



ACTwatch 2009 Supply Chain Survey Results Benin

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Definitions & Key Indicator Descriptions

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

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

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

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

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

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

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

Availability of any antimalarial or RDTs: The proportion of wholesalers in which the specified antimalarial medicine or rapid diagnostic test (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 (in this case outlets) of a type not adequately represented in the main survey, but which are of special interest. In Benin, the booster sample during the second ACTwatch Outlet Survey included all public health facilities in the commune within which a selected arrondissement fell, while the booster sample of pharmacies comprised a simple random sample of a further two-thirds of pharmacies in the department within which a selected arrondissement fell. No booster sample of public health facilities or pharmacies was collected during the first ACTwatch Outlet Survey in Benin.

Censused sub-district: Sampled areas (defined as the arrondissement in Benin) encompassing 10,000-15,000 people, where field teams conducted a full census of all outlets with the potential to sell antimalarials.

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.

First-line treatment: The government recommended treatment for uncomplicated malaria. Benin's first-line treatment for *Plasmodium falciparum* malaria is artemether-lumefantrine, 20mg/120mg, and artesunate-amodiaquine (4mg/10mg/kg) for infants under six months of age, for those who cannot tolerate artemether-lumefantrine, or when artemether-lumefantrine is not available.

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 (4 June to 29 June 2009) was 478.059 West African CFA francs (XOF) to US\$1; the average exchange rate during the data collection period for retail purchase prices (28 April to 13 May 2009, and 11 to 27 July 2009 for the pharmacy booster sample) was 482.7088 West African CFA francs (XOF) 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, granules, 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 6.2 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 (4 June to 29 June 2009) was 478.059 West African CFA francs (XOF) to US\$1; the average exchange rate during the data collection period for retail purchase prices (28 April to 13 May 2009, and 11 to 27 July 2009 for the pharmacy booster sample) was 482.7088 West African CFA francs (XOF) to US\$1 (www.oanda.com).

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

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

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 (also referred to as cluster in the second ACTwatch Outlet Survey), corresponding to arrondissements as demarcated in the 2002 census, which encompass a population 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.

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

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 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

ABMS	<i>Association béninoise pour le marketing social</i> (PSI affiliate in Benin)
ACT	artemisinin-based combination therapy
AETD	adult equivalent treatment dose
AL	artemether lumefantrine
AMFm	Affordable Medicine Facility - malaria
AMT	artemisinin monotherapy
ASAQ	artesunate-amodiaquine
ASMQ	artesunate and mefloquine
CAME	<i>Centrale d'achat de médicament essentiels et des consommable médicaux</i> (central stores)
CQ	chloroquine
DHA	dihydroartemisinin
DHA+PP	dihydroartemisinin and piperaquine
DPM	<i>Direction des pharmacies et médicaments</i> (drug regulatory agency)
IMCI	Integrated Management of Childhood Illnesses
INT	intermediate level (wholesaler of supply chain)
IPT	intermittent preventive treatment of malaria
IQR	inter-quartile range
IRS	indoor residual spraying
LLIN	long lasting insecticide treated net
LSHTM	London School of Hygiene & Tropical Medicine
MEC	mutually-exclusive category of wholesalers
MOH	Ministry of Health, Benin
MQ	mefloquine
nAT	non-artemisinin therapy
NGO	non-governmental organisation
OS	ACTwatch Outlet Survey
OTC	over-the-counter
Pf	<i>Plasmodium falciparum</i>
PGHT	manufacturer's price before taxes
PMI	US President's Malaria Initiative
PNLP	<i>Programme nationale de lutte contre le paludisme</i> (national malaria control programme)
POM	prescription only medicine
PPMV	Proprietary Patent Medicine Vendor
PPS	probability proportional to size
PSI	Population Services International
RDT	rapid diagnostic test
SP	sulphadoxine pyrimethamine
WHO	World Health Organization
WS	wholesaler
XOF	West African CFA franc

Executive Summary

Background

In Benin, 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 (Benin, Cambodia, the Democratic Republic of Congo (DRC), Madagascar, Nigeria, Uganda and Zambia). 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 Benin in June 2009.

Methods

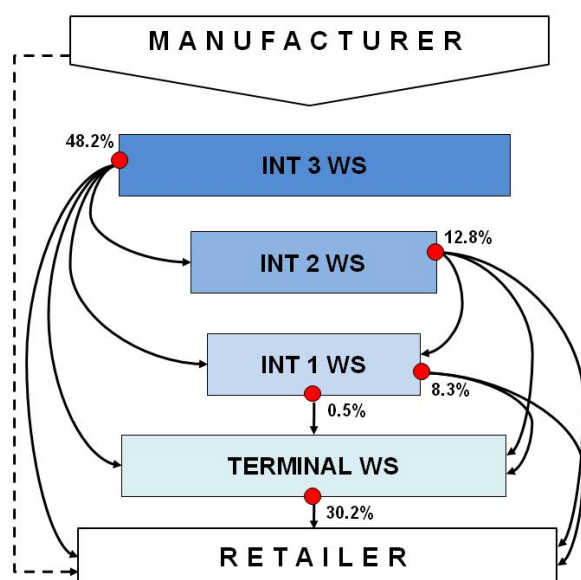
The Supply Chain survey was implemented by the London School of Hygiene & Tropical Medicine (LSHTM), with support from the *Association béninoise pour le marketing social* (ABMS, the PSI affiliate in Benin), and conducted concurrently with the second round of the ACTwatch Outlet Survey implemented by ABMS and PSI. Wholesalers operating at different levels of the supply chain that served a representative sample of public and private sector outlets in Benin 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, the 19 sub-districts included in the first round of the ACTwatch Outlet Survey were used to form the sample for the ACTwatch Supply Chain Survey. 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 19 selected Outlet Survey sub-districts. 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 second round of 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

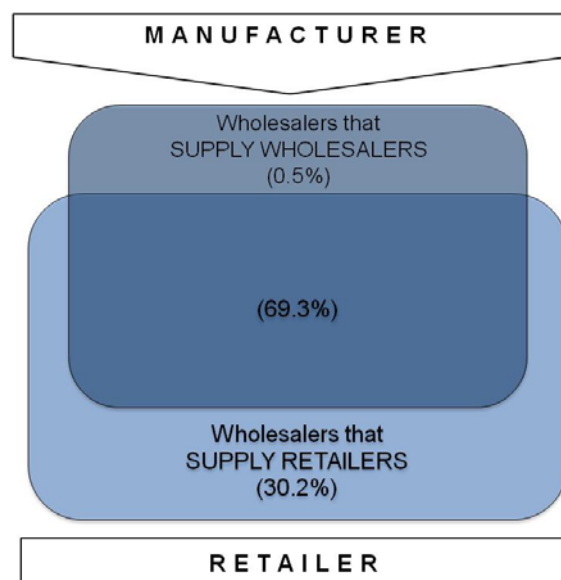
STRUCTURE OF THE SUPPLY CHAIN: A total of 218 antimalarial wholesalers were identified, and 204 were successfully interviewed. Each red dot on Figure 1 represents a mutually exclusive group of wholesalers and the array of arrows emanating from them describes the specific supply chain levels that each wholesaler group serves. Their percentage share is attached to each group. Figure 2 illustrates how the overlapping analytical categories used throughout this report are derived from the different mutually exclusive wholesaler categories depicted in Figure 1. 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. However, two distinct distribution chains for antimalarials were observed to operate in parallel. One of these is dominated by three large, registered pharmaceutical wholesalers and the public sector procurement agency, CAME, which largely serves more formal types of private sector medicine outlets, such as registered pharmacies and private health facilities; while the other parallel distribution chain is dominated by pharmaceutical wholesalers based in traditional open air markets located throughout Benin that supply less formal types of private retailers, such as general stores, market stalls and itinerant medicine vendors. Overall, few wholesalers (11%) reported either a domestic or foreign manufacturer as one of their top suppliers of antimalarials; however, nearly a quarter (23%) of wholesalers based in markets had been supplied by a business located outside of Benin, many of which were market-based wholesalers in neighbouring countries. The dashed line in Figure 1 from manufacturer to retailer indicates that a few retailers purchased antimalarials directly from manufacturers, although this was rare (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

