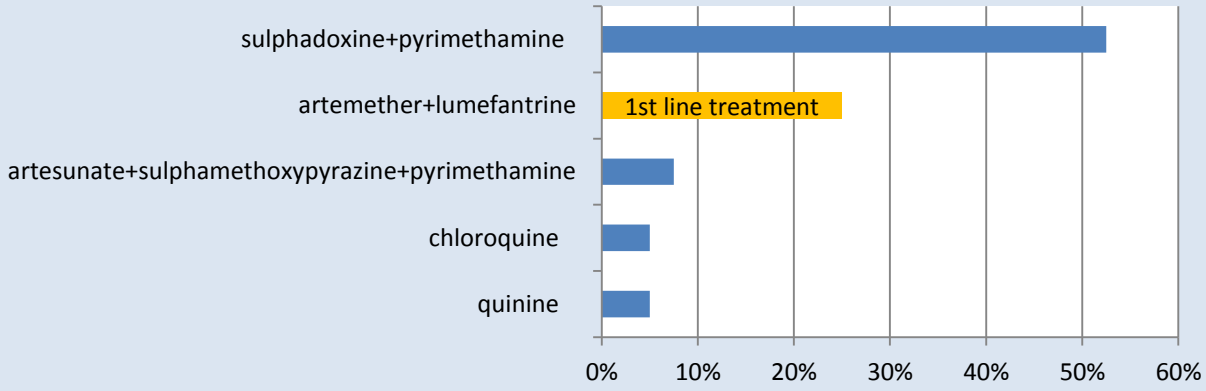
AVAILABILITY OF ANTIMALARIALS & RDTS: Only 7% of all wholesalers interviewed did not stock any antimalarial drugs at the time of interview, 72% had ACT in stock, and 67% stocked the ACT artemether+ lumefantrine (AL, the recommended first line treatment for uncomplicated *Pf* malaria in Zambia). Availability of other antimalarial drugs was relatively high, with both oral and non-oral artemisinin monotherapies (AMT) being stocked by a third (33% and 35%) of all wholesalers and non-artemisinin therapies (nAT) by around three quarters (77%) of wholesalers. RDTs were stocked by less than a quarter (23%) of wholesalers.

% of wholesalers that stocked...

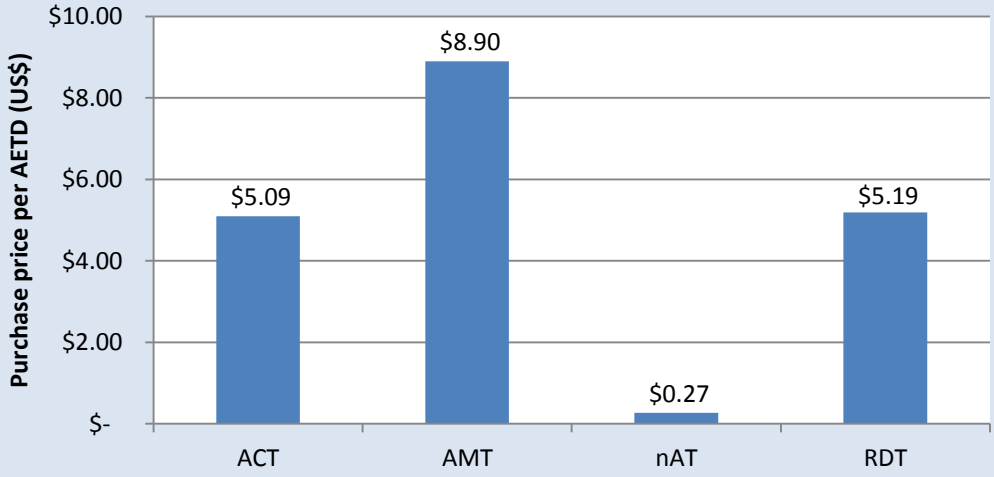


ANTIMALARIAL & RDT SALES VOLUMES: The median number of adult equivalent treatment doses (AETDs) of antimalarials sold the week preceding the survey was 35.7 for ACT and 0 for AMT. For nATs, the median number of AETDs sold was 320.9. These figures reflect the fact that, among wholesalers who sold antimalarials the week before the survey (n=40), 53% reported the nAT sulphadoxine-pyrimethamine (SP) to be their top selling antimalarial, while only 25% reported AL, the government recommended first-line treatment, as their top selling antimalarial. Wholesalers reported selling a median of 0 RDTs over the week preceding the survey.

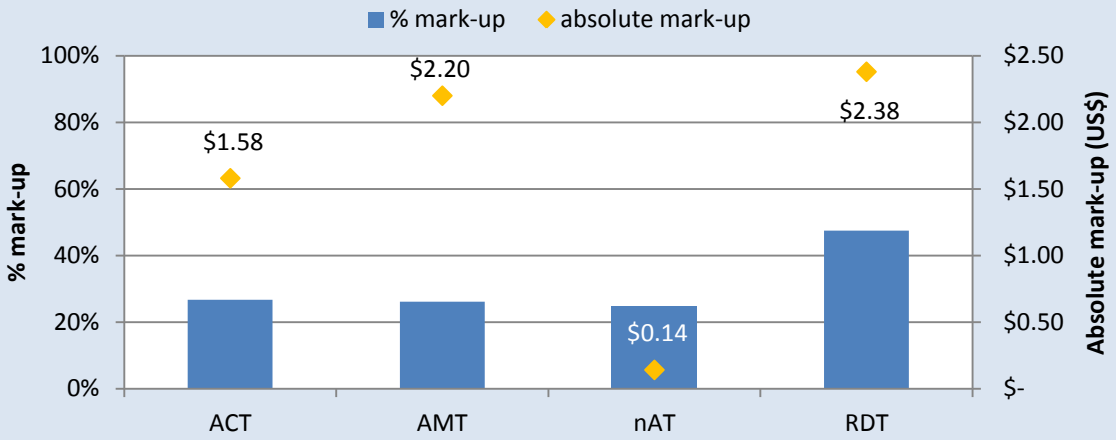
% of wholesalers who reported the top selling antimalarial to be...



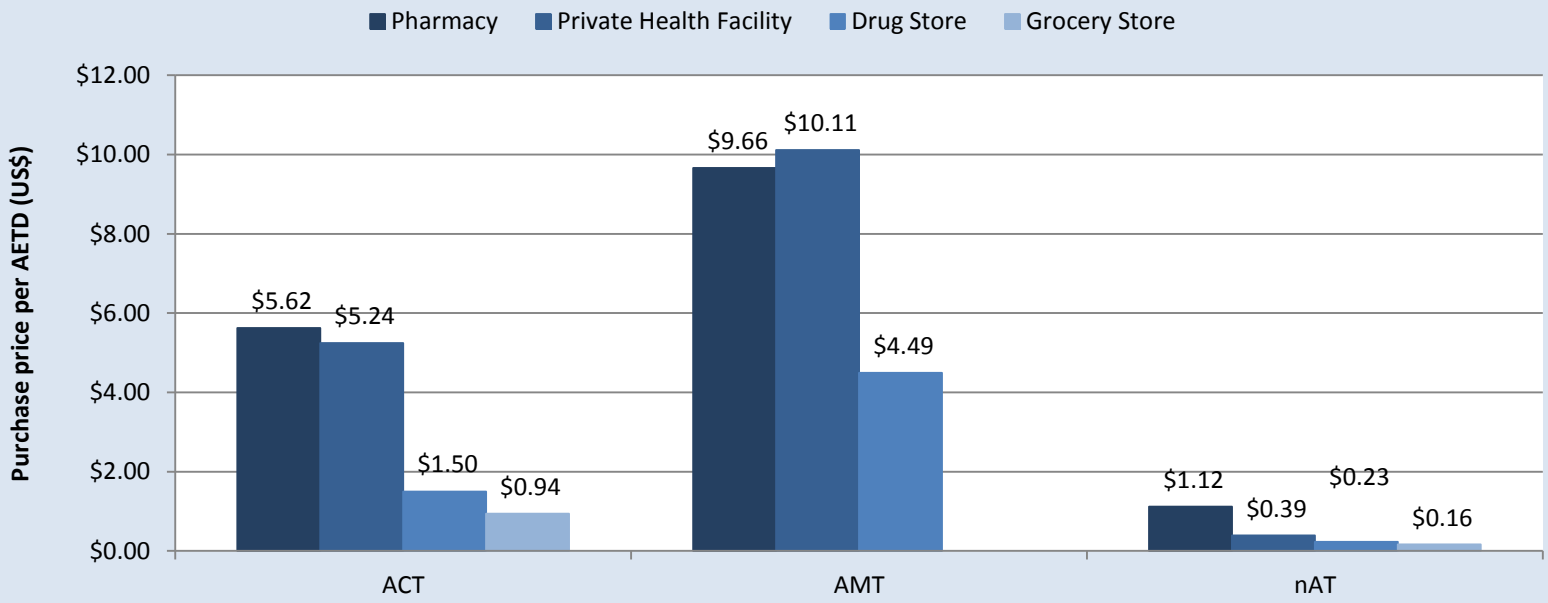
WHOLESALE PURCHASE PRICES: The median wholesale purchase price (i.e. the price paid by wholesalers to purchase stock from their suppliers) per AETD varied across antimalarial drug categories. Overall, AMTs had the highest median purchase price per AETD (US$8.90), followed by ACTs (US$ 5.09 per AETD) while nATs had a much lower median purchase price (US$ 0.27). Among wholesalers, the median purchase price for the government recommended first-line treatment, AL (US$ 5.29), was more than 30 times the wholesale purchase price of SP. The wholesale purchase price for RDTs was similar to that of ACTs at US$ 5.19 per test.



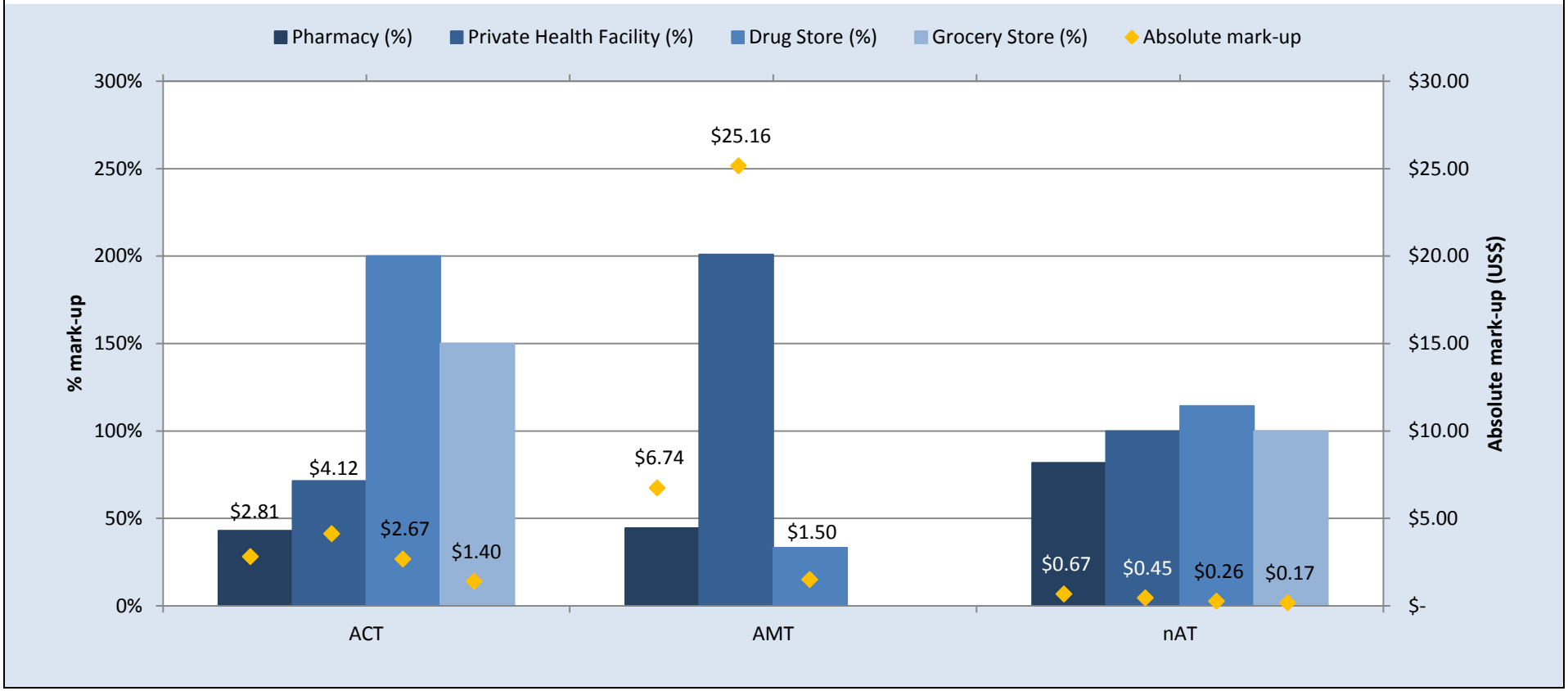
WHOLESALE MARK-UPS FOR ANTIMALARIALS & RDTS: The median mid percent mark-ups were similar across antimalarial categories: 27% on ACTs, 26% on AMTs and 25% on nATs. Wholesale percent mark-ups were also fairly consistent across dosage forms, ranging from 24% for ACT tablets to 31% for AMT oral liquids. In absolute terms, mark-ups per AETD were the highest on AMT (US$ 2.20), followed by ACT (US$ 1.58) and nAT (US$ 0.14), which reflected differences in purchase prices across drug categories. For similar reasons, variation in absolute mark-up was also seen across dosage forms, with injectables tending to have the highest absolute mark-ups, followed by oral liquids and then tablets. For example, the median mid absolute mark-up on AMT injectables was US$ 4.22, compared to US$ 1.47 for oral liquids, and US$ 1.12 for tablets. For AL, median mid percent mark-up was 24% (corresponding to a median mid absolute mark-up of US$ 1.32 per AETD), compared to 24% for SP (corresponding to a median mid absolute mark-up of US$ 0.03 per AETD). For RDTs, the median wholesale percent mark-up was 48%, equivalent to US$ 2.38 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 (ranging from US$ 4.49 at drug stores to US$ 10.11 at private health facilities), followed by ACTs (ranging from US$ 0.94 at grocery stores to US$ 5.62 at pharmacies), and nATs (ranging from US$ 0.16 at grocery stores to US$ 1.12 at pharmacies). Pharmacies and private health facilities tended to have paid higher purchase prices for antimalarials compared to drug stores and grocery stores. This reflected pharmacies' and private health facilities' tendency to stock more antimalarials in injection and suspension forms, paediatric formulations, and 'premium priced' products (i.e. products strategically priced toward the high end of the price range to attract status-conscious consumers; an example is halofantrine). This, in turn, may reflect the preferences of customers at pharmacies and private health facilities that may differ from those at drugs stores and grocery stores.



RETAIL MARK-UPS FOR ANTIMALARIALS: Median mid percent mark-ups among retailers tended to be higher than those observed among wholesalers. They also varied considerably across outlet type and antimalarial category. For ACTs, the median mark-up ranged between 43% in pharmacies and 200% at drug stores; on AMT between 33% at drug stores and 201% at private health facilities; and on nAT between 82% at pharmacies and 114% at drug stores. Mark-ups above 100% were commonly observed, particularly among nATs. Variation in absolute mark-ups was also observed across antimalarial categories and across outlet types, corresponding closely with variations in purchase price: mark-ups on ACTs ranged between US$ 1.40 and US$ 4.12; on AMT between US$ 1.50 and US$ 25.16; and on nAT between US$ 0.17 and US$ 0.67. For AL, the median mid percent mark-up was 43% (US$ 2.99 absolute mark-up) at pharmacies, 71% (US$ 4.31) at private health facilities, 150% (US$ 1.40) at grocery stores, and 200% (US$ 2.67) at drug stores.



Conclusion

This report presents a number of important new insights into the market for antimalarial drugs in Zambia. The distribution chain had a pyramid shape, with a relatively broad base and narrow top. While we observed wholesalers to operate over 4 overlapping levels, all wholesalers identified were observed to supply retailers directly and a high proportion of wholesalers (42%) identified a manufacturer as one of their top antimalarial suppliers. As such, it is likely that most antimalarials in the private sector pass through a 2- or 3-step supply chain between manufacturer to retailer. ACTs, and in particular artemether-lumefantrine, the recommended first-line treatment for uncomplicated malaria, were observed to be available in about 70% of wholesalers; however, wholesale purchase prices for ACTs are high and are many times more expensive than other common antimalarials, such as SP. This may have contributed to our observation that SP was the most commonly reported top-selling antimalarial by wholesalers (50%), while only 28% of wholesalers reported AL as their top-selling antimalarial. With respect to oral AMTs, despite the ban on their sale since October 2008, one third (33%) of all wholesalers continued to stock oral AMTs; however, their sales volumes during the week prior to the survey were observed to be very low. 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 high and they were not widely available among wholesalers.

1. Introduction & Objectives

Alongside the public and non-profit sectors, private commercial providers are important sources of malaria treatment in Zambia. To design effective interventions for improved access to accurate diagnosis and effective malaria 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 Zambia, Cambodia, Uganda, Nigeria, Benin, Madagascar and the Democratic Republic of Congo. 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 Population Services International (PSI).

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 Zambia between February and May 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 the Society for Family Health/Zambia between April and July 2009.

2. Country Background

Economic Profile

Zambia is a landlocked country located in Southern Africa sharing borders with Angola, Democratic Republic of Congo, Malawi, Mozambique, Namibia, Tanzania, and Zimbabwe. The population is approximately 12 million people of which an estimated 65% live in rural areas. In recent years, Zambia has experienced relatively high economic growth, with a gross domestic product (GDP) growth rate ranging between 5.7% and 7.0% from 2008 to 2010, and per capita GDP estimated at US$ 1,500 in 2010. [1] Historically, the country's economy has relied heavily on the copper mining industry; however, the government has made efforts to diversify by promoting agriculture, tourism, gemstone mining and hydro-power, relying on a private-sector-led model of economic development. [2] Most recently in 2009, the government launched the second phase of the Private Sector Development Reform Programme which aims to accelerate and broaden private sector growth. [3] Despite this, 85% of the labour force was engaged in agriculture in 2004, while only 6% were employed in the industrial sector and 9% in the service sector; 50% of the estimated 5.5 million labour force were unemployed; and a majority of the population was estimated to live below the poverty line. [1]

Pharmaceutical Sector

The sector is regulated by the Pharmaceutical Regulatory Authority of Zambia (PRA), which is responsible for the registration of all products prior to importation and sale, the licensing of pharmaceutical manufacturers, importers, wholesalers and retail pharmacies, and post-marketing surveillance. [4] With only limited domestic pharmaceutical manufacturing capacity, the country relies heavily on the importation of medicines. The public and mission pharmaceutical sectors both follow a highly centralised model for medicine procurement and distribution, while less is known about the structure and operations of the private pharmaceutical sector. All private pharmaceutical importers, wholesalers, and retail pharmacies are required to employ a pharmacist registered with Medical Council of Zambia. The PRA issues several licenses for the importation, wholesale and pharmacy retail of medicines. Hospital pharmacies also require a specific license from the PRA, while the Medical Council of Zambia maintains a register of private clinics. Drug stores registered with local governments, rather than licensed by the PRA, and are not required to employ a pharmacist. These retails outlets are common and should only dispense over-the-counter medicines, but in practice also dispense prescription only medicines. Other common sources of over-the-counter medicines in the private sector include grocery stores and several other types of general shops that focus on the sale of fast moving consumer goods. Medicine prices or mark-ups in Zambia are not regulated.

Health System

Zambia's health system is dominated by the public sector: of the 1,327 healthcare facilities in Zambia, 85% percent are government-run facilities, ranging from health posts to large tertiary hospitals; while 9% are private sector facilities and 6% are mission facilities. Geographic access to healthcare varies widely with 99% of urban households residing within five kilometres of a health facility, compared to 50% of rural households. [5] Since 1993, government health facilities charge user fees for the majority of services, but fees were removed for publicly provided primary health care services in rural areas in 2006, which dramatically increased health service use in these areas following implementation. [6] By 2008, it was estimated that the public sector provided care for over 80% of the population, with the non-profit and private sectors providing the remaining services. [6] Despite these improvements in access to health services, there is still considerable room for improvement in national health indicators. Life expectancy in 2006 for both men and women was below 45 years and nearly one in six children die before reaching their fifth birthday, with malaria acting as a key driver of child mortality. [7] In 2007, the country had an estimated 4.3 million clinically diagnosed cases of malaria, accounting for 36% of outpatient visits, 48% of the disease burden among children below five years of age, and up to 20% of maternal deaths. [8]

Malaria Epidemiology and Control Strategies

Malaria is endemic throughout Zambia. Between 90% and 100% of the population are at risk for infection, with peaks occurring during the rainy season between November and April. Despite widespread endemicity, certain areas of the country can be characterised as hyperendemic, mesoendemic, or epidemic prone. The predominant parasite is *Plasmodium falciparum* (*Pf*) which accounts for the vast majority of infections. [9] The National Malaria Control Strategy identifies pregnant women and children under five as the population groups most at risk. Key malaria prevention and treatment interventions include distribution of insecticide treated nets (ITNs) through campaigns, antenatal clinics (ANCs) and the commercial sector; indoor residual spraying (IRS) in urban and peri-urban areas; intermittent preventive treatment (IPT) for pregnant women through ANCs; and administration of ACTs through health facilities with increasing focus on confirmed diagnosis using microscopy or RDTs. [10] A recent study that examined the progress and impact of the

national control strategy showed that, by 2008, 68% of households had at list one ITN or had received IRS and a similar proportion of pregnant women (66%) received 2+ doses of IPT. [11]

Malaria Financing

Malaria prevention and treatment in Zambia is largely supported by international donors. As noted above, the key malaria partners include the Global Fund, the World Bank, the US President's Malaria Initiative (PMI), UNITAID, and DfID. The NMCC received US$ 39.2 million during the Global Fund Round 1, US$ 42.7 million during Round 4, and US$ 17.7 million during Round 7 for a range of malaria prevention and treatment interventions. The World Bank provided US$ 20 million through its 2005-2010 Malaria Health Booster program for health systems strengthening and small community grants. PMI awarded US$ 9.5 million in 2007 and US$ 14.8 million in 2008. UNITAID has provided support for the procurement of 1.1 million ACT doses since 2007.

National Treatment Policy

In 2003, Zambia became the first African country to adopt the use of ACTs over chloroquine, selecting artemether lumefantrine (AL) as the first-line treatment, sulphadoxine-pyrimethamine (SP) as the alternative first line treatment in pregnant women and children less than 5kg, and oral quinine as the second-line treatment in cases of failure of first-line drugs in all age groups (Table 1). Severe malaria is treated with quinine. In Zambia, ACTs are classified as prescription-only medications and are therefore not sold legally through unlicensed private sector providers; their availability has therefore remained largely restricted to the public sector, registered pharmacies and private facilities. [8, 12, 13] In 2003, the Ministry of Health placed a ban on the use of oral artemisinin monotherapies (AMTs) for the treatment of uncomplicated malaria to delay the emergence of resistance to ACTs [14]; however the results from the ACTwatch Outlet Survey in 2009 indicated that oral AMTs were still widely available in the private sector, particularly among registered pharmacies and private health facilities. [12] The National Malaria Control Centre (NMCC) recommends parasitological diagnosis for all patients with suspected malaria at hospitals and health centres with laboratory facilities. Clinical diagnosis is recommended where laboratory facilities are not available. Children under five years of age are treated based on laboratory diagnosis in health facilities where available, and otherwise are evaluated and treated according to the algorithm of the Integrated Management of Childhood Illness (IMCI).

Table2.1: National Malaria Treatment Guidelines

Condition	Recommendation	Dosage form	Strength
Uncomplicated malaria	Artemether-Lumefantrine	Tablet	20mg/120mg
Pregnant women & children under 5kg – uncomplicated	Sulphadoxine Pyrimethamine	Tablet	500mg/25mg
Treatment failure	Quinine (oral)	Tablet	200mg or 300mg
Severe & complicated malaria	Quinine (injection)	Ampoule	150mg/ml

Antimalarial Treatment Distribution and Delivery

As part of Zambia's implementation of its Global Fund grants, ACT treatment has been procured and is dispensed in the public sector free of charge. AL has been distributed to health facilities since the end of 2004. In order to ensure rational use of these drugs, the Global Fund also supported procurement and

distribution of RDTs and microscopes, and training of health workers in their use. A round 1 grant from the Global Fund provided sufficient ACTs to cover 28 out of the 72 districts in Zambia between 2003 and 2009, and national scale up commenced with resources from a round 4 grant from 2005, via health facilities, community health workers (CHWs) and pharmacies. As of November 2008, 11 districts had also started community-based treatment of malaria with ACTs.

ACT delivery in Zambia is also supported by financing from other donors. The World Bank Malaria Booster project provides health system strengthening to improve service delivery, small grants for community-level malaria control, and funding to the Ministry of Health (MOH)/NMCC; UNITAID has supplied 1.1 million ACT doses for community distribution; and the UK Department for International Development (DfID) has provided funds to redesign Zambia's public sector supply chain distribution system in collaboration with John Snow International/DELIVER and the World Bank.

According to the ACTwatch Outlet Survey, public health facilities, private health facilities, pharmacies, and drug shops were the most common outlets carrying any type of antimalarial in Zambia in 2009. [12] ACTs were rarely available in unlicensed private sector providers (e.g. around 6% in drug stores, and less than 1% in other types of providers). [12] The majority of antimalarial treatments are obtained through public facilities; the ACTwatch Household Survey also conducted in 2009 showed that 85% all antimalarial treatment for children were acquired from the public sector; however 7.5% of treatment for malaria was obtained through private sector sources such as pharmacies, drug shops and private health facilities. [13]

3. Methods

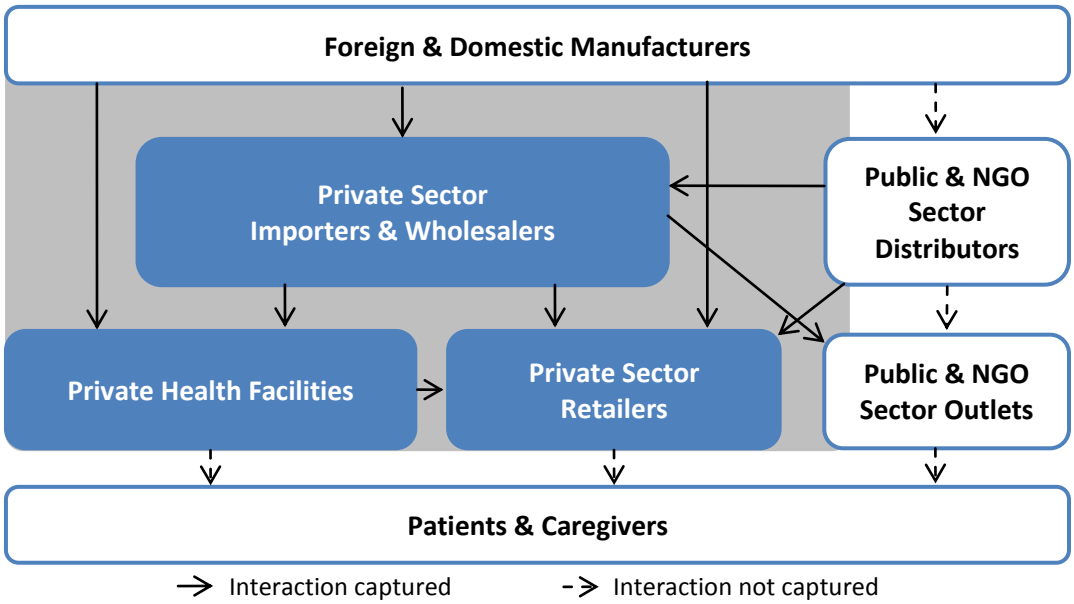
3.1. Scope of the supply chain survey

The Supply Chain structured survey was conducted amongst wholesalers who operate in the private commercial distribution chain that serve the antimalarial drug retailers described in the ACTwatch Outlet Survey report. [12] The term 'private commercial sector distribution chain' refers to any type of supplier (public or private) who serve private commercial outlets as well as private suppliers who serve 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 artemisinin-combination therapy or ACT (e.g. artesunate and mefloquine), artemisinin monotherapies or AMT (e.g. artesunate, artemether) and non- artemisinin monotherapies or nAT (e.g. chloroquine, quinine). It considered all formulations (tablets, syrups, injectables etc), whether they are used for inpatient or outpatient care and 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 PSI/Society for Family Health-Zambia (SFH) between April and July 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, Zambia was divided into 2 strata: one stratum each for rural and urban areas. 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 electoral wards in 2000. 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. 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 operating in the district that includes the sampled sub-district or ward, and all 44 registered pharmacies operating in Zambia at the time of data collection.[1] The use of a booster sample is a common procedure across all ACTwatch outlet surveys to ensure adequate representation of relatively rare but important antimalarial provider types. Public sector outlets (e.g. health posts, health centres, hospitals) that stocked antimalarials were identified through a census in the relevant districts.