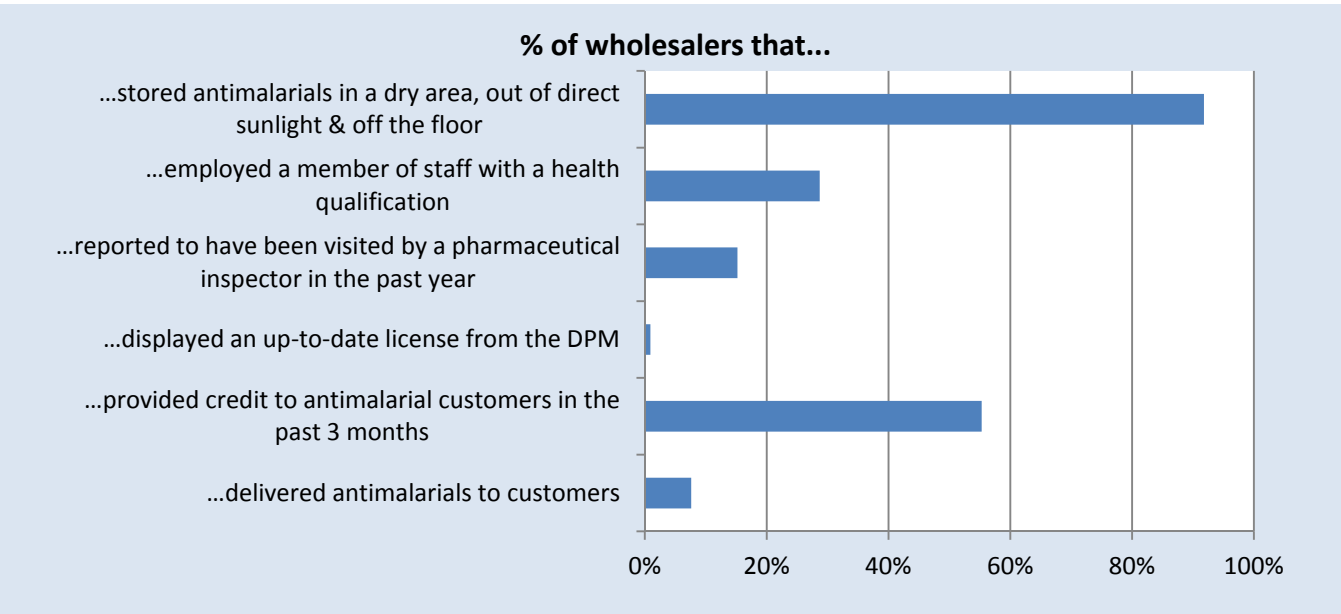


Note: WS: wholesaler; INT: intermediate

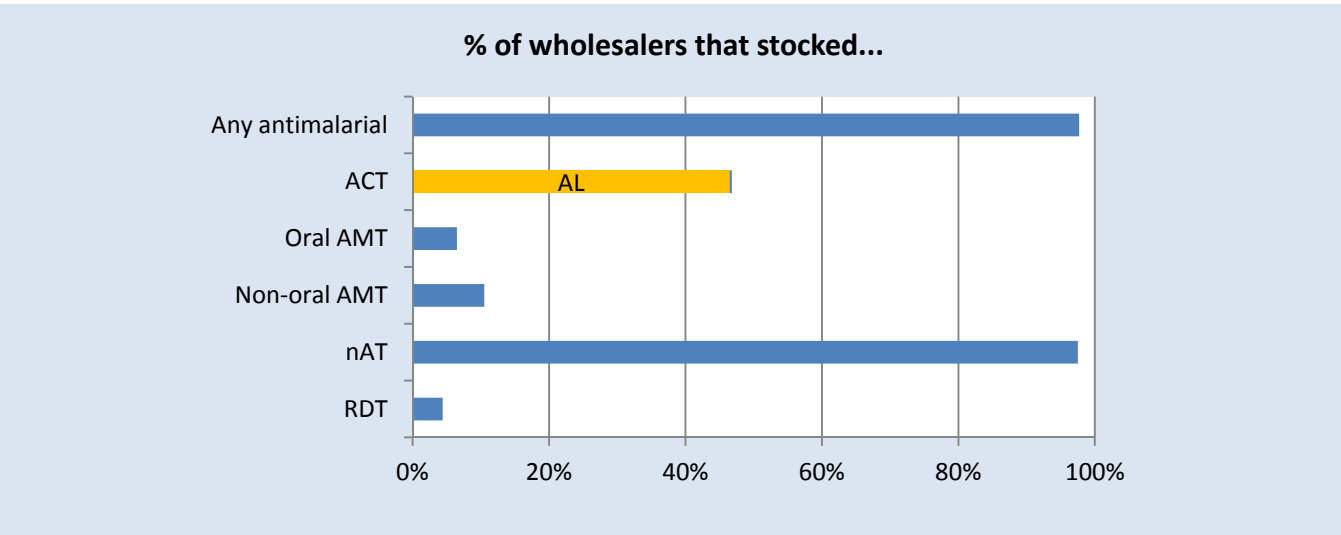
Figure 2: Representation of the antimalarial distribution chain showing the overlap between wholesaler categories used for analysis



WHOLESALE CHARACTERISTICS: Wholesalers had been in operation for a median of 8 years; however, this varied considerably. Wholesalers operating outside of markets were larger (median of 7 employees) and had been in operation longer (median of 14 years) than wholesalers operating inside of markets (median of 2 employees and 6 years). Most wholesalers (92%) were observed to store their antimalarials appropriately (off the floor, in dry areas and out of direct sunlight); however, only 29% reported employing a member of staff with a health qualification, 15% reported having been visited by a pharmaceutical inspector in the past year, and less than 1% of wholesalers were observed to have any up-to-date license (wholesale or retail) from the *Direction des pharmacies et médicaments* (DPM), Benin’s drug regulatory agency. More than half of all wholesalers interviewed had provided credit facilities to their customers in the past 3 months, but only 8% reported delivering antimalarial orders.