[1] Due to logistical limitations, only 39 of the 44 registered pharmacies operating in Zambia at the time of data collection were included in the first round of the ACTwatch Outlet Survey.

The Outlet Survey was conducted in the sampled sub-districts and booster districts by PSI/SFH Zambia between April and July 2009. The Outlet Survey 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, type of provider, 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, with support from SFH Zambia, shortly after the Outlet Survey, from February to May 2009. All 38 of the Outlet Survey's sampled sub-districts were used to create a list of antimalarial wholesale sources mentioned by retailers as their two top antimalarial wholesale sources (termed the "terminal wholesalers").[2,] 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 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 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.[3]

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 trained data collectors, and further revisions were made to adapt the tools to the Zambian context. Before each interview, trained interviewers sought to speak with the most knowledgeable person about the 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 wholesalers' characteristics and operations and on their 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

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

[3] 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.

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 University of Zambia Biomedical Research Ethics Committee 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, grocery stores, and public health facilities. See appendix 6.1 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 3 dosage forms[4], namely tablets, oral liquids and injectables[5] and 3 antimalarial categories[6] 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 6.2 for data used during calculation of AETD). 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.

[4] Other dosage forms, such as suppositories and granules, are not mentioned in this report because no suppositories and only 1 granule product were found during the ACTwatch surveys conducted in Zambia

[5] Liquid and powder injectables form a single category. The prevalence of powder injectables was very low (never found at wholesale level, 2 observations at retail level).

[6] Antimalarial drugs intended for prophylaxis only and drug combinations not used to treat malaria but that contain an ingredient with antimalarial action were excluded from analysis.

In the case of ACTs as the treatment consists of 2 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*[7]. 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:

[[[(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 ACTwatch Outlet Survey. 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. Appendix 6.3 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

[7] 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.

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 for the duration of the fieldwork period.[8]

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 the analytical purpose, 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 Supply Chain survey sample

A total of 315 supply sources were listed by retailers censused in the 38 selected Outlet Survey sub-districts, of which 8 (2.5%) referred to local manufacturers, and 37 (12%) were obvious duplicates (a source named by more than one outlet). For 10 (3%) sources, there was too little information on either business name or location for identification, so these sources were removed. Uncertainties around other suppliers' business name or location were clarified by calling suppliers, and in the absence of contact numbers, advice on location was sought from local informants, including SFH staff members and data collectors who had participated in the Outlet Survey data collection. This process identified 211 (67%) additional duplicates, leaving a total of 57 suppliers to form the sample of terminal wholesalers. Out of the 57 terminal level wholesalers identified, 9 were ineligible to participate and 1 could not be located. Among those eligible wholesalers invited to participate, 1 refused, 2 were not interviewed as a suitable respondent was not available following 3 visits, and 1 stopped the interview to indicate that they refer all wholesale customers to their partner branch[9], thus leaving 43 terminal wholesalers who were successfully interviewed. (Table 4.1)

All 43 terminal wholesalers who were successfully interviewed were asked about their top two supply sources for antimalarials. From a total of 69 wholesaler mentions, 26 referred to foreign manufacturers (which are beyond the scope of this study), and the remaining 43 wholesaler mentions referred to 11 unique wholesale businesses, called intermediate-1 wholesalers as they supplied terminal wholesalers, all of whom had already been identified at the terminal level (as they also supplied retailers included in the Outlet Survey sample directly). As these 11 intermediate-1 wholesalers had already been interviewed at the terminal level, an interview was not re-administered; however, a list of intermediate-1 wholesaler suppliers was generated from the responses in the 11 interviews conducted at the terminal level, which identified 4 intermediate-2 wholesalers as they supplied intermediate-1 wholesalers, all of whom had already been identified and interviewed at the terminal level. Repeating this process once again indentified 1 intermediate-3 wholesaler who reported an antimalarial manufacturer as their only supply source. To this effect, the top of the chain was deemed to have been reached with a total of 47 wholesalers that stocked antimalarials identified and 43 interviews completed.

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[8] Outlet Survey data collection took place between April and July 2009 and an average exchange rate of 1 US$ to 5342.47 Zambian Kwacha was used for the calculation of retail absolute mark-ups. Supply Chain Survey data collection took place between 28 February and 6 May 2009 and an average exchange rate of 1 US$ to 5693.71 Zambian Kwacha 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.

[9] This respondent did not rescind consent, so where responses were recorded, these contribute to calculated indicators

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	Number of duplicates[1]	Number not eligible[2]	Number not interviewed for other reasons[3]	Number not found	Number of interviews conducted[4]
Total	-	-	1	0	9	2	1	44
Terminal	57	-	1	0	9	2	1	44
Intermediate-1	11	11	0	0	0	0	0	0
Intermediate-2	4	4	0	0	0	0	0	0
Intermediate-3[5]	1	1	0	0	0	0	0	0

1: Wholesalers included in the initial sample and found to be duplicates during data collection. 2: Outlets not stocking antimalarials or RDTs at the time of the interview or in the preceding 3 months. 3: At terminal level, 2 were not interviewed as a suitable respondent was not available following 3 visits. 4: At terminal level, 1 respondent stopped the interview to indicate that they refer all wholesale customers to their partner branch, resulting in 1 partial interview and 43 completed interviews. 5: This is the top of the chain, defined as the level at which wholesalers who were reported to supply intermediate-2 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. Following the protocol classification, there would be 13 primary suppliers, all of which received supplies from foreign manufacturers.

4.2. Structure of the private commercial sector distribution chain for antimalarial drugs

The structure of the private commercial sector distribution chain for antimalarials in Zambia 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 which 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. 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.

- The observed maximum number of steps from manufacturers' factory gate to retail outlet is 5: manufacturer → intermediate-3 wholesaler → intermediate-2 wholesaler → intermediate-1 wholesaler → terminal wholesaler → retailer.
- All wholesalers surveyed, regardless of supply chain level, were observed to sell directly to retailers and nearly 20% of these also supplied other wholesalers (i.e. horizontal trading)
- There were no observed instances of private sector antimalarial wholesalers or retailers reporting a public sector source as one of their two top suppliers of antimalarials; however, 8 (out of 286) eligible public facilities at outlet level reported a private sector source as one of their two top antimalarial suppliers.

Figure 4.2.1: Representation of the antimalarial distribution chain showing interactions between supply chain levels by mutually exclusive wholesaler category

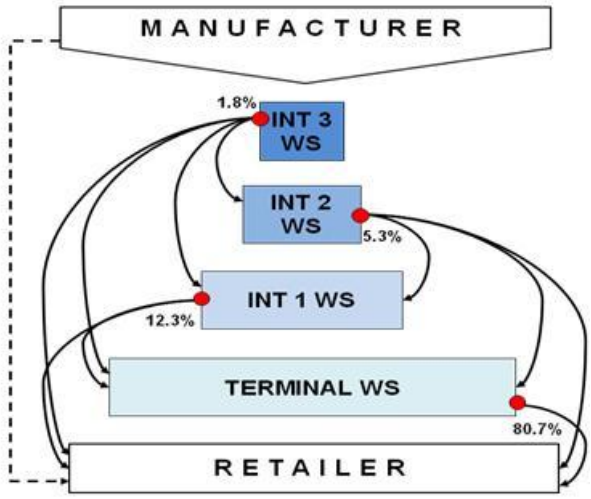

Figure 4.2.2: Representation of the antimalarial distribution chain showing the overlap between wholesaler categories used for analysis

WS: wholesaler; INT: intermediate

Table 4.2: Defining analytical categories from mutually exclusive wholesaler categories

WHOLESALER CATEGORIES	Total number identified	MUTUALLY EXCLUSIVE CATEGORIES				ANALYTICAL CATEGORIES	
		Supplies retailer	Supplies intermediate 1, terminal & retailer	Supplies terminal & retailer	Supplies intermediate 2, intermediate 1, terminal & retailer	Supply Retailers	Supply Wholesalers
% of wholesalers	100%	80.7%	5.3%	12.3%	1.8%	100.0%	19.3%
(N)	(57)	(46)	(3)	(7)	(1)	(57)	(11)

Note: this table presents the number of wholesalers identified and not only those interviewed

4.3. Wholesaler characteristics and business practices

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

- Wholesale businesses ranged in size, with wholesalers that supply retailers being smaller (median of 8 workers) than those supplying other wholesalers (median of 20 workers). Both groups had been in operation for a median of 9 years.
- More than 70% of wholesalers supplying the retail level sold other products alongside pharmaceutical products. The most common consumer goods stocked were toiletries (59% of all wholesalers) and household goods (35% of all wholesalers).

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

CHARACTERISTICS		WHOLESALER CATEGORIES	
		SUPPLY WHOLESALERS	SUPPLY RETAILERS (ALL WHOLESALERS)
Years in operation	**Median** IQR (N)	**8.5** 7-10 (10)	**9** 7-16 (42)
Number of people working at outlet	**Median** IQR (N)	**20** 10-40 (10)	**8** 5-15 (43)
Sells other products in addition to pharmaceuticals[1]	**%** (N)	**40.0** (10)	**70.5** (44)

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

- Private clinics, surgeries or hospitals were the most frequently mentioned customers by wholesalers (83.7%), pharmacies and drug stores (77.2%), and public and mission health facilities (mentioned by 70-75% of wholesalers); nearly 57% of wholesalers reported serving retail customers.
- Only 15% of wholesalers interviewed reported selling antimalarials to customers in other countries; 13% of wholesalers had customers in Zimbabwe, 5% in both DRC and Malawi, and 3% in Mozambique.
- Nearly half (48.8%) of all wholesalers interviewed reported importing antimalarials, while 41.5% identified a manufacturer as one of their two top antimalarial suppliers.
- Two-thirds (67.4%) of all wholesalers reported delivering antimalarials to their customers.
- More than 60% of all wholesalers interviewed had offered credit to customers in the past 3 months, offering a median of 30 days credit (IQR 30-30). Wholesalers operating at the higher levels of the supply chain (i.e. wholesalers supplying wholesalers) were observed to offer comparatively longer credit terms (median of 60 days, IQR 30-60).

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

		WHOLESALER CATEGORIES	
ANTIMALARIAL CUSTOMER TYPES		**SUPPLY WHOLESALERS**	**SUPPLY RETAILERS (ALL WHOLESALERS)**
Retail Customers (e.g. patients, care-takers)	**%** (N)	**20.0** (10)	**56.8** (44)
Retail Outlets			
Pharmacies or drug stores	**%** (N)	**100.0** (10)	**77.2** (44)
General retailers (grocery stores, kiosks, containers, mobile providers, kantembas, etc.)	**%** (N)	**10.0** (10)	**22.7** (44)
Medical Stores Limited[1]	**%** (N)	**50.0** (10)	**21.4** (42)
Public health centres	**%** (N)	**100.0** (10)	**75.0** (44)
Public hospitals	**%** (N)	**80.0** (10)	**70.5** (44)
Private clinics, surgeries or hospitals	**%** (N)	**100.0** (10)	**83.7** (43)
Mission clinics or hospitals	**%** (N)	**80.0** (10)	**72.7** (44)
Wholesale Outlets			
Drug wholesalers	**%** (N)	**90.0**[2] (10)	**50.0** (44)
General wholesalers	**%** (N)	**0.0** (10)	**2.3** (44)
Customers in Other Countries	**%** (N)	**10.0** (10)	**15.0** (40)
BUSINESS PRACTICES		**SUPPLY WHOLESALERS**	**SUPPLY RETAILERS (ALL WHOLESALERS)**
Import antimalarial drugs	**%** (N)	**90.0** (10)	**48.8** (43)
Buy directly from antimalarial manufacturers (as one of two top antimalarial suppliers)	**%** (N)	**90.0** (10)	**41.5** (41)
Deliver antimalarials to customers	**%** (N)	**90.0** (10)	**67.4** (43)
Provided credit to customers in the past 3 months	**%** (N)	**80.0** (10)	**62.8** (43)
Most common terms of credit offered in the past 3 months (number of days)	**Median** IQR (N)	**60** 30-60 (7)	**30** 30-30 (25)

1: Zambia's Medical Stores Limited (MSL) is a government-owned company mandated to stock and distribute all pharmaceuticals, medical supplies and other health commodities procured by or for the Zambian government; 2: One of the ten 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 90.0% rather than 100.0% based on the information reported by respondents.

4.4. Licensing & inspection

- Three-quarters (75.6%) of all wholesalers reported having a wholesale pharmacy license, and nearly a third (28.2%) reported having a retail pharmacy licence.
- Any up-to-date license (i.e. either a retail or wholesale pharmacy license) from the Pharmaceutical Regulatory Authority was observed in 70.0% of all wholesalers, and an up-to-date wholesale pharmacy license was observed in 55.0% of wholesalers.
- While 100% of wholesalers who operated at higher levels of the supply chain (i.e. wholesalers supplying wholesalers) reported having a wholesale license, an up-to-date wholesale license was only observed in 60% of these wholesalers.
- The proportion of wholesalers who reported having an import license is consistently greater or equal to the number of wholesalers who reported that they imported antimalarials: 70% of all wholesalers interviewed reported having an import license while 49% reported importing antimalarials; 90% of wholesalers that supply other wholesalers reported having an import license and the same proportion reported importing antimalarials.
- However, the percentage of wholesalers that reported selling antimalarials directly to retail customers (56.8%) was higher than the percentage of wholesalers that reported having the required license to do so (28.2%).
- Nearly all (97.5%) wholesalers interviewed reported that they had been visited by a pharmaceutical inspector in the past year.

Table 4.4: Licensing & Inspection

REGISTRATION STATUS		WHOLESALER CATEGORIES	
		SUPPLY WHOLESALERS	SUPPLY RETAILERS (ALL WHOLESALERS)
Reported having a license allowing wholesale of pharmaceuticals	% (N)	**100.0** (10)	**75.6** (41)
Reported having a license allowing retail of pharmaceuticals	% (N)	**0.0** (10)	**28.2** (39)
Reported having an import license	% (N)	**90.0** (10)	**70.0** (40)
Reported having a exporter license	% (N)	**0.0** (10)	**0.0** (39)
Reported having a manufacturer license	% (N)	**11.1** (9)	**5.3** (38)
Any up-to-date license from the Pharmaceutical Regulatory Authority was observed[1]	% (N)	**60.0** (10)	**70.0** (40)
An up-to-date wholesale license from the Pharmaceutical Regulatory Authority was observed[1]	% (N)	**60.0** (10)	**55.0** (40)
An up-to-date general business or trading license was observed	% (N)	**80.0** (10)	**86.0** (43)
Reported they had been visited by a pharmaceutical inspector in the past year	% (N)	**100.0** (10)	**97.5** (40)

1: This license may be either a retail or wholesale license

4.5. Knowledge, qualifications and training

- More than three-quarters of wholesalers (76.7%) were able to correctly identify artemether-lumefantrine as the government recommended first-line treatment for uncomplicated malaria.
- However, the percent of wholesalers identifying this drug, or any other ACT, as the most effective medication for treating uncomplicated malaria was somewhat lower (61.9% for children and 69.0% for adults).
- Almost all wholesalers reported employing staff with health qualifications. The most commonly reported health qualifications included pharmacists (90.5% of the 42 wholesalers who answered the question 'do you employ a staff with health qualifications?' reported at least one staff with pharmacist qualifications), followed by pharmacy technologists (78.6%), and dispenser (29.3%).
- The percentage of wholesalers who indicated that staff had participated in in-service training related to malaria treatment in the past 2 years was very low, with only 5% of wholesalers that supply retailers having staff who participated in such training, while no wholesalers that supply wholesalers had staff who participated in such training

Table 4.5: Wholesalers' knowledge, qualifications and training

HEALTH QUALIFICATIONS, TRAINING AND KNOWLEDGE		WHOLESALER CATEGORIES	
		SUPPLY WHOLESALERS	SUPPLY RETAILERS (ALL WHOLESALERS)
Employ a member of staff with health qualifications[1]	% (N)	**100.0** (10)	**97.6** (42)
Employ staff who participated in in-service training related to malaria treatment	% (N)	**0.0** (10)	**4.9** (41)
Identify any ACT as the most effective medication for treating uncomplicated *Pf* malaria in adults	% (N)	**70.0** (10)	**69.0** (42)
Identify any ACT as the most effective medication for treating uncomplicated *Pf* malaria in children	% (N)	**60.0** (10)	**61.9** (42)
Correctly identify the government recommended first line treatment for uncomplicated *Pf* malaria	% (N)	**90.0** (10)	**76.7** (43)

1: Health qualifications included pharmacist, pharmacy technologist, dispenser, medical doctor, nurse, midwife, clinical officer, dental surgeon, laboratory technician, veterinary technician, microbiologist

4.6. Storage of antimalarial drugs

- Almost all wholesalers (97.2%) were observed to store antimalarials in a dry area and out of direct sunlight; although a smaller percentage (91.7%) was observed to keep them off the floor.
- Only 86.1% of all wholesalers met all specified conditions for good storage of antimalarials (in a dry area, out of direct sunlight and off the floor); however, among the wholesalers supplying other wholesalers, 100% complied with all conditions.

Table 4.6: Wholesalers' storage practices

STORAGE		WHOLESALER CATEGORIES	
		SUPPLY WHOLESALERS	SUPPLY RETAILERS (ALL WHOLESALERS)
Store antimalarials in a dry area	**%** (N)	**100.0** (7)	**97.2** (36)
Store antimalarials out of direct sunlight	**%** (N)	**100.0** (7)	**97.2** (36)
Store antimalarials off the floor	**%** (N)	**100.0** (7)	**91.7** (36)
Store antimalarials in a dry area, out of direct sunlight & off the floor	**%** (N)	**100.0** (7)	**86.1** (36)

4.7. Availability of antimalarials & RDTs

- Nearly all wholesalers surveyed (93%) had at least one antimalarial in stock at the time of interview
- More than two-thirds of all wholesalers surveyed (72.1%) had an ACT in stock at the time of interview, and 68.1% of all wholesalers reported having had at least one ACT in stock throughout the three month period prior to interview
- A higher proportion of wholesalers had non-WHO prequalified ACTs in stock (62.8%) compared to WHO prequalified ACTs (44.2%)
- One third of all wholesalers were observed to stock oral AMTs (32.6%) and non-oral AMTs (34.9%); while two-thirds of wholesalers (76.7%) were observed to stock nATs
- Artemether-lumefantrine, the first-line treatment for uncomplicated malaria, was stocked by 67.4% of all wholesalers
- Artemether-lumefantrine was also the most frequently observed antimalarial, accounting for 24.0% of all antimalarial products stocked by wholesalers and 66.3% of all ACTs stocked, followed by sulphadoxine-pyrimethamine (19.9% of all antimalarial products stocked), and artemether monotherapy (15.9% of all antimalarial products stocked, a third of which were oral dosage forms)
- The second most frequently observed ACT stocked by wholesalers after artemether-lumefantrine was artesunate-sulphamethoxypyrazine-pyrimethamine, accounting for 8.9% of all antimalarial products stocked by wholesalers and 24.5% of all ACTs stocked.
- RDTs were stocked by less than a quarter (23.3%) of all wholesalers at the time of interview

Table 4.7: Antimalarial & RDT availability

AVAILABILITY		WHOLESALER CATEGORIES	
		SUPPLY WHOLESALERS	SUPPLY RETAILERS (ALL WHOLESALERS)
Had antimalarials in stock	**%** (N)	**90.0** (10)	**93.0** (43)
Had ACT in stock	**%** (N)	**90.0** (10)	**72.1** (43)
Always had at least one ACT in stock over the past 3 months	**%** (N)	**70.0** (10)	**62.8** (43)
Had WHO prequalified ACT in stock	% (N)	**50.0** (10)	**44.2** (43)
Had non-WHO prequalified ACT in stock	**%** (N)	**70.0** (10)	**62.8** (43)
Had oral AMT in stock	% (N)	**20.0** (10)	**32.6** (43)
Had non-oral AMT in stock	% (N)	**40.0** (10)	**34.9** (43)
Had nAT in stock	% (N)	**50.0** (10)	**76.7** (43)
Had RDT in stock	**%** (N)	**30.0** (10)	**23.3** (43)

4.8. Sales volumes of antimalarials and RDTs

Sales volume data are presented first for all wholesalers (Table 4.8.1) and secondly for only those wholesalers stocking the corresponding product category (Table 4.8.2).

- Among wholesalers who sold antimalarials the week before the survey (n=40), only a quarter (25.0%) of all wholesalers reported the recommended first line treatment for uncomplicated malaria, artemether-lumefantrine (AL), to be their top selling antimalarial, while half (52.5%) of all wholesalers reported sulphadoxine-pyrimethamine (SP) to be their top selling antimalarial.[10]
- However, AL was reported to be the top selling antimalarial drug by 44.4% of wholesalers supplying wholesalers, while SP was the top selling antimalarial among 33.3% of these wholesalers. Another ACT, artesunate-sulphamethoxypyrazine-pyrimethamine, was the third most commonly reported top selling antimalarial within this group of wholesalers (22.2%).
- Among all wholesalers, the median number of adult equivalent treatment doses (AETDs) sold the week preceding the survey was 35.7 (IQR 0.8-176.8) for ACTs and 0 (IQR 0-9.2) for AMT. For nATs, the median number of AETDs sold was 320.9 (IQR 13.3-1260.4). 25% of all wholesalers reported not having sold an ACT during the week preceding the survey, while the figure was 60% for AMTs. In contrast, 75% of all wholesalers reported having sold nATs during the week preceding the survey.
- As expected, the median sales volumes for ACTs among wholesalers that supply other wholesalers (450.0 AETDs, IQR 90.0-1000.0) was higher than that observed among those that supply retailers; but the reverse was observed with respect to nATs, where wholesalers that supply wholesalers were observed to have sold a median of 0 AETDs (IQR 0-8136.7) in the week prior to the survey.
- When ACTs were stocked and sold by wholesalers, the median sales volumes of WHO prequalified ACTs (30.0, IQR 2.0-80.0) were similar to non-WHO prequalified ACTs (35.6, IQR 7.0-239.8); however among wholesalers supplying other wholesalers, the median sales volumes of WHO prequalified ACTs (500.0, IQR 50.0-3721.0) was substantially larger than for non-WHO prequalified ACTs (242.3, IQR 37.5-1000.0).
- Although ACT and nATs were stocked and sold by a similar number of wholesalers (n=31 vs. n=33, respectively), the median sales volumes of nATs (620.0, IQR 61.7-1750.0) was much larger than for ACTs (65.0, IQR 17.0-300.0).
- Although RDTs were not commonly stocked by wholesalers, among those who did stock RDTs, the volume of tests sold varied widely both within and across supply chain levels. Among all wholesalers who stocked RDTs, the median number of tests sold during the week preceding the survey was 0 (IQR 0-250); however, among wholesalers supplying wholesalers, the median number of tests sold was 250 (IQR 0-400).

[10]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			**WHOLESALER CATEGORIES**	
			SUPPLY WHOLESALERS N=9	**SUPPLY RETAILERS (ALL WHOLESALERS) N=40**[2]
All ACT	All	**Median**	**450.0**	**35.7**
		IQR	90.0-1000.0	0.8-176.8
	Tablet	**Median**	**242.3**	**31.0**
		IQR	90.0-500.0	0.0-96.3
	Oral liquid	**Median**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-3.8
WHO prequalified ACT	All products were tablets	**Median**	**2.0**	**0.0**
		IQR	0.0-500.0	0.0-25.0
Non-WHO prequalified ACT	All	**Median**	**90.0**	**7.7**
		IQR	6.0-400.0	0.0-78.4
	Tablet	**Median**	**90.0**	**6.0**
		IQR	6.0-242.3	0.0-43.8
	Oral liquid	**Median**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-3.8
AMT	All	**Median**	**7.0**	**0.0**
		IQR	0.0-172.5	0.0-9.2
	Tablet	**Median**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0
	Oral liquid	**Median**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0
	Injectable	**Median**	**0.0**	**0.0**
		IQR	0.0-41.3	0.0-3.9
nAT	All	**Median**	**0.0**	**320.9**
		IQR	0.0-8136.7	13.3-1260.4
	Tablet	**Median**	**0.0**	**301.6**
		IQR	0.0-8110.0	0.0-1200.0
	Oral liquid	**Median**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-3.4
	Injectable	**Median**	**0.0**	**0.0**
		IQR	0.0-0.0	0.0-0.0
RDT[3] (per unit)		**Median**	**0.0**	**0.0**
		IQR	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 For antimalarials: there were a total of 40 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, 57 wholesalers were identified, of which 14 were excluded from the volumes analysis (9 did not stock antimalarials at the time of interview, 1 refused to participate, 2 were not interviewed because a suitable respondent was not available following 3 visits, 1 could not be located, and 1 stopped the interview to indicate that they refer all wholesale customers to their partner branch). Of the remaining 43 wholesalers successfully interviewed, 1 was excluded from the volume analysis as it did not stock antimalarial at the time of interview, but did at some point in the 3 months prior to interview (Table 1). The volumes for 2 wholesalers were set as missing for all antimalarial categories as they reported stocking antimalarials but no audit sheet information was recorded, leaving the remaining 40 wholesalers included in the volume analysis. Overall, there were a total of 271 antimalarials audited, of which 36 (13.3%) had missing sales volumes that were imputed using the mi impute pmm command. 3 For RDTs, 40 of the 57 wholesalers identified reported that they did not stock RDTs, and 14 reported stocking RDT from whom inventory data were collected from 10 wholesalers for 10 different products (responses were not recorded for 3 wholesalers). Of these, 1 did not provide sales volume information; however imputation was not performed as there were too few observations to reliably perform linear regression. Sales volumes were set as missing for the 4 wholesalers who reported stocking RDTs but from whom inventory data were not collected.