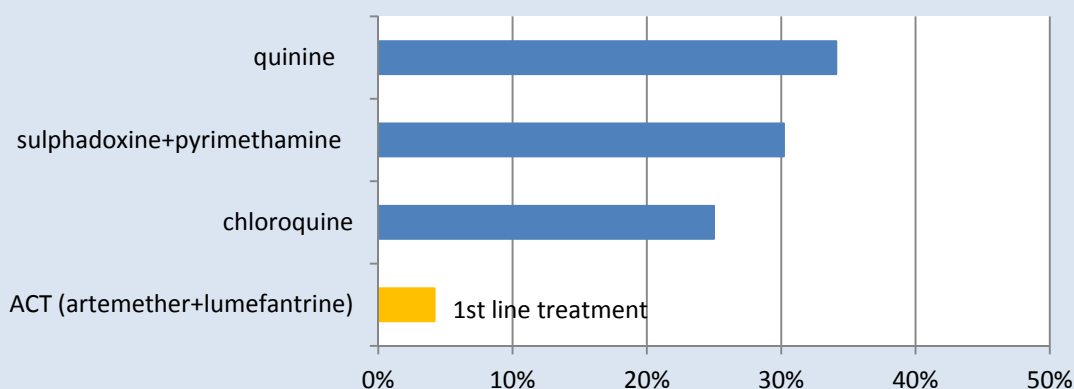


AVAILABILITY OF ANTIMALARIALS & RDTs: Nearly all wholesalers (98%) had at least one antimalarial in stock at the time of interview; however, only 47% had ACT in stock. Nearly all of the wholesalers stocking any ACT stocked artemether+lumefantrine (AL), the recommended first line ACT treatment for uncomplicated *Pf* malaria in Benin; although fewer wholesalers operating inside of markets stocked the first-line drug (38%). Availability of non-artemisinin therapies (nAT) was much higher than for ACT, and was stocked by 98% of wholesalers; while oral artemisinin monotherapies (AMT) were stocked by 7% of all wholesalers. Only 4% of wholesalers stocked RDTs.

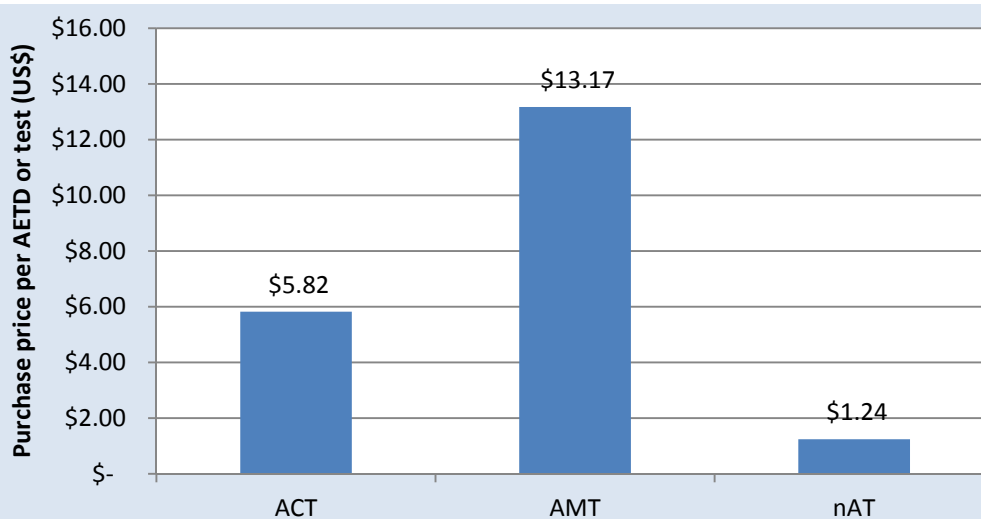


ANTIMALARIAL & RDT SALES VOLUMES: The median number of adult equivalent treatment doses (AETDs) of antimalarials sold the week preceding the survey was highest for nATs (222.1, IQR 21.3-1104.1), most of which tended to be sold in tablet form. The typical sales volumes of both ACTs and AMTs, regardless of dosage form, were very small: for ACTs the median number of AETDs sold was 0.0 (IQR 0.0-45.0), and for AMTs, 0.0 (IQR 0.0-0.0) among all wholesalers interviewed. Among wholesalers who stocked antimalarials at the time of interview (n=199), the nAT quinine was the top selling antimalarial for 34% of firms, sulphadoxine-pyrimethamine (SP) was the top selling antimalarial for another 30%, followed by chloroquine (25%). The next most common top selling antimalarial was the government recommended first-line treatment, AL, which was the top selling antimalarial for only 4% of firms. Very few wholesalers sold RDTs during the week preceding the survey, and the median number of RDTs sold was 0.

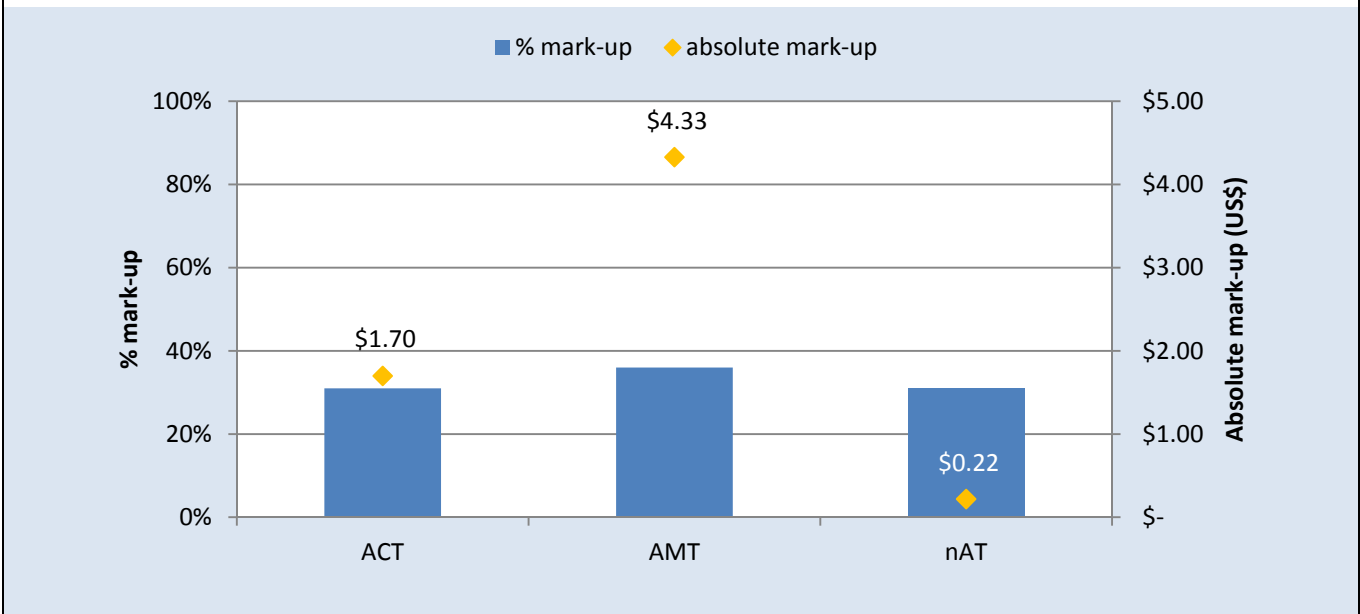
% of wholesalers who for whom the top selling antimalarial was...