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			**WHOLESALER CATEGORIES**[2]	
			SUPPLY WHOLESALERS	**SUPPLY RETAILERS (ALL WHOLESALERS)**
All ACT	All	**Median**	**450.0**	**65.0**
		IQR	90.0-1000.0	17.0-300.0
		(n)	(9)	(31)
	Tablet	**Median**	**242.3**	**54.0**
		IQR	90.0-500.0	17.0-242.3
		(n)	(9)	(31)
	Oral liquid	**Median**	**487.5**	**3.8**
		IQR	300.0-675.0	1.9-16.9
		(n)	(2)	(19)
WHO prequalified ACT	All products were tablets	**Median**	**500.0**	**30.0**
		IQR	50.0-3721.0	2.0-80.0
		(n)	(5)	(19)
Non-WHO prequalified ACT	All	**Median**	**242.3**	**35.6**
		IQR	37.5-1000.0	7.0-239.8
		(n)	(7)	(27)
	Tablet	**Median**	**100.0**	**31.2**
		IQR	37.5-325.0	6.0-100.0
		(n)	(7)	(26)
	Oral liquid	**Median**	**487.5**	**3.8**
		IQR	300.0-675.0	1.9-16.9
		(n)	(2)	(19)
AMT	All	**Median**	**172.5**	**7.9**
		IQR	18.8-250.0	0.0-34.4
		(n)	(5)	(22)
	Tablet	**Median**	**-**	**6.3**
		IQR	-	0.6-26.6
		(n)	-	(7)
	Oral liquid	**Median**	**75.0**	**1.9**
		IQR	18.8-131.3	0.0-5.9
		(n)	(2)	(13)
	Injectable	**Median**	**145.6**	**7.0**
		IQR	24.1-316.9	1.9-87.5
		(n)	(4)	(15)
nAT	All	**Median**	**8136.7**	**620.0**
		IQR	900.5-10075.0	61.7-1750.0
		(n)	(5)	(33)
	Tablet	**Median**	**8110.0**	**550.0**
		IQR	650.0-10000.0	59.8-1500.0
		(n)	(5)	(32)
	Oral liquid	**Median**	**50.8**	**6.5**
		IQR	26.7-75.0	2.3-24.2
		(n)	(2)	(16)
	Injectable	**Median**	**127.6**	**363.3**
		IQR	4.8-250.5	127.6-3095.2
		(n)	(2)	(4)
RDT (units)		**Median**	**250**	**0**
		IQR	0-400	0-250
		(n)	(3)	(9)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 (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.

- Median wholesale purchase price per AETD ranged from US$ 0.27 (IQR 0.14-2.42) for nATs, and US$ 5.09 (IQR 3.51-7.03) for ACTs, to US$ 8.90 (IQR 4.36-16.49) for AMTs.
- Across different retail outlet types, the median retail purchase price per AETD for ACTs ranged from US$ 0.94 (IQR 0.94-0.94, 1 observation in grocery stores) to US$ 5.62 (IQR 4.44-7.49) in pharmacies; for AMTs from US$ 4.49 (IQR 3.46-5.54) in drug stores to US$ 10.11 (IQR 7.86-19.09) in private health facilities; and for nATs from US$ 0.16 (IQR 0.07-0.27) in grocery stores to US$ 1.12 (IQR 0.19-6.74) in pharmacies. Registered pharmacies and private health facilities tended to have paid higher purchase prices for antimalarials compared to drug stores and grocery stores, however, a higher proportion of the products purchased by registered pharmacies and private health facilities were non-tablets (e.g. suspensions or injectables), paediatric formulations, and 'premium priced' products (i.e. products, such as halofantrine, strategically priced at, or near, the high end of the price range to attract status-conscious consumers). Public health facilities usually did not pay for their antimalarial purchases.
- For AL, the first-line treatment for uncomplicated *Pf* malaria, the median purchase price per AETD was US$ 5.62 (IQR 4.42-7.99) at pharmacies, US$ 5.24 (IQR 4.12-8.98) at private health facilities, US$ 1.50 (IQR 1.07-2.50) at drug stores, and US$ 0.94 (IQR 0.94-0.94) at grocery stores; at the wholesale level supplying retailers, median purchase price was US$ 5.29 (IQR 3.51-8.66) and US$ 4.90 (IQR 3.51-7.96) at the level supplying wholesalers.
- For SP, the antimalarial with the highest number of AETDs distributed, the median purchase price per AETD was US$ 0.19 (IQR 0.17-0.28) at pharmacies, US$ 0.12 (IQR 0.09-0.22) at private health facilities, US$ 0.19 (IQR 0.12-0.28) at drug stores, and US$ 0.14 (IQR 0.05-0.16) at grocery stores; at the wholesale level, median purchase price was US$ 0.14 (IQR 0.09-0.20).
- As expected, median purchase prices tended to be higher for oral liquids than tablets for ACTs, AMTs and nATs; and higher still on injectables for both AMTs and nATs.
- Wholesalers supplying retailers reported purchasing 1 RDT unit at US$ 5.19 (IQR 2.85-7.56) and wholesalers supplying wholesalers at US$ 3.06 (IQR 3.06-3.06).

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

ANTIMALARIAL TYPE[1] Formulation			**WHOLESALER CATEGORIES**	
			SUPPLY WHOLESALERS N=9	**SUPPLY RETAILERS (ALL WHOLESALERS) N=40**
All ACT	All	**Median**	**4.14**	**5.09**
		IQR	3.51-5.44	3.51-7.03
		(n)	(7)	(58)
	Tablet	**Median**	**3.92**	**4.35**
		IQR	3.51-4.14	3.16-5.27
		(n)	(5)	(41)
	Oral liquid	**Median**	**6.43**	**9.13**
		IQR	4.90-7.96	7.03-12.18
		(n)	(2)	(17)
WHO prequalified ACT	All products were tablets	**Median**	**3.51**	**4.92**
		IQR	3.51-3.51	4.04-5.62
		(n)	(1)	(13)
Non WHO prequalified ACT	All	**Median**	**4.52**	**5.27**
		IQR	3.92-5.44	3.34-8.66
		(n)	(6)	(45)
	Tablet	**Median**	**4.03**	**3.80**
		IQR	3.48-4.79	3.16-5.09
		(n)	(4)	(28)
	Oral liquid	**Median**	**6.43**	**9.13**
		IQR	4.90-7.96	7.03-12.18
		(n)	(2)	(17)
AMT	All	**Median**	**16.22**	**8.90**
		IQR	9.93-22.51	4.36-16.49
		(n)	(2)	(32)
	Tablet	**Median**	-	**4.22**
		IQR	-	3.65-5.20
		(n)	-	(9)
	Oral liquid	**Median**	-	**6.43**
		IQR	-	4.65-10.40
		(n)	-	(8)
	Injectable	**Median**	**16.22**	**16.11**
		IQR	9.93-22.51	10.75-46.37
		(n)	(2)	(15)
nAT	All	**Median**	**4.33**	**0.27**
		IQR	4.33-4.33	0.14-2.42
		(n)	(1)	(51)
	Tablet	**Median**	**4.33**	**0.20**
		IQR	4.33-4.33	0.13-0.74
		(n)	(1)	(41)
	Oral liquid	**Median**	-	**2.63**
		IQR	-	1.90-7.38
		(n)	-	(9)
	Injectable	**Median**	-	**3.69**
		IQR	-	3.69-3.69
		(n)	-	(1)
RDT (per unit)		**Median**	**3.06**	**5.19**
		IQR	(3.06-3.06)	(2.85-7.56)
		(n)	(1)	(4)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria.

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

ANTIMALARIAL TYPE[1] Formulation			RETAILER CATEGORIES[2]				
			PHARMACIES N=39	PRIVATE HEALTH FACILITIES N=27	DRUG STORES N=92	GROCERY STORES N=33	PUBLIC HEALTH FACILITIES N=160
All ACT	All	**Median**	**5.62**	**5.24**	**1.50**	**0.94**	**0.00**
		IQR	4.44-7.49	3.93-9.48	1.07-2.50	0.94-0.94	0.00-0.00
		(n)	(123)	(22)	(15)	(1)	(459)
	Tablet	**Median**	**5.52**	**5.24**	**1.12**	**0.94**	**0.00**
		IQR	4.12-6.74	3.93-6.55	1.07-1.87	0.94-0.94	0.00-0.00
		(n)	(96)	(16)	(12)	(1)	(457)
	Oral liquid	**Median**	**8.74**	**9.48**	**2.50**	**-**	**3.74**
		IQR	8.04-11.36	7.99-9.48	2.50-3.69	-	0.00-3.74
		(n)	(27)	(6)	(3)	-	(2)
WHO prequalified ACT	All products were tablets	**Median**	**5.62**	**5.24**	**1.12**	**0.94**	**0.00**
		IQR	5.62-7.49	2.81-5.99	1.07-1.87	0.94-0.94	0.00-0.00
		(n)	(28)	(7)	(12)	(1)	(453)
Non WHO prequalified ACT	All	**Median**	**5.52**	**5.99**	**2.50**	**-**	**0.00**
		IQR	4.02-8.61	4.68-9.48	2.50-3.69	-	0.00-3.74
		(n)	(95)	(15)	(3)	-	(6)
	Tablet	**Median**	**4.68**	**5.24**	**-**	**-**	**0.00**
		IQR	3.46-6.16	3.93-7.30	-	-	0.00-0.00
		(n)	(68)	(9)	-	-	(4)
	Oral liquid	**Median**	**8.74**	**9.48**	**2.50**	**-**	**3.74**
		IQR	8.04-11.36	7.99-9.48	2.50-3.69	-	0.00-3.74
		(n)	(27)	(6)	(3)	-	(2)
AMT	All	**Median**	**9.66**	**10.11**	**4.49**	**-**	**0.00**
		IQR	5.39-14.60	7.86-19.09	3.46-5.54	-	0.00-0.00
		(n)	(49)	(10)	(5)	-	(6)
	Tablet	**Median**	**3.74**	**-**	**5.54**	**-**	**0.00**
		IQR	2.70-5.14	-	3.46-5.54	-	0.00-0.00
		(n)	(9)	-	(3)	-	(4)
	Oral liquid	**Median**	**11.53**	**8.98**	**4.49**	**-**	**0.00**
		IQR	6.46-13.98	7.19-8.98	4.49-4.49	-	0.00-0.00
		(n)	(18)	(2)	(1)	-	(1)
	Injectable	**Median**	**11.23**	**10.11**	**44.92**	**-**	**0.00**
		IQR	5.39-15.72	7.86-19.09	44.92-44.92	-	0.00-0.00
		(n)	(22)	(8)	(1)	-	(1)
nAT	All	**Median**	**1.12**	**0.39**	**0.23**	**0.16**	**0.00**
		IQR	0.19-6.74	0.10-2.53	0.14-0.37	0.07-0.27	0.00-0.00
		(n)	(113)	(54)	(154)	(33)	(348)
	Tablet	**Median**	**0.28**	**0.19**	**0.22**	**0.16**	**0.00**
		IQR	0.17-2.83	0.10-0.94	0.13-0.37	0.07-0.27	0.00-0.00
		(n)	(78)	(39)	(141)	(33)	(261)
	Oral liquid	**Median**	**2.13**	**2.81**	**2.25**	**-**	**0.00**
		IQR	1.40-8.25	2.81-6.68	1.68-5.62	-	0.00-9.83
		(n)	(29)	(6)	(13)	-	(9)
	Injectable	**Median**	**11.79**	**5.90**	**-**	**-**	**0.00**
		IQR	7.08-11.79	2.95-6.29	-	-	0.00-0.00
		(n)	(6)	(9)	-	-	(78)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 As these are weighted medians, medians are not the average of the middle two ordered observations for instances where there are an even number of observations. Note: 22 of 1783 (1.2%) purchase price observations (9 in pharmacies, 5 in private health facilities, 7 in drug stores, 1 in grocery stores) were set to missing due to mark-ups in excess of 1000% which were likely due to errors during data collection. Data collected by the ACTwatch Group during the Zambia 2009 Outlet Survey. www.actwatch.info

4.10. Price mark-ups on antimalarials and RDTs

4.10.1. Percent Mark-Ups on Antimalarials and RDTs[11]

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 percentage mark-up was calculated using the retail selling price and purchase price collected during the ACTwatch Outlet Survey.

Wholesale level

- Wholesale-level mid percent mark-ups ranged from 18.8%-28.6% across all antimalarial categories.
- Wholesalers supplying wholesalers did not commonly vary their prices according to volume purchased; of a total of 54 audited products, 51 had wholesale price data, and for only 3 (5.9%) did price vary with volume. However, in these 3 cases it was not possible to calculate mark-ups because no purchase prices were recorded. The remaining audited products had prices that did not vary hence the mid, low and high mark-ups are the same. Among wholesalers supplying retailers, there were 271 audited products in total, of which 259 had wholesale price data, and 42 (16.2%) products were audited where price varied with volume.
- The mid wholesaler mark up was 26.7% (IQR 20.0-39.5) on ACT, 18.8% (IQR 12.5-24.0) on WHO prequalified ACTs, 28.6% (IQR 24.0-42.9) on non-WHO prequalified ACTs, 26.1% (IQR 18.0-33.8) on AMT and 24.7% (IQR 13.0-50.0) on nATs. Wholesalers supplying retailers reported lower mark ups than wholesalers supplying wholesalers on ACTs, which was driven mainly by mark-ups for non-WHO prequalified products.
- The median wholesaler mid percent mark up on RDTs was 47.5% (IQR 35.3-85.2) among all wholesalers.