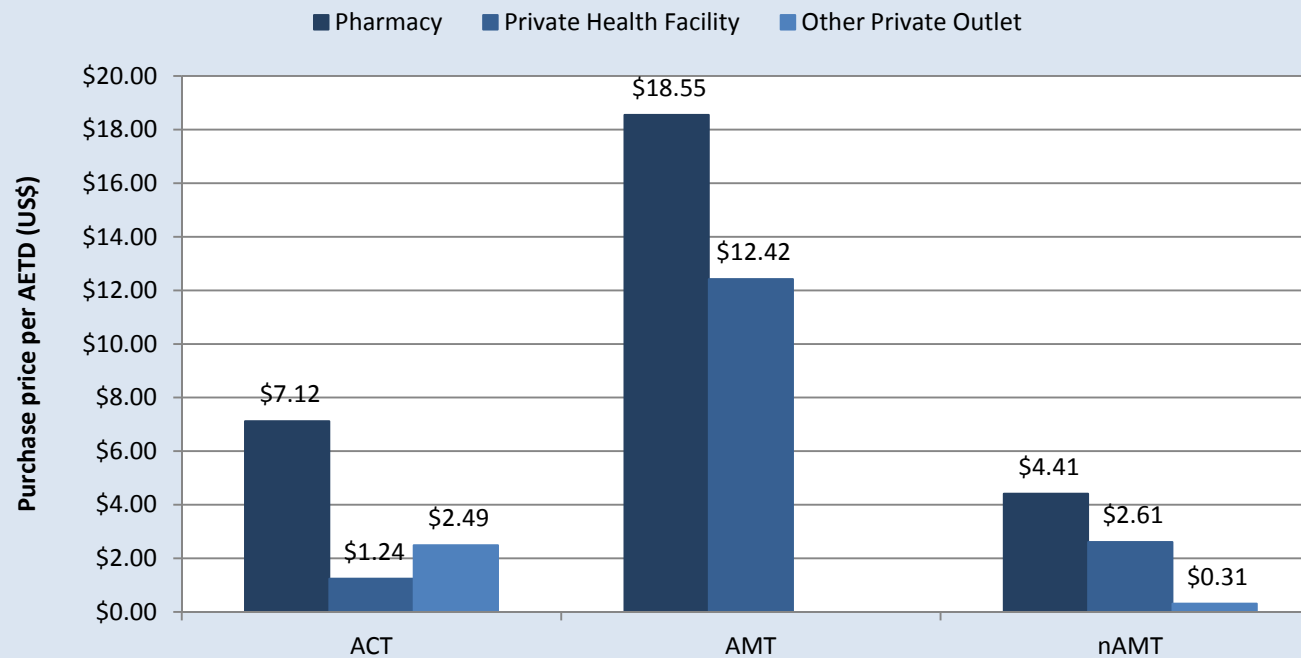
WHOLESALE PURCHASE PRICES: The median wholesale purchase price (i.e. the price paid by wholesalers to purchase stock from their suppliers) per AETD varied across antimalarial drug categories. Overall, AMTs had the highest median purchase price per AETD (US\$ 13.17), driven by the relatively higher proportion of expensive injectable products observed, compared to other antimalarials types. The median wholesale purchase price for ACTs was US\$ 5.82, which was comparable to the median purchase price for AMT tablets (US\$ 5.91); while nATs had a much lower median purchase price of US\$ 1.24. The median wholesale purchase price for the government recommended first-line treatment, AL (US\$ 4.40), was several times higher than the wholesale purchase price of SP (US\$ 0.60). RDTs were rare in the private sector and insufficient wholesale purchase price data were collected to obtain a robust estimate.



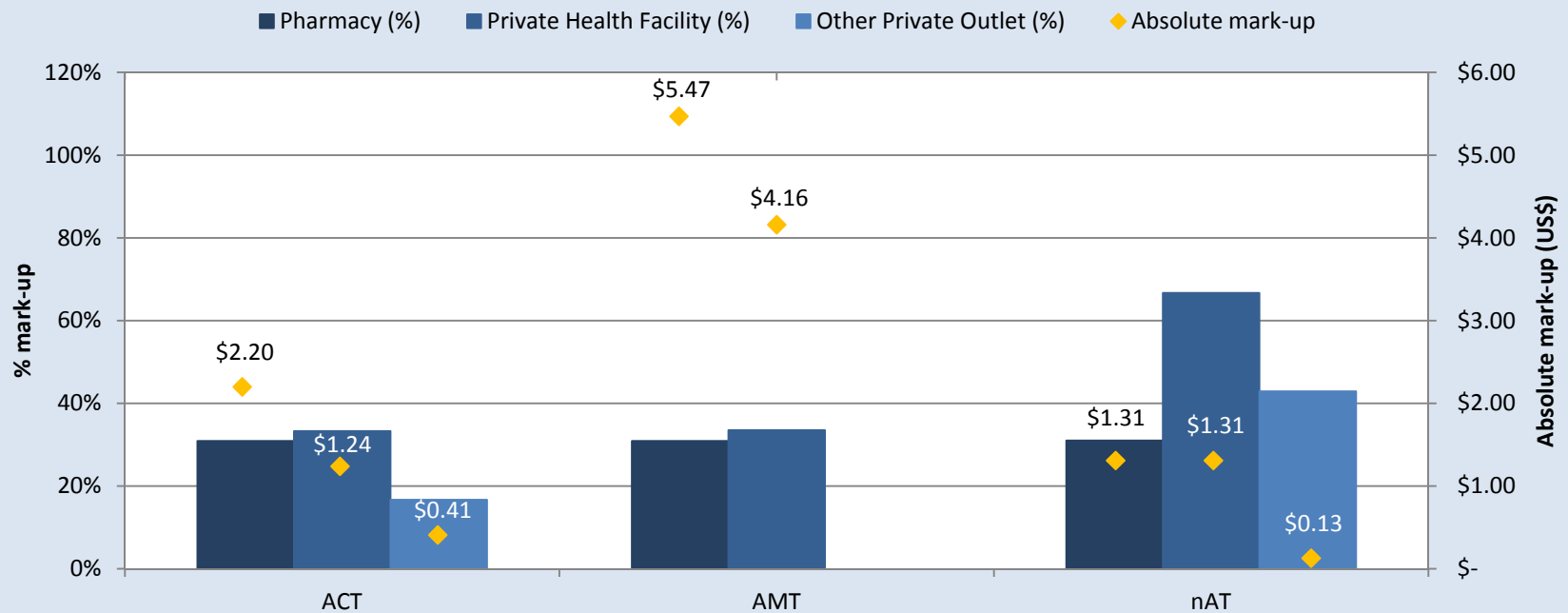
WHOLESALE MARK-UPS FOR ANTIMALARIALS & RDTs: Among all wholesalers, the median mid percent mark-ups were similar across antimalarial type: 31% on ACTs, 36% on AMTs, and 31% on nATs; and did not vary considerably across dosage form. However, the typical percent mark-ups applied by market-based wholesalers were consistently lower than those applied by non-market wholesalers. For example, the median mid percent mark-up applied to ACTs by market-based wholesalers was 13%; while non-market wholesalers applied a median mid percent mark-up of 33%. In absolute terms, mark-ups per AETD were the highest on AMT (US\$ 4.33), followed by ACT (US\$ 1.70) and nAT (US\$ 0.22), corresponding to the differences in purchase prices across drug categories. Although the median mid percent mark-ups for AL and ASAQ were similar to that for SP (AL: 31% vs. SP: 33%), there were considerable differences between median mid absolute mark-ups due to differences in purchase prices (AL: US\$ 1.28 vs. SP: US\$ 0.18). RDTs were rare in the private sector and insufficient wholesale mark-up data were collected to obtain a robust estimate.



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. Pharmacies tended to have paid the highest purchase prices for antimalarials, while other private outlets, such as market stalls, tended to have paid the lowest, reflecting the formal and informal divisions in the antimalarial supply chain in Benin. Overall, AMTs were observed to have the highest median retail purchase prices per AETD (ranging from US\$ 12.42 at private health facilities to US\$ 18.55 at pharmacies), while nATs had the lowest median retail purchase prices per AETD (ranging from US\$ 0.31 at other private outlets, to US\$ 4.41 at pharmacies). AMTs had the highest median purchase prices because a greater proportion of AMT products were observed to be in expensive injectable form.



RETAIL MARK-UPS FOR ANTIMALARIALS: Mark-ups were relatively low and were infrequently observed to exceed 100%. Median mid percent mark-ups among pharmacies (31%) were consistent with existing pricing regulations, and as such, did not vary across antimalarial category; while percent mark-ups did vary across antimalarial categories within the other outlet types. Among private health facilities, median mark-ups ranged from 33% on ACTs to 67% on nATs; while among other private outlets, median mark-ups ranged between 17% on ACTs to 43% on nATs. Variation in absolute mark-ups was observed across antimalarial and retailer categories, which corresponded closely with variations in purchase price: mark-ups on ACTs ranged between US\$ 0.41 and US\$ 2.20 across outlet categories; on AMT between US\$ 4.16 and US\$ 5.47; and on nAT between US\$ 0.13 and US\$ 1.31.



Conclusions

This report has presented a number of important new insights into the market for antimalarial drugs in Benin. There were two distinct private sector distribution chains for antimalarials, one dominated by more formal wholesalers serving registered pharmacies and private health facilities, and another dominated by less formal wholesalers, largely based in traditional markets, serving less formal types of medicine retailers, such as market stalls, boutiques and itinerant vendors. A number of factors, including Benin's current regulatory environment, have likely contributed to this division. Wholesalers in the two distribution chains were observed to differ considerably in a number of respects, such as in the knowledge of recommended first-line treatment for uncomplicated malaria; however, most wholesalers in both distribution chains were not observed to have an up-to-date license permitting the wholesale of antimalarials. Availability of different antimalarials also differed across the two distribution chains. Overall, oral AMTs were stocked by few wholesalers; but availability of ACTs was also relatively low, particularly among wholesalers based in markets. nATs were ubiquitous among all types of wholesaler and were being sold in larger quantities than ACTs. Percent mark-ups on antimalarials among more formal wholesalers and retailers were consistent with existing price setting regulations; but among less formal wholesale and retail businesses, percent mark-ups were less consistent and were considerably lower for ACTs. RDTs were rarely available at wholesale level.

1. Introduction & Objectives

In Benin, 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 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 Benin, Cambodia, the Democratic Republic of Congo (DRC), Madagascar, Nigeria, Uganda and Zambia. The overall goal of ACTwatch is to generate and disseminate evidence to policy makers on artemisinin-based combination therapy (ACT) availability and price in order to inform the development of policies designed to increase rates of access to effective malaria treatment. Along with the Supply Chain Study, the ACTwatch project also includes Outlet and Household Surveys led by PSI in Benin.

The objective of the Supply Chain component of ACTwatch is to document and analyse the distribution 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 Benin during June 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 second round of the ACTwatch Outlet Survey by PSI/Benin between April and May 2009.

2. Country Background

Economic Profile

Benin, located on the Gulf of Guinea, shares borders with Nigeria, Togo, Burkina Faso and Niger and has a population of 8.8 million. [1] Governed by a strict Marxist-Leninist government that enacted heavily interventionist economic policies in the 1970s and 1980s, Benin's annual gross domestic product (GDP) growth rate in that period was extremely volatile. However, following a transition to democratic government in the early 1990s, annual GDP growth has remained positive, averaging 4.4%. [1]

Despite sustained growth over the last two decades, Benin remains a largely poor country. GDP per capita is estimated at US\$1,500 (constant 2008 US\$, adjusted for purchasing power parity, PPP) [2], and about 39%¹ of the population lives under the national poverty line. [3] The percentage increases to over 47% when looking at the standard poverty line of US\$1.25/day PPP-adjusted. [3] In terms of the Human Development Index, Benin is ranked 163rd out of a total of 177 countries. [4] The majority of the population, approximately 58%, lives in rural areas. [1] The agricultural sector accounts for 32% of GDP and provides a source of livelihood for about 70% of the population. Cotton is Benin's main export commodity, making up between 25% and 40% of the country's exports. [5] India and China are Benin's most important trade partners, jointly buying 46.7% of Benin's exports. [6]

¹ Most recent figure for 2003

Pharmaceutical Sector

The pharmaceutical sector in Benin is regulated by the *Direction des Pharmacies et Médicaments* (DPM), which is under the umbrella of the Ministry of Health (MOH) and is in charge of designing and ensuring the implementation of the national health policy in relation to the pharmaceutical sector, medications and traditional medicine. The DPM's tasks include creating and enforcing national pharmaceutical policies and requirements for opening and operating businesses that carry medical and pharmaceutical products. Additionally, DPM is in charge of regulating the supply of medical and pharmaceutical goods for both the private and public sectors, creating and disseminating a list of authorised medications, and examining policies related to taxation and price setting of the aforementioned goods. Lastly, the DPM is also responsible for controlling the sale of illicit medications. [7] Benin produces some medications domestically, but also imports from Western Europe, India, China and neighbouring countries, such as Nigeria. [8]

At the top of the distribution chain for the private sector are four private wholesalers registered with the DPM (although one is not involved in distributing antimalarials), as well as Benin's public sector procurement agent, the *Centrale d'Achat des Médicaments Essentiels et des Consommables médicaux* (CAME), all of which procure medicines from both domestic and international manufacturers. Barriers to entering the private wholesale market are high: regulations require 70% of the capital of wholesale businesses to be owned and operated by registered pharmacists. Wholesalers are also required to register with the *Registre de Commerce et du Crédit*, complete a technical feasibility study, pay a registration fee of 550,000 XOF (approx. US\$ 1000), and maintain an operating capital of 100,000,000 XOF (approx. US\$ 190,000), which is reviewed every 5 years. Furthermore, wholesalers are required to hold stock of 90% of all pharmaceutical products registered in Benin. [8] The four private sector wholesalers and CAME distribute medicines to retail outlets, such as pharmacies. In 2009, there were 180 registered pharmacies in Benin, which must be owned and managed by a registered pharmacist. These retail outlets sell prescription and over-the-counter medicines, as well as nutritional supplements and cosmetics. They tend to be mostly concentrated in urban areas; 48% of registered pharmacies are in Cotonou, and 8.3% are based in Porto Novo, the two largest cities. They, in turn, supply to rural outpost pharmacies (see below) and private clinics².

Since the majority of the population lives in rural areas, a tier of formal retail outlets similar to drug shops, called rural outpost pharmacies, were created to increase geographical accessibility of pharmaceutical products. Rural outpost pharmacies are required to be located at least 10 miles away from a registered pharmacy, and must close if a pharmacy opens in the area. Additionally, they have to sign a memorandum of understanding with a nearby pharmacy, and are required to procure all of their goods directly from it, instead of through wholesalers or CAME. Private clinics are also not supposed to sell medicines to patients, but can charge patients for medicines used during their hospitalizations. For outpatient visits, the clinic is supposed to write prescriptions that are filled at registered pharmacies or rural outpost pharmacies. However, there is a widespread perception that clinics, many of which are unregistered, ignore this rule and sell medicines directly to patients. [8]

The prices of pharmaceutical products in the private sector are regulated to ensure that the entire population can buy medicines for the same price regardless of where they live. The basis for calculating the prices of pharmaceuticals bought from private wholesalers is the manufacturer's price before taxes (PGHT). This price excludes all taxes, transportation and insurance costs. The wholesaler's selling price is calculated by multiplying the PGHT by a coefficient of 1.36 (equal to a 36% mark-up on PGHT). Similarly, the retail price

² Private clinics are also officially supplied by CAME; however rural outpost pharmacies are not.