Retail level

- Retail level percent mark-ups ranged from 42.9%-233.3% across outlet types and all antimalarial categories, and were observed to be generally higher than wholesale-level percent mark-ups.
- Although public health facilities were observed to apply very high percentage mark-ups on some antimalarial drug categories, it was relatively rare to encounter drugs for which there was a charge in public health facilities.
- At the private sector retail level, observed median mark-ups varied considerably both across outlet type and antimalarial category, ranging from about 30% to 200%; however, retail pharmacies were observed to consistently add the lowest mark-ups across different antimalarial types (mark-up of around 40-80%).
- Across different retail outlet types, the median mark-up on ACT ranged between 42.9% (IQR 37.0-66.7) in pharmacies and 200.0% (IQR 84.6-248.8) at drug stores; on AMT between 33.3% (IQR 13.5-54.1) at drug stores and 200.9% (IQR 38.9-328.6) at private health facilities; on nAT between 81.8% (IQR 44.4-150.0) at pharmacies and 114.3% (IQR 64.5-212.5) at drug stores.

First-line and most popular treatment

- For AL, the first-line treatment for uncomplicated malaria, median percent mark-up was 42.9% (IQR 37.0-66.7) at pharmacies, 71.4% (IQR 47.4-78.6) at private health facilities, and 200.0% (IQR 84.6-248.8) at drug stores; at wholesale level, median mid percent mark-up was 19.4% (IQR 10.0-32.4) among wholesalers supplying wholesalers, and 24.0% (IQR18.8-34.6) among wholesalers supplying retailers.
- For SP, the antimalarial with the highest number of AETDs distributed, median percent mark-up was 150.0% (IQR 66.7-156.4) at pharmacies, 100.0% (IQR 0-334.8) at private health facilities, 114.3% (IQR 69.5-233.3) at drug stores, and 150.0% (IQR 76.5-525.0) at grocery stores; at wholesale levels, median mid percent mark-up was 23.9% (IQR 11.1-58.2) among all wholesalers.

[11] Negative % mark-ups were recorded in several cases. There are a number of potential explanations for this: (1) these may be data collection errors (it was noted during training/fieldwork that antimalarials bought in relatively large pack sizes and sold by the tablet (i.e. chloroquine) were subject to frequent errors); (2) some businesses may have applied negative mark ups as they sold products at lower prices than they bought them 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.

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

ANTIMALARIAL TYPE[1] Formulation			WHOLESALER CATEGORIES					
			SUPPLY WHOLESALERS N=9			SUPPLY RETAILERS (ALL WHOLESALERS) N=40		
			MID	LOW	HIGH	MID	LOW	HIGH
All ACT	All	**Median**	**32.4**	**32.4**	**32.4**	**26.7**	**24.2**	**30.0**
		IQR	19.4-65.3	19.4-65.3	19.4-65.3	20.0-39.5	17.5-34.6	21.7-42.9
		(n)		(7)			(58)	
	Tablet	**Median**	**61.4**	**61.4**	**61.4**	**24.2**	**22.2**	**29.0**
		IQR	27.3-65.3	27.3-65.3	27.3-65.3	18.8-34.6	14.3-34.6	21.7-40.0
		(n)		(5)			(41)	
	Oral liquid	**Median**	**25.9**	**25.9**	**25.9**	**29.7**	**27.4**	**30.2**
		IQR	19.4-32.4	19.4-32.4	19.4-32.4	25.0-42.9	23.5-42.9	25.0-42.9
		(n)		(2)			(17)	
WHO prequalified ACT	All products were tablets	**Median**	**10.0**	**10.0**	**10.0**	**18.8**	**14.3**	**21.7**
		IQR	10.0-10.0	10.0-10.0	10.0-10.0	12.5-24.0	12.5-21.7	14.3-30.0
		(n)		(1)			(13)	
Non WHO prequalified ACT	All	**Median**	**46.9**	**46.9**	**46.9**	**28.6**	**27.3**	**30.6**
		IQR	27.3-65.3	27.3-65.3	27.3-65.3	24.0-42.9	20.0-42.9	25.0-44.4
		(n)		(6)			(45)	
	Tablet	**Median**	**63.4**	**63.4**	**63.4**	**28.0**	**26.2**	**30.6**
		IQR	44.4-66.5	44.4-66.5	44.4-66.5	23.0-43.7	17.6-43.7	24.3-45.4
		(n)		(4)			(28)	
	Oral liquid	**Median**	**25.9**	**25.9**	**25.9**	**29.7**	**27.4**	**30.2**
		IQR	19.4-32.4	19.4-32.4	19.4-32.4	25.0-42.9	23.5-42.9	25.0-42.9
		(n)		(2)		(17)	(17)	(17)
AMT	All	**Median**	**7.5**	**7.5**	**7.5**	**26.1**	**24.0**	**29.3**
		IQR	6.7-8.2	6.7-8.2	6.7-8.2	18.0-33.8	17.7-32.5	18.0-37.6
		(n)		(2)			(32)	
	Tablet	**Median**	-	-	-	**25.5**	**21.6**	**32.1**
		IQR	-	-	-	21.6-42.5	19.4-35.0	21.6-50.0
		(n)		-			(9)	
	Oral liquid	**Median**	-	-	-	**31.0**	**27.5**	**34.2**
		IQR	-	-	-	20.6-35.0	18.1-32.5	20.8-40.3
		(n)		-			(8)	
	Injectable	**Median**	**7.5**	**7.5**	**7.5**	**25.0**	**22.1**	**25.0**
		IQR	6.7-8.2	6.7-8.2	6.7-8.2	11.1-33.0	11.1-30.0	11.1-34.6
		(n)		(2)			(15)	
nAT	All	**Median**	**82.8**	**82.8**	**82.8**	**24.7**	**22.7**	**25.0**
		IQR	82.8-82.8	82.8-82.8	82.8-82.8	13.0-50.0	12.5-50.0	13.0-50.0
		(n)		(1)		(53)	(53)	(53)
	Tablet	**Median**	**82.8**	**82.8**	**82.8**	**24.7**	**22.7**	**27.7**
		IQR	82.8-82.8	82.8-82.8	82.8-82.8	14.6-50.0	12.5-50.0	14.6-50.0
		(n)		(1)			(43)	
	Oral liquid	**Median**	-	-	-	**25.0**	**24.9**	**25.0**
		IQR	-	-	-	13.0-50.0	13.0-50.0	13.0-50.0
		(n)		-			(9)	
	Injectable	**Median**	-	-	-	**-84.0**	**-84.0**	**-84.0**
		IQR	-	-	-	-84.0--84.0	-84.0--84.0	-84.0--84.0
		(n)		-			(1)	
RDT (per unit)		**Median**	**51.7**	**51.7**	**51.7**	**47.5**	**47.5**	**47.5**
		IQR	51.7-51.7	51.7-51.7	51.7-51.7	35.3-85.2	34.2-85.2	36.5-85.2
		(n)	(1)	(1)	(1)		(4)	

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria.

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

ANTIMALARIAL TYPE[1] Formulation			RETAILER CATEGORIES[2]				
			PHARMACIES N=39	PRIVATE HEALTH FACILITIES N=27	DRUG STORES N=92	GROCERY STORES N=32	PUBLIC HEALTH FACILITIES N=158
All ACT	All	**Median**	**42.9**	**71.4**	**200.0**	**150.0**	**0.0**
		IQR	37.0-66.7	47.4-89.7	84.6-248.8	150.0-150.0	0.0-0.0
		(n)	(122)	(22)	(15)	(1)	(456)
	Tablet	**Median**	**42.9**	**71.4**	**233.3**	**150.0**	**0.0**
		IQR	36.4-66.7	33.3-89.7	84.6-248.8	150.0-150.0	0.0-0.0
		(n)	(95)	(16)	(12)	(1)	(454)
	Oral liquid	**Median**	**42.9**	**71.4**	**100.0**	**-**	**33.3**
		IQR	42.1-59.1	47.4-94.4	1.4-200.0	-	0.0-33.3
		(n)	(27)	(6)	(3)	-	(2)
WHO prequalified ACT	All products were tablets	**Median**	**50.0**	**71.4**	**233.3**	**150.0**	**0.0**
		IQR	30.0-66.7	50.0-71.9	84.6-248.8	150.0-150.0	0.0-0.0
		(n)	(28)	(7)	(12)	(1)	(450)
Non WHO prequalified ACT	All	**Median**	**42.9**	**78.6**	**100.0**	**-**	**0.0**
		IQR	40.0-59.1	47.4-89.7	1.4-200.0	-	0.0-33.3
		(n)	(94)	(15)	(3)	-	(6)
	Tablet	**Median**	**42.9**	**78.6**	**-**	**-**	**0.0**
		IQR	37.0-66.7	23.1-89.7	-	-	0.0-0.0
		(n)	(67)	(9)	-	-	(4)
	Oral liquid	**Median**	**42.9**	**71.4**	**100.0**	**-**	**33.3**
		IQR	42.1-59.1	47.4-94.4	1.4-200.0	-	0.0-33.3
		(n)	(27)	(6)	(3)	-	(2)
AMT	All	**Median**	**44.4**	**200.9**	**33.3**	**-**	**0.0**
		IQR	38.5-109.3	38.9-328.6	13.5-54.1	-	0.0-0.0
		(n)	(49)	(10)	(5)	-	(5)
	Tablet	**Median**	**36.4**	**-**	**54.1**	**-**	**0.0**
		IQR	32.0-42.9	-	13.5-54.1	-	0.0-0.0
		(n)	(9)	-	(3)	-	(3)
	Oral liquid	**Median**	**42.9**	**0.0**	**33.3**	**-**	**0.0**
		IQR	40.6-83.7	0.0-66.7	33.3-33.3	-	0.0-0.0
		(n)	(18)	(2)	(1)	-	(1)
	Injectable	**Median**	**66.7**	**233.3**	**60.0**	**-**	**0.0**
		IQR	42.9-295.8	53.8-328.6	60.0-60.0	-	0.0-0.0
		(n)	(22)	(8)	(1)	-	(1)
nAT	All	**Median**	**81.8**	**100.0**	**114.3**	**100.0**	**0.0**
		IQR	44.4-150.0	25.0-396.0	64.5-212.5	51.5-257.1	0.0-0.0
		(n)	(113)	(54)	(154)	(32)	(346)
	Tablet	**Median**	**87.5**	**100.0**	**114.3**	**100.0**	**0.0**
		IQR	48.1-150.0	25.0-328.6	69.5-228.9	51.5-257.1	0.0-0.0
		(n)	(78)	(39)	(141)	(32)	(259)
	Oral liquid	**Median**	**66.7**	**40.0**	**50.0**	**-**	**0.0**
		IQR	42.9-88.9	17.6-100.0	50.0-75.0	-	0.0-33.3
		(n)	(29)	(6)	(13)	-	(9)
	Injectable	**Median**	**66.7**	**400.0**	**-**	**-**	**0.0**
		IQR	38.9-66.7	100.0-500.0	-	-	0.0-0.0
		(n)	(6)	(9)	-	-	(78)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 As these are weighted medians, medians are not the average of the middle two ordered observations for instances where there are an even number of observations. Note: 22 of 1783 (1.2%) mark-ups observations (9 in pharmacies, 5 in private health facilities, 7 in drug stores, 1 in grocery stores) were set to missing due to mark-ups in excess of 1000% which were likely due to errors during data collection. Data collected by the ACTwatch Group during the Zambia 2009 Outlet Survey. www.actwatch.info

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.

Wholesale level

- The mid wholesaler mark-up was US$ 1.58 (IQR 0.88-2.58) on ACT, US$ 0.88 (IQR 0.76-1.05) on WHO prequalified ACT, US$ 1.64 (IQR 0.94-2.71) on non-WHO prequalified ACT, US$ 2.20 (IQR 0.98-5.48) on AMT and US$ 0.14 (IQR 0.02-0.59) on nAT.
- As noted in section 4.10.1, for wholesalers supplying wholesalers none of the 51 audited products with mark-up data exhibited selling price variation, so mid, low and high mark-ups are the same. Among wholesalers supplying retailers, a total of 271 products were audited, of which 259 had wholesale price data, and 42 (16.2%) products were audited where price varied with volume.
- The median wholesaler mid mark up on RDTs was US$ 2.38 (IQR 1.15-6.22).

Retail level

- Across different retail outlet types, the median mark-up on ACT ranged between US$ 1.40 (IQR 1.40-1.40) at grocery stores and US$ 4.12 (IQR 2.06-5.99) at private health facilities; on AMT between US$ 1.50 (IQR 0.75-1.87) at drug stores and US$ 25.16 (IQR 16.25-25.83) at private health facilities; and on nAT between US$ 0.17 (IQR 0.12-0.28) at grocery stores and US$ 0.67 (IQR 0.28-2.83) at pharmacies.
- Registered pharmacies and private health facilities tended to have higher absolute mark-ups for antimalarials compared to drug stores and grocery stores, however, a higher proportion of the products purchased by registered pharmacies and private health facilities were non-tablets (e.g. suspensions or injectables), paediatric formulations, and 'premium priced' products (e.g. halofantrine).

First line and most popular treatment

- For AL, the first-line treatment for uncomplicated *Pf* malaria, the median absolute mark-up was US$ 2.99 (IQR 1.87-3.74) at pharmacies, US$ 4.31 (IQR 2.81-5.99) at private health facilities, US$ 2.67 (IQR 1.37-3.77) at drug stores, and US$ 1.40 (IQR 1.40-1.40) at grocery stores; at the wholesale level supplying retailers, median mid absolute mark-up was US$ 1.32 (IQR 0.79-2.58) and US$ 0.95 (IQR 0.35-2.58) at the level supplying wholesalers.
- For SP, the antimalarial with the highest number of AETDs distributed, the median absolute mark-up was US$ 0.28 (IQR 0.17-0.39) at pharmacies, US$ 0.28 (IQR 0.00-0.43) at private health facilities, US$ 0.25 (IQR 0.17-0.30) at drug stores, and US$ 0.17 (IQR 0.12-0.28) at grocery stores; at the wholesale level, median mid absolute mark-up was US$ 0.03 (IQR 0.02-0.12).