is calculated by multiplying the PGHT by a coefficient of 1.78 (equal to a 78% mark-up on PGHT or 31% mark-up on wholesaler's selling price). Rural outpost pharmacies are able to purchase products from registered pharmacies at a discount of 8% from the retail price. Public health facilities are able to purchase products from wholesalers at a discount of 13% from the retail price. To ensure that prices are stable, at the time a pharmaceutical is registered the manufacturer must provide a detailed explanation of the product's cost structure and set the PGHT for a period of five years. After five years, the manufacturer may apply to adjust the PGHT. Products bought from CAME have a different pricing structure where selling price is calculated by multiplying the total price of the product once it reaches the central warehouse (including freight, insurance, clearance, and other charges) by a coefficient of 1.2. The retail price is calculated by multiplying CAME's selling price by a coefficient of 1.5; however, if the resulting price is higher than the price obtained by multiplying the identical product's PGHT by a coefficient of 1.78, the final price must be reduced to this level. The pricing structure created for CAME's products is not applied uniformly as the regulation that established the pricing structure applies to public and private health facilities only. There is ambiguity on how registered pharmacies and rural outpost pharmacies should price products procured from CAME. [8]

Health System

Benin's health system is largely decentralised and is relatively easily accessible by the general population. For example, 77% of the population lives less than 5km away from a health facility; however, it is important to note that only 44% of the population use the health services offered at these facilities. [4] Although 11% of the national budget is allocated to the health sector (accounting for 4.7% of GDP and 8% of total public expenditure), households are the source of 52% of total health expenditure. [4] Public health facilities typically charge fees for consultation, medications and procedures; and the income raised from the fees, which accounts on average for 43% of the MOH budget, is kept at facility-level and allocated based on the community's needs in accordance with MOH policies. [9] The MOH subsidises fees for the poorest families, although there are reports that many at the bottom of the socio-economic ladder are unaware they are eligible for these benefits. [9]

Health service delivery in the public health sector was reorganized in 2010 and is structured as a pyramid with three levels. At the top are the Ministry of Health and Central Directorates, as well as a National Referral Hospital. The intermediate level is comprised of Departmental Directorates for health and six referral hospitals. The bottom level is comprised of 34 health zones, which each cover an average population of 230,000³. In theory, each health zone contains zone hospitals, community health centres, private health facilities and village health units. [9] The private health sector in Benin includes licensed practitioners, private hospitals, and faith-based organizations, as well as unregistered clinics, drug providers and drug sellers. The number of unlicensed health facilities is difficult to determine, but it is widely accepted that a large number of patients acquire medication from informal sellers. A 2003 study from the *Fondation Pierre-Fabre* found that 40% of the 600 households interviewed in Cotonou acquired medicines from informal sellers. [10] Furthermore many private health clinics are not registered with the Ministry of Health; a 2005 study of private health practices in four of the country's twelve departments showed that only 12% of private health practices were authorised by the Ministry of Health. [11]

³ Although for health purposes the country is divided into health zones, administratively the country is divided into 12 departments, which are further subdivided into 77 communes. Each health zone covers between one and four communes.

Malaria Epidemiology and Control Strategies

Malaria is a leading cause of morbidity and mortality in Benin. In 2009, 4,537,600 suspected malaria cases were reported. [12] The disease burden is especially severe on children. One in 8 children in Benin die before their fifth birthday, [13] and malaria is responsible for about 32% of those deaths. [14] The disease also places an enormous strain on the health infrastructure, accounting for 40% of outpatient consultations and 25% of hospital admissions. [14]

Malaria is endemic across the entire country. The predominant parasite is *Plasmodium falciparum* and the predominant vector is *Anopheles gambiae*. [9] There are three distinct regions of malaria transmission: the coastal region in the south where malaria transmission is heterogeneous due to the presence of both *Anopheles gambiae* and *Anopheles melas* mosquito vector species, the inland area where transmission is holoendemic, and the north where malaria transmission is seasonal. Although malaria transmission occurs year round, malaria rates are highest during the rainy season. [9]

The government of Benin aimed to reduce malaria morbidity and mortality by half by the year 2010. To meet this goal, the five-year National Malaria Control Strategy was developed for the period 2006 to 2010. The core interventions for malaria control in Benin include long lasting insecticide-treated net (LLIN) distribution through antenatal care clinics and immunisation visits, universal campaigns, and subsidised and at-cost sales in the private sector; intermittent preventive treatment for pregnant women (IPTp); case management (following diagnosis) at all levels of health care; and, to a more limited extent, indoor residual spraying (IRS). Benin has removed import tariffs on mosquito nets, antimalarials and RDTs; as of August 2010 tariffs still apply to pumps and insecticides used for IRS. [15]

In 2007, a national campaign distributed 1.4 million LLINs to households across Benin. This followed survey estimates that although 56% of households owned a mosquito net, only 25% of households reported owning an insecticide treated net, and only 20% of children under five had slept under such a net the previous night. [16] The PNLN's universal coverage campaign envisions one net for every two people, and a second-round of mass distribution was planned for 2010. LLINs are also available through antenatal care and immunisation visits, where they form part of a kit that includes two doses of SP, one dose of mebendazole, folic acid and iron. These kits cost around US\$ 1, although the nets and SP are 'free' and provided using funds from the US President's Malaria Initiative (PMI), UNICEF and the World Bank. A partnership between PMI and PSI/Benin also plans to sell highly subsidised, socially-marketed LLINs in the private sector. The 2006 Benin Demographic & Health Survey found that although 84% of pregnant women accessed an antenatal care clinic at least twice during their last pregnancy, less than 1% of women received two doses of SP from antenatal care visits. However, IPTp was only introduced at a national level in 2005. Recent research at selected maternity hospitals shows that coverage for two doses of IPTp has increased in some facilities from 3% in 2005 to 68% in 2009. [17] The results of the 2011 DHS will show whether this finding is generalisable.

IRS has been recommended by the PNLN since 2006, and spraying rounds have been funded by PMI in 4 communes in Ouémé in 2008 and 2009, covering more than 520,000 people. LLINs were distributed to households following each round of spraying. Looking ahead, PMI intends to find other suitable locations in Benin for IRS, most likely in the north of the country where LLIN coverage is lower than the south and malaria transmission is seasonal. [14]

National Treatment Policy

In 2005, the country adopted artemether-lumefantrine (AL) as the first-line treatment for uncomplicated malaria. Artesunate-amodiaquine (ASAQ) is recommended for patients under six months of age, for those who cannot tolerate AL, and when AL is not available. Parenteral quinine is recommended for severe malaria. Cases of malaria in pregnant women are defined as severe and, as such, should also be treated with quinine. Furthermore, Integrated Management of Childhood Illnesses (IMCI) guidelines recommend that children under the age of five with anaemia should also be treated with antimalarials. [9] Oral artemisinin monotherapy has been banned since 2006. [13] At the time of data collection public facilities provide AL for a fee and are permitted to keep part of the proceeds from these sales. AL blister packs of 6, 12, 18, and 24 tablets were sold for 150 XOF [US\$0.33], 300 XOF [US\$0.66], 450 XOF [US\$1.00], and 600 XOF [US\$1.33], respectively. [9]

According to the national policy, children under the age of five with a febrile illness should be treated presumptively for malaria. For patients aged five or older, the policy recommends that antimalarials be reserved for those whose malaria has been confirmed, either through RDTs or through microscopy. However, according to a report from the PMI published in 2011, the government is considering changing the policy and requiring that all cases of malaria, regardless of age, be confirmed. Consequently, diagnostic testing is being scaled up alongside ACTs. Although microscopy should in theory be available in hospitals and large health facilities, equipment is not always functional and laboratory technician skills are often sub-optimal.