Table 4.10.2.2: Absolute price mark ups on antimalarials and RDTs, wholesale level (US$)

ANTIMALARIAL TYPE[1] Formulation			WHOLESALER CATEGORIES					
			SUPPLY WHOLESALERS N=9			SUPPLY RETAILERS (ALL WHOLESALERS) N=40		
			MID	LOW	HIGH	MID	LOW	HIGH
All ACT	All	**Median**	**2.41**	**2.41**	**2.41**	**1.58**	**1.58**	**1.58**
		IQR	0.83-2.71	0.83-2.71	0.83-2.71	0.88-2.58	0.79-2.58	0.88-2.71
		(n)		(7)			(58)	
	Tablet	**Median**	**2.41**	**2.41**	**2.41**	**1.05**	**0.88**	**1.41**
		IQR	0.83-2.71	0.83-2.71	0.83-2.71	0.79-1.58	0.63-1.58	0.88-1.58
		(n)		(5)			(41)	
	Oral liquid	**Median**	**1.76**	**1.76**	**1.76**	**2.81**	**2.81**	**3.04**
		IQR	0.95-2.58	0.95-2.58	0.95-2.58	1.88-4.68	1.65-4.68	2.11-4.68
		(n)		(2)			(17)	
WHO prequalified ACT	All products were tablets	**Median**	**0.35**	**0.35**	**0.35**	**0.88**	**0.88**	**0.88**
		IQR	0.35-0.35	0.35-0.35	0.35-0.35	0.76-1.05	0.55-0.88	0.88-1.41
		(n)		(1)			(13)	
Non WHO prequalified ACT	All	**Median**	**2.49**	**2.49**	**2.49**	**1.64**	**1.64**	**1.64**
		IQR	0.95-2.71	0.95-2.71	0.95-2.71	0.94-2.71	0.88-2.71	0.97-2.81
		(n)		(6)			(45)	
	Tablet	**Median**	**2.56**	**2.56**	**2.56**	**1.36**	**1.23**	**1.49**
		IQR	1.62-3.20	1.62-3.20	1.62-3.20	0.79-2.15	0.75-2.15	0.85-2.15
		(n)		(4)			(28)	
	Oral liquid	**Median**	**1.76**	**1.76**	**1.76**	**2.81**	**2.81**	**3.04**
		IQR	0.95-2.58	0.95-2.58	0.95-2.58	1.88-4.68	1.65-4.68	2.11-4.68
		(n)		(2)			(17)	
AMT	All	**Median**	**1.17**	**1.17**	**1.17**	**2.20**	**1.86**	**2.53**
		IQR	0.82-1.52	0.82-1.52	0.82-1.52	0.98-5.48	0.84-5.48	0.98-5.48
		(n)		(2)			(32)	
	Tablet	**Median**	-	-	-	**1.12**	**1.12**	**1.41**
		IQR	-	-	-	0.84-2.01	0.84-1.76	0.84-2.53
		(n)		-			(9)	
	Oral liquid	**Median**	-	-	-	**1.47**	**1.31**	**1.62**
		IQR	-	-	-	1.02-4.71	0.97-4.36	1.08-5.06
		(n)		-			(8)	
	Injectable	**Median**	**1.17**	**1.17**	**1.17**	**4.22**	**4.22**	**4.22**
		IQR	0.82-1.52	0.82-1.52	0.82-1.52	1.52-14.05	1.52-13.70	1.52-14.05
		(n)		(2)			(15)	
nAT	All	**Median**	**3.59**	**3.59**	**3.59**	**0.14**	**0.12**	**0.14**
		IQR	3.59-3.59	3.59-3.59	3.59-3.59	0.02-0.59	0.02-0.59	0.02-0.59
		(n)		(1)			(50)	
	Tablet	**Median**	**3.59**	**3.59**	**3.59**	**0.05**	**0.04**	**0.05**
		IQR	3.59-3.59	3.59-3.59	3.59-3.59	0.02-0.33	0.02-0.28	0.02-0.37
		(n)		(1)			(40)	
	Oral liquid	**Median**	-	-	-	**0.79**	**0.79**	**0.79**
		IQR	-	-	-	0.32-1.58	0.32-1.58	0.32-1.58
		(n)		-			(9)	
	Injectable	**Median**	-	-	-	**-3.10**	**-3.10**	**-3.10**
		IQR	-	-	-	-3.10--3.10	-3.10--3.10	-3.10--3.10
		(n)		-			(1)	
RDT (per unit)		**Median**	**1.58**	**1.58**	**1.58**	**2.38**	**2.38**	**2.38**
		IQR	1.58-1.58	1.58-1.58	1.58-1.58	1.15-6.22	1.12-6.22	1.18-6.22
		(n)		(1)			(4)	

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria.

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

ANTIMALARIAL TYPE[1] Formulation			RETAILER CATEGORIES[2]				
			PHARMACIES N=39	PRIVATE HEALTH FACILITIES N=27	DRUG STORES N=92	GROCERY STORES N=33	PUBLIC HEALTH FACILITIES N=160
All ACT	All	**Median**	**2.81**	**4.12**	**2.67**	**1.40**	**0.00**
		IQR	1.87-3.74	2.06-5.99	1.37-3.77	1.40-1.40	0.00-0.00
		(n)	(122)	(22)	(15)	(1)	(459)
	Tablet	**Median**	**2.47**	**3.93**	**2.67**	**1.40**	**0.00**
		IQR	1.72-3.74	1.87-4.31	1.37-3.77	1.40-1.40	0.00-0.00
		(n)	(95)	(16)	(12)	(1)	(457)
	Oral liquid	**Median**	**4.87**	**6.49**	**2.50**	**-**	**1.25**
		IQR	3.74-6.49	4.49-8.49	0.05-4.99	-	0.00-1.25
		(n)	(27)	(6)	(3)	-	(2)
WHO prequalified ACT	All products were tablets	**Median**	**2.99**	**4.31**	**2.67**	**1.40**	**0.00**
		IQR	1.87-3.74	2.81-4.31	1.37-3.77	1.40-1.40	0.00-0.00
		(n)	(28)	(7)	(12)	(1)	(453)
Non WHO prequalified ACT	All	**Median**	**2.81**	**4.12**	**2.50**	**-**	**0.00**
		IQR	1.87-4.12	2.06-6.49	0.05-4.99	-	0.00-1.25
		(n)	(94)	(15)	(3)	-	(6)
	Tablet	**Median**	**2.25**	**3.93**	**-**	**-**	**0.00**
		IQR	1.59-2.99	1.68-4.12	-	-	0.00-0.00
		(n)	(67)	(9)	-	-	(4)
	Oral liquid	**Median**	**4.87**	**6.49**	**2.50**	**-**	**1.25**
		IQR	3.74-6.49	4.49-8.49	0.05-4.99	-	0.00-1.25
		(n)	(27)	(6)	(3)	-	(2)
AMT	All	**Median**	**6.74**	**25.16**	**1.50**	**-**	**0.00**
		IQR	2.92-12.28	16.25-25.83	0.75-1.87	-	0.00-0.00
		(n)	(49)	(10)	(5)	-	(6)
	Tablet	**Median**	**1.46**	**-**	**1.87**	**-**	**0.00**
		IQR	1.20-2.20	-	0.75-1.87	-	0.00-0.00
		(n)	(9)	-	(3)	-	(4)
	Oral liquid	**Median**	**5.77**	**0.00**	**1.50**	**-**	**0.00**
		IQR	3.49-11.23	0.00-4.79	1.50-1.50	-	0.00-0.00
		(n)	(18)	(2)	(1)	-	(1)
	Injectable	**Median**	**10.56**	**25.83**	**26.95**	**-**	**0.00**
		IQR	6.74-15.95	23.58-25.83	26.95-26.95	-	0.00-0.00
		(n)	(22)	(8)	(1)	-	(1)
nAT	All	**Median**	**0.67**	**0.45**	**0.26**	**0.17**	**0.00**
		IQR	0.28-2.83	0.19-2.28	0.19-0.33	0.12-0.28	0.00-0.00
		(n)	(113)	(54)	(154)	(33)	(348)
	Tablet	**Median**	**0.32**	**0.29**	**0.25**	**0.17**	**0.00**
		IQR	0.20-1.57	0.09-0.72	0.19-0.31	0.12-0.28	0.00-0.00
		(n)	(78)	(39)	(141)	(33)	(261)
	Oral liquid	**Median**	**1.50**	**1.18**	**2.25**	**-**	**0.00**
		IQR	0.90-3.93	1.12-2.53	1.12-3.65	-	0.00-3.28
		(n)	(29)	(6)	(13)	-	(9)
	Injectable	**Median**	**7.86**	**19.65**	**-**	**-**	**0.00**
		IQR	2.75-7.86	4.07-29.48	-	-	0.00-0.00
		(n)	(6)	(9)	-	-	(78)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 As these are weighted medians, medians are not the average of the middle two ordered observations for instances where there are an even number of observations. Note: 22 of 1783 (1.2%) mark-ups observations (9 in pharmacies, 5 in private health facilities, 7 in drug stores, 1 in grocery stores) were set to missing due to mark-ups in excess of 1000% which were likely due to errors during data collection. Data collected by the ACTwatch Group during the Zambia 2009 Outlet Survey. www.actwatch.info

5. Discussion

Supply Chain Structure and Wholesaler Characteristics

Broad-based pyramidal structure of private sector distribution chain: As in other low income countries, the private commercial sector distribution chain in Zambia had a pyramidal shape with a very broad base (i.e. there are many distributors at the lower level of the chain) and narrowed considerably at the top (i.e. there are very few operating at the top of the chain). While all of the wholesalers indentified were observed to supply retailers directly (80% of whom were observed to supply retailers only), we also found that nearly a fifth of these (19.3%) were supplying other wholesalers and operated across 4 overlapping levels (intermediate-3 wholesalers, intermediate-2 wholesalers, intermediate-1 and terminal wholesalers).

Number of steps: The maximum number of steps from manufacturers' factory gate to retailers could be as high as 5 (manufacturer → intermediate-3 wholesaler → intermediate-2 wholesaler → intermediate-1 wholesaler → terminal wholesaler → retailer). However, as all of the wholesalers who operated at the higher levels of the supply chain (i.e. wholesalers supplying wholesaler) were already identified at the terminal level and because a high proportion of wholesalers identified a manufacturer as one of their top antimalarial suppliers (41.5% of all wholesalers; 90% of wholesalers that supply other wholesalers), it is likely that most antimalarials passed through 2 steps (manufacturer → terminal wholesaler → retailer), or a maximum of 3 (manufacturer → intermediate-1 wholesaler → terminal wholesaler → retailer).

Factors that could explain the distribution chain structure: The lack of local manufacturing capacity for antimalarials in Zambia is an important factor that likely drives many wholesalers to purchase directly from foreign manufacturers. [4] Our survey showed that a large proportion of wholesalers (70%) reported having a license to import pharmaceuticals, and this license was observed in around half of all wholesalers. Data from the ACTwatch Outlet Survey data indicates that the vast majority of antimalarials observed in the country (95%) were manufactured elsewhere. However, entering the market as an antimalarial importer in Zambia could be particularly difficult as it is more challenging to cultivate relationships with foreign suppliers (often leading to sole distributorships [4]) and importing incurs high transaction costs, particularly as Zambia is landlocked and consignments must be large to maximise profits. Despite the government's recent focus on private sector led development, relatively low access to bank credit and high cost of borrowing (collateral requests as high as 100-200%), and high communication and transport costs present additional challenges to starting and operating a pharmaceutical wholesaling business in Zambia. [3] The low numbers of wholesalers and the relatively high age of businesses (median of 9 years in operation), could reflect these difficulties in market entry. One instance of a vertically integrated business that engaged in the import, wholesale and retail of antimalarials was observed, as was horizontal trading among wholesalers, which is consistent with the distribution chain structures in other settings. [15]

Transactions between public and private sectors: There were no observed instances of private sector antimalarial wholesalers or retailers reporting a public sector source as one of their two top suppliers of antimalarials; however, 8 (out of 286) eligible public facilities at outlet level reported a private sector source as one of their two top antimalarial suppliers and many wholesalers (over 70%) reported public facilities as their customers for antimalarials. While there have been efforts to improve the public sector supply chains (e.g. the DELIVER programme), it is reasonable to assume that public facilities make ad hoc purchases from private wholesalers where there has been a disruption in their regular supply lines [4].

Wholesaler characteristics: Wholesale businesses were medium-sized with a median of 8 workers; but wholesalers operating at higher levels of the chain tended to be larger with a median of 20 workers. Most wholesalers (70.5%) sold other products in addition to pharmaceuticals, but these tended to be related products, such as toiletries (59% of all wholesalers) and household goods (35% of all wholesalers), rather than products such as mobile air time (9%), cigarettes (2%) or food (2%).

Business practices within the supply chain: Two-thirds (67.4%) of all wholesalers reported having organised delivery of antimalarial purchases to their customers, and nearly all wholesalers supplying other wholesalers (90%) reported doing so. As most wholesalers were observed to be located in either Lusaka (61%) or the Copperbelt Province (23%), and considering the relatively high cost of transportation, organising deliveries is a likely strategy designed to attract customers located in various parts of the country. Despite the relatively low access to bank credit in Zambia, many wholesalers (60%) reported having offered credit to customers in the past 3 months, offering a median of 30 days' credit. However, another study reported that credit is likely offered to larger customers, while smaller customers were required to pay for their purchases up front. [4]

Licensing and Inspection

Only three-quarters (31 of 41) of all wholesalers interviewed reported having a licence to wholesale medicines from the Pharmaceutical Regulatory Authority, and an up-to-date wholesaler license was only observed in 21 of these (67.7%). However, a further 7 wholesalers (17.5%) where a valid wholesaler license was not observed did have an up-to-date license allowing pharmaceutical retailing. Because of the bottom-up approach used for this study to identify de facto wholesalers (i.e. businesses that sell to other businesses), 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. Despite this, almost all wholesalers interviewed reported having been visited by a pharmaceutical inspector in the 12 months prior to interview and 91% also reported employing a pharmacist, which is a regulatory requirement of the PRA to wholesale medicines.

Wholesaler knowledge

Although Zambia was the first country in Sub-Saharan Africa to adopt ACTs as first-line treatment policy in 2002, only three-quarters of wholesalers interviewed (76.7%) were able to correctly identify AL as the government recommended treatment, and a smaller proportion of wholesalers identified AL, or any other ACT, as the most effective medication for treating uncomplicated malaria in either children (61.9%) or adults (69.0%). This could affect demand for ACTs at lower levels of the chain. One study of antimalarial retailers in Zambia found that perceived efficacy of SP was an important factor that led 60% of interviewed shopkeepers to recommend SP over other antimalarials to their customers. [16] The authors suggest that this perceived efficacy of SP over AL could, at least in part, be the residual effect of training received during Zambia's transition from chloroquine to AL as first-line treatment, where districts without AL were instructed to use SP for uncomplicated malaria;. As the percentage of wholesalers in our study who indicated that staff had participated in in-service training related to malaria treatment in the past 2 years was very low (5% of wholesalers that supply retailers, and no wholesalers that supply wholesalers), more training of wholesalers on updated malaria treatment guidelines could possibly enhance uptake of ACTs in the private sector.

Availability

ACT availability was relatively high: More than two-thirds of all wholesalers surveyed (72.1%) had an ACT in stock at the time of interview, and 68.1% of all wholesalers reported always having at least one ACT in stock throughout the three month period prior to interview, although a higher proportion of wholesalers had non-WHO prequalified ACTs in stock (62.8%) compared to WHO prequalified ACTs (44.2%). The recommended first-line treatment for uncomplicated malaria, AL, was stocked by 67.4% of all wholesalers and was also the most frequently observed antimalarial, accounting for 24.0% of all antimalarial products stocked by wholesalers and 66.3%. Another ACT, artesunate-sulphamethoxypyrazine-pyrimethamine, was the third most commonly stocked antimalarial by wholesalers, accounting for 8.9% of all antimalarial products stocked by wholesalers.

AMT and nAT availability was also relatively high, while RDT availability was low: Despite the ban on AMTs that has been in place since 2008, half of all wholesalers were observed to have AMTs in stock, and two-thirds of wholesalers (76.7%) were observed to stock nATs. On the other hand, only 23.3% of wholesalers were observed to have RDTs in stock at the time of interview; however 40% of wholesalers did report having stocked an RDT at least once in the 3 month period preceding the interview.

Sales Volumes

ACTs are being sold by wholesalers, but in smaller quantities than nATs: For ACTs, the median number of AETDs sold the week preceding the survey among all wholesalers (i.e. both those with and without ACTs in stock at the time of interview) was 12.3, and 65.0 AETDs among those wholesalers that had ACTs in stock at the time of interview. In contrast, the volume of nATs sold was much larger: the median number of AETDs sold was 77.3 among all wholesalers identified, and 620.0 AETDs among those with nATs in stock. Sales of SP, the most commonly reported top selling antimalarial among wholesalers, are the major driver of nAT sales; however, injectable quinine (the recommended treatment for severe and complicated malaria) also forms a significant component of nAT sales.

Volumes of AMTs and RDTs sold are low, but persist despite the ban on their sale: Despite availability in more than half of all wholesalers identified, the median volume of AMT sold the week preceding the survey among all wholesalers identified was low (0 AETDs). Even among just those wholesalers with AMTs in stock at the time of interview, the volume of AMTs sold (7.9 AETDs) was comparatively lower than those for ACTs and nATs. As for RDTs, even among those wholesalers who had RDTs in stock at the time of interview, the median number of RDTs sold in the week preceding the interview was 0 tests; however there was a wide variation in the volumes sold (IQR of 0 to 250 tests).

Price Mark-ups

Wholesaler mark-ups were lower than retailer mark-ups: Among wholesalers, the median mid percent price mark-ups were observed to be fairly consistent across antimalarial categories: 26.7% on ACT, 26.1% on AMT and 24.7% on nATs. Percent price mark-ups were also observed to be consistent across dosage form at wholesale level. The median percent price mark-ups among retailers were not only observed to be consistently higher that wholesaler mark-ups, but also varied widely across different retail outlet types and dosage forms. For example, retail mark-ups on ACTs ranged from 42.9% in pharmacies to 200.0% at drug stores, and median percent mark-ups greater than 100% were commonly observed in private health facilities, drug stores and grocery stores. In absolute terms, wholesaler mark-ups also tended to be lower than retailer mark-ups. Among wholesalers, median absolute mid mark-ups were US$ 1.58 on ACT, US$ 2.20 on AMT and US$ 0.14 on nAT; while at retail level, mark-ups ranged between US$ 1.40-4.12 on ACTs, US$

1.50-25.16 on AMT and US$ 0.17-0.67 on nATs. These higher mark-ups at retail level could be due to a variety of reasons. In private health facilities, higher margins may be required to absorb the costs of other services rendered to clientele, such as diagnosis. In drug stores and grocery stores, larger percent mark-ups may reflect their greater tendency to sell a product mix favouring relatively cheaper products compared to those sold by pharmacies and private health facilities, such as tablets rather than oral liquids, older nATs (e.g. SP) rather than 'premium priced' products (i.e. products strategically priced toward the high end of the price range to attract status-conscious consumers; an example is halofantrine), or generics rather than innovator products.

Large disparities in price and mark-up between AL and SP: Retailers reported having purchased AL from wholesalers at a median price that ranged from US$ 0.94-5.62; while the median purchase price for SP, the most commonly cited top selling product, ranged from US$ 0.12 to US$ 0.19. Among wholesalers, the median purchase price for AL was US$ 5.29 compared to a median purchase price for SP of US$ 0.14. This large difference in purchase price is reflected in the higher percent mark-ups added by retailers to SP, which ranged from 114-150% across all retail outlet categories. Although the absolute mark-up gained from each AETD of SP sold is small in comparison to AL (US$0.17-0.28 for SP vs. US$ 1.40-4.31), it is likely that the continued popularity of SP still makes the sale of this product fairly lucrative. As SP continues to be the recommended antimalarial for the treatment of pregnant women and uncomplicated cases among children less than 5kg in weight, demand for this product is likely to continue.

Conclusion

This report presents a number of important new insights into the market for antimalarial drugs in Zambia. The distribution chain had a pyramid shape, with a relatively broad base and narrow top. While we observed wholesalers to operate over 4 overlapping levels, all wholesalers identified were observed to supply retailers directly and a high proportion of wholesalers (42%) identified a manufacturer as one of their top antimalarial suppliers. As such, it is likely that most antimalarials in the private sector pass through a 2- or 3-step supply chain between manufacturer to retailer. ACTs, and in particular artemether-lumefantrine, the recommended first-line treatment for uncomplicated malaria, were observed to be available in about 70% of wholesalers; however, wholesale purchase prices for ACTs are high and are many times more expensive than other common antimalarials, such as SP. This may have contributed to our observation that SP was the most commonly reported top-selling antimalarial by wholesalers (50%), while only 28% of wholesalers reported AL as their top-selling antimalarial. With respect to oral AMTs, despite the ban on their sale since 2003, one third (33%) of all wholesalers continued to stock oral AMTs; however, their sales volumes during the week prior to the survey were observed to be very low. 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 high and they were not widely available among wholesalers.

6. Appendices

6.1. Range of health and non-health retail outlets selling pharmaceutical drugs in Zambia

Outlet Type	N	Description
Public Health Facility	**202**	
Third-level hospital	7	These are government health facilities providing free prescription medicine, medical consultations, and diagnosis. Health centres serve a catchment area of between 10,000 (rural) to 50,000 (urban) residents. They are staffed by a nurse or clinical officer. First-level hospitals accept referrals from local health centres and health posts. They serve populations of between 80,000 and 200,000 people with surgical, obstetric and diagnostic services. At the provincial level, second-level hospitals typically offer services in internal medicine, gynaecology, psychiatry and intensive care. Third-level hospitals serve a catchment of 800,000 people and expand upon provincial level services, while also serving as training and research institutions.
Second-level hospital (Provincial level)	5	
First-level hospital (District-level)	20	
Hospital affiliated centre	3	
Urban health centre	76	
Rural health centre	76	
Health post	15	
Part One Pharmacy	**56**	
Part One pharmacy	56	Pharmacies that are licensed by the Pharmaceutical Regulatory Authority (PRA) and sell prescription medicine at a commercial rate. Part One pharmacies are manned by pharmacists and qualified health practitioners. They sell all classes of medicines. In addition to being regulated by the PRA, they are also required to have a trading license from the local council. These pharmacies may also sell cosmetics.
Drug Store	**202**	
Drug store	202	Drug stores sells medicines at a commercial rate, but differ from pharmacies in a number of aspects: 1) Drug stores are usually smaller than pharmacies; 2) they are not regulated by the Pharmaceutical Regulatory Authority, and instead are licensed by the local government board (however, an unknown proportion operate without a license); 3) they are only permitted to sell over the counter medicines; 4) they are not guaranteed to be manned by qualified health dispensers/ practitioners, and are sometimes manned by relatives of qualified health dispensers or someone with only basic education or knowledge about medicines.
Private Health Facility	**48**	
Private hospitals	4	Private hospitals sell medicines at a commercial rate and are manned by qualified health dispensers/practitioners, who are registered with the medical council. These facilities are regulated by the Pharmaceutical Regulatory Authority. They have a hospital license and can admit patients for more than 48 hours.
Private clinic	36	Private clinics sell medicines at a commercial rate and are manned by qualified health dispensers/practitioners, who are registered with the medical council. As with private hospitals, they are regulated by the Pharmaceutical Regulatory Authority. Private clinics have a clinic license, and differ from hospitals in that they can admit patients for a maximum of 48 hours.
Surgery	8	Surgeries are also manned by qualified health practitioners who are registered with the medical council. They have a clinic license and offer certain specialized services, but they are not allowed to admit patients. They are most common in urban areas.

Grocery Store	**2,236**	
Grocery store	2,236	Small businesses that sell fast moving consumer goods including food, beverages, and household products. These outlets commonly sell antipyretics.
Other Outlet	**1,096**	
Kiosk	23	Small businesses, made from temporary wooden structures, which sell fast moving consumer goods. They may also sell medicines. Kiosks are usually found near schools, colleges and universities.
Kantemba	982	These are similar to kiosks but have a more permanent structure. They are twice the size of a phone booth with walls made from metal.
Super/Mini market or Petrol station	44	Express stores at filling stations. Small businesses which sell general groceries; they may stock some medicines such as such as antipyretics or cough syrups.
Container	37	This is a shipment container that has been turned into a shop. They have commodities that can also be found in grocery stores but may also sell over the counter medicines. Containers need to obtain a trading license from the local council.
Mobile provider	5	These are street hawkers who sell a variety of items, which may include medicines. They typically operate in residential areas and at road junctions. In residential zones, hawkers mostly target low income and rural areas. In urban zones, they may have a hawker's license under the local council.
Pharmacy/Chemist (not registered)	2	
Other	3	Other outlet types that did not fit into any of the aforementioned outlet types. These were largely market stands and stalls.

6.2. 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

6.3. Rationale and method of calculating weights and how to use weights to calculate indicators

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-district populations for non-PHFs non-POPs, and for analysis involving only the non-booster sample (i.e. estimation of volumes for all outlet types). District populations were used for PHF and POP outlet types where analysis included the booster sample (i.e. availability and price).

A correction factor was included in the weighting formula for booster outlets. This allows us to account for potentially different approaches taken to reach outlets in the larger geographical booster areas, and the knowledge that a full census was not conducted for all districts and specifically for the registered pharmacies.

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` option in *Stata* commands. The weight calculations are summarized as follows:

Availability and Price analysis:

i. All PHFs enumerated in a district;

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

where the number of districts visited is 10 for urban and 17 for rural.

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 13 for urban and 17 for rural. Note that this differs from those values used in equation ii., reflecting the fact that districts outside those containing selected sub-districts were enumerated for POPs.

iii. Non-PHF non-POP outlets enumerated in a selected sub-district;

$$Weight_i = \frac{\text{Strata Population}}{19 \times \text{SubDistrict Population}}$$

Volumes analysis (restricted to the non-booster sample):

i. All outlets enumerated in a selected sub-district;

$$Weight_i = \frac{\text{Strata Population}}{19 \times \text{SubDistrict Population}}$$

Data provided for weight estimation

i. Population size at sub-district level (projections for 2008) (*Ref: Final Sampling Frame 2000 Zambia, Central Statistical Office, Lusaka, Zambia. Unpublished*)

ii. A list of the selected sub-districts in the two strata: urban and rural

iii. List of PHFs at district level (*Ref: Health Institutions in Zambia, Zambia MoH, 2008*)

iv. List of registered pharmacies (POPs) by district, dated April 2009 (*Ref: List of licensed pharmaceutical retail outlets as at April 2009, Pharmaceutical Regulatory Authority (MoH), Zambia)*

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