The National Malaria Control Programme (*Programme nationale de lutte contre le paludisme*, PNLPP), with help from PMI and the World Bank Booster Programme, is currently working to identify weaknesses in diagnostic services. It is estimated that Benin needs a total of 129 microscopes to cover departmental hospitals, health zones, and commune health centres through 2015. It is also estimated that approximately 648,000 RDTs are needed to cover the public sector in 2011. Because RDTs have been introduced recently, procurement is difficult as there is little data on consumption practices. [9]

Antimalarial Treatment Distribution and Delivery

Antimalarial products destined for the private sector are bought from international and domestic manufacturers by Benin's public sector procurement agent, CAME, and by three out of the four wholesalers registered with the DPM (as of November 2009). Domestic manufacturers do not produce ACTs, only unbranded generic quinine and SP products. In order to clear customs, importing wholesalers need to present authorization from the DPM and pay a clearance tax totalling 2.5%. The three wholesalers and CAME directly and indirectly supply the 180 registered pharmacies, 279 registered rural outpost pharmacies, and private clinics with antimalarials.

According to the ACTwatch Baseline Outlet Survey completed in October 2008, first-line treatment (AL) was most frequently available in public health facilities (66%) or pharmacies and rural outpost pharmacies (77%). However, it was infrequently found in private health facilities (9%) and very rarely found in other types of informal outlets (1%). In total, only about 7% of outlets surveyed carried AL. Non-artemisinin therapies, on the other hand, were carried by a total of 67% of outlets surveyed, with chloroquine, quinine and SP the kinds of medication that were most frequently in stock. [18]

In terms of treatment seeking behaviour, the ACTwatch household survey conducted in April and May 2009, found that only 41% of children under five with fever were treated with antimalarials, and only 7% with first-

line treatment. Approximately 40% of those treated with an antimalarial received it from a public health facility, while 17% sourced antimalarials from informal outlet types, such as kiosks, market stalls and mobile vendors. Public health facilities were by far the most common source of ACT treatment; 73% of those seeking ACT obtained it from this source.[13]

Malaria Financing

Financing for malaria control activities has increased dramatically in recent years, from less than US\$ 5 million annually between 2001 and 2005, to over US\$ 22 million in 2009. The main sources are PMI, World Bank, Government of Benin, and Global Fund. The PNLN received funding from the Global Fund Round 3 Grant (US\$ 2.14 million) which was channelled to a project providing 458 villages with ACTs, with the aim (among others) of improving case management of malaria in children under five through health facilities and community-based management. The project was implemented in Mono and Couffo, two departments with high malaria transmission. A Round 3 Rolling Continuation Channel (RCC) to the implementing partner will provide US\$ 94 million to expand this project (as well as financing net distribution campaigns). A Round 7 (US\$ 22.6 million) grant launched in July 2008 aims to cover community-level ACT distribution for 14 of the 34 health zones (approximately 40% of the population) not already covered by the RCC. Thus, together, these awards will finance community case management of malaria countrywide.

In 2007, a four-year grant (US\$ 31 million) from the World Bank Malaria Booster Programme commenced covering an important portion of ACT needs and the bulk of RDTs required. Benin also received US\$ 3.6 million in 2007 and US\$ 13.8 million in 2008 for malaria control activities from the PMI. Funds from 2008 were used to procure 900,000 LLINs; 250,000 ACT treatment doses for children under five; and kits for the treatment of severe malaria. In addition, PMI funds supported the training and supervision of laboratory staff, and public and private health workers. Of the US\$ 13.8 million allocated for 2009, approximately \$2 million of this was for malaria treatment and diagnosis. [14]

3. Methods

3.1. Scope of the supply chain survey

The Supply Chain structured survey was conducted amongst wholesalers who operated in the private commercial distribution chain that served the antimalarial drug retailers described in the first round of the ACTwatch Outlet Survey conducted in 2008. [18] The term 'private commercial sector distribution chain' refers to any type of supplier (public or private) who served private commercial outlets as well as private suppliers who served public and NGO outlets. This allows any transactions between public, NGO and private commercial sectors to be noted. Public suppliers of public outlets are, however, not included because much more is already known about the structure of the public sector chain compared to that of the private commercial sector. The focus is on suppliers who operate from the point where commodities leave the factory gate or port of entry down to those directly supplying retailers. See Figure 3.1 for a representation of the wholesale supplier interactions that are captured by the Supply Chain Survey.

The Supply Chain Survey explored the distribution chain for antimalarials, comprising artemisinin-based combination therapy or ACT (e.g. artemether-lumefantrine), artemisinin monotherapies or AMT (e.g. artesunate, artemether) and non-artemisinin therapies or nAT (e.g. chloroquine, quinine), and including all formulations (tablets, syrups, injectables, etc.), whether they are used for inpatient or outpatient care. It excluded complementary products, such as drips, water and syringes. It also explored the availability, sales volumes, and mark-ups on RDTs sold in the distribution chain under study, but excluded microscopy services.

The latter were excluded because of the wide range of different products used in providing microscopy services and the problems in distinguishing those used for malaria diagnosis from those with other purposes.

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

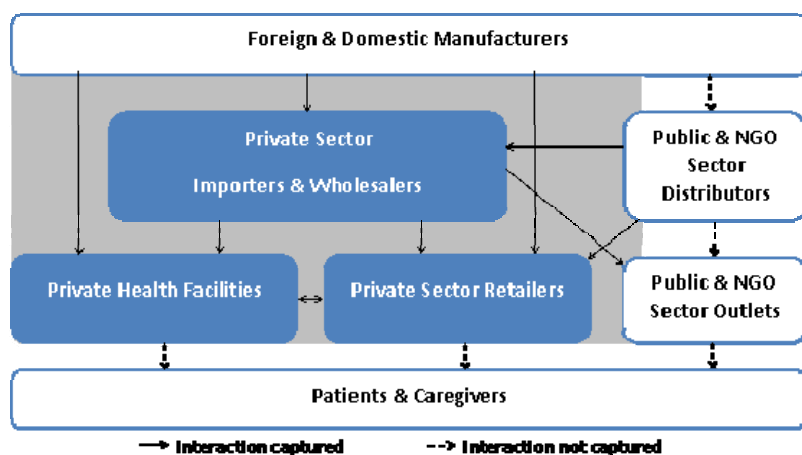


Figure 3.1: Antimalarial wholesale supplier interactions captured by the Supply Chain Study

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 first ACTwatch Outlet Survey, 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 corresponded to existing *arrondissements* demarcated for the 2002 census and typically encompass a population size of approximately 10,000 to 15,000 inhabitants⁴. 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. Since the second Outlet Survey in 2009, this sample was supplemented by a booster sample in order to estimate antimalarial availability and price across different outlet types. The booster sample included all public health facilities in the *commune* within which a selected *arrondissement* fell, while the booster sample of pharmacies comprised a simple random sample of a further two-thirds of registered pharmacies in the department within which a selected *arrondissement* fell.⁵

The first Outlet Survey was conducted by PSI/Benin in October 2008, with a second outlet survey conducted between April and July 2009. The Outlet Surveys collected data on antimalarial drug availability, sales volumes and selling prices, retail outlet and shopkeeper characteristics (antimalarials stocked, other drugs

⁴ By the time data collection for the ACTwatch Outlet Surveys began in 2008, one of the 19 selected sub-districts defined by the 2002 census *arrondissement* demarcations had divided into two separate *arrondissements*. To adhere to the sampling protocol, the original 2002 boundaries were maintained and data was collected from both *arrondissements*, which were coded as two different sub-district names in the 2008 Outlet Survey dataset.

⁵ No booster sample was included during the first Outlet Survey conducted in Benin.

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 top two supply sources for antimalarials (name, location, provider type, whether they distribute, collect or both) and antimalarial wholesale purchase prices.

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

The Supply Chain survey was implemented by LSHTM, with support from PSI/Benin, after the first round of the Outlet Survey, during June 2009. Supplier data collected by PSI/Benin from outlets in each of the 19 sub-districts selected for the first Outlet Survey were used to create a list of all antimalarial wholesale sources mentioned by retailers as their two top antimalarial wholesale sources (termed the "terminal wholesalers"). All these terminal wholesalers that could be located 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 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.⁶

In Benin, traditional markets that are common throughout West Africa are important sources of antimalarial wholesaling. When retailers and wholesalers in Benin were asked about their two top antimalarial supply sources, respondents commonly indicated that they purchased antimalarials from such markets, and often did not name a specific vendor in the market as their supply source, giving just the market name as the source of antimalarials. As such, it was difficult to ascertain which and how many wholesalers needed to be interviewed in a given market. In addition, some potential wholesaler respondents were reluctant to participate in the study due to political and regulatory sensitivities surrounding medicine-selling in markets. To address these issues, attempts were made to sample as wide a selection of wholesalers that was possible within each market visited, often with the assistance of local leaders or PSI/Benin staff responsible for working with market wholesalers who accompanied data collection teams to try to foster goodwill in the marketplace and encourage participation among vendors. Also, because markets do not all operate every day of the week, it was not possible to survey market wholesalers in each of the market towns mentioned, in which case wholesalers were sampled from markets in nearby towns to represent them. Ideally, the number of wholesalers interviewed in a particular market would be proportional to the number of mentions each market received; however, for the reasons mentioned above, this was not always the case. Therefore, summary measures that include observations from markets were adjusted to account for over- or under-sampling of market wholesalers that may have occurred. See sections 3.3.2 to 3.3.4, and appendix 6.4 for additional information on sampling in markets and the calculation of weighted summary measures.

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 French, piloted by

⁶ 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.

members of the research team, and further revisions were made to adapt the tools to the specificities of the Benin context. Before each interview, trained interviewers sought to speak with the most knowledgeable person about their antimalarial/RDT wholesale business. They informed respondents about the study by providing the information sheet in French. 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 emphasised that individual information was confidential and that no information would be passed on to regulatory authorities or competitors.

The provider questionnaire was used for collecting data on each wholesale business's characteristics and operations and on the wholesalers' top two supply sources for antimalarials and RDTs. Inventory sheets were used for collecting data for each antimalarial/RDT stocked, on brand name, generic name and strengths (for antimalarials), package type and size, recall of volumes sold over the week before the survey, recall of last purchase value and selling and purchase prices. The Supply Chain component of the ACTwatch study received ethical approval from the *Comité national provisoire d'éthique pour la recherche en santé* of Benin 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 3 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 issue of individual MECs including very few wholesalers. Furthermore, this approach reflects the actual operations of the distribution chain.
- To account for the situation in Benin where businesses operating within traditional markets constitute an important source of pharmaceutical supply, wholesalers were also classified into groups defined by their location of operations: market wholesalers and non-market wholesalers.

In order to get a complete picture of the distribution chain for antimalarial drugs, data relevant to the retail level are also presented for 4 mutually exclusive categories of retailers: pharmacies (including rural outpost pharmacies), private health facilities (both for-profit and not-for-profit), other private outlet types (e.g. market stalls, boutiques, itinerant vendors, etc.), and public health facilities. See appendix 6.2 for descriptions of the type of retailers included in these categories.

3.3.2. Calculation of sales volumes

Antimalarial volumes and price data are reported for 5 dosage forms, namely tablets, oral liquids,

injectables⁷, suppositories and granules; and 3 antimalarial categories⁸ namely artemisinin-based combination therapy (ACT), artemisinin monotherapies (AMT) and non-artemisinin therapies (nAT). ACTs were further sub-divided into WHO-prequalified ACT and non-WHO-prequalified ACT.

Antimalarial volumes were calculated on the basis of an adult equivalent treatment dose (AETD). An AETD was defined as the number of milligrams (mg) of an antimalarial drug needed to treat a 60 kg adult (refer to Appendix 6.3 for data used during calculation of AETDs). The number of mg/kg used to calculate one AETD was defined as what was, at the time of the study, recommended for a particular drug combination in the treatment guidelines for uncomplicated malaria in areas of low drug resistance issued by the WHO. Where WHO treatment guidelines did not exist, AETDs were based on product manufacturers' treatment guidelines. In the case of ACTs as the treatment consists of 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 weighted 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 weighted median across the wholesaler category. Similar estimates were made for RDT sales volumes in each wholesaler category. See appendix 6.4 for additional information on the calculation of weighted estimates.

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*⁹. For eligible 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 eligible wholesale 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:

⁷ Liquid and powder injectables form a single category.

⁸ Antimalarial drugs intended for prophylaxis and drug combinations not used to treat malaria but that contain an ingredient with antimalarial action were excluded from analysis.

⁹ 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.

$$\frac{(((\text{highest selling price})+(\text{lowest selling price}))/2)-(\text{wholesale purchase price})}{(\text{wholesale purchase price})}$$

Retail purchase prices and mark-ups were calculated using price data collected during the second ACTwatch Outlet Survey. Retail percentage mark-ups were calculated for each product as the difference between selling price and purchase price, divided by purchase price. For both retail and wholesale observations, absolute mark-ups per AETD were calculated for each product as selling price minus purchase price. Data were collected in local currencies and converted to their US\$ equivalent using the average interbank rate during the data collection period.¹⁰

When calculating summary estimates for purchase prices and mark-ups, there was a need to weight survey data to account for (a) the over- or under-sampling of *wholesalers* in markets that may have occurred, (b) the sampling strategy of *retail outlets* which involves a census in the sub-districts of varying size selected using PPS, and (c) the oversampling of certain outlets included in the booster. Appendix 6.4 and 6.5 provide detailed descriptions of the calculations performed and weights used at both wholesale and retail levels.

3.3.4. Summary measures

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

4. Results

4.1. Overview of the sample¹¹

Outlet-level supplier mentions

A total of 835 supply sources were mentioned by public and private sector outlets sampled in the 19 Outlet Survey sub-districts: 760 supplier mentions were gathered from private sector outlets, while the remaining 75 were gathered from either public or NGO sector outlets. A majority of the 75 mentions from public or NGO outlets were for public or NGO sector suppliers: 45 mentions were for CAME or one of its regional depots (3 for CAME Parakou, 1 for CAME Comé); 15 mentions were for public health centres or hospitals (some of which are also supplied through CAME); the *Direction des unités des armées* was mentioned once as a supplier; and the NGO Africare was mentioned by 2 village associations sampled as part of the Outlet Survey. The remaining supplier mentions gathered from public and NGO sector outlets were private sector sources: 5 mentions were for the domestic manufacturer, Pharmaquick; 4 for UBPHAR, one of the 4 licensed wholesalers in Benin; 1 mentioned a private pharmacy; and 1 mentioned a sales representative as one of their top two sources of antimalarials. Only 1 supplier mention gathered from public or NGO sector outlets was for a market located in the town of Azove with no specific business named.

¹⁰ Outlet Survey data collection took place between 28 April to 13 May 2009 (11 to 27 July 2009 for the pharmacy booster sample) and an average exchange rate of 482.7088 West African CFA francs (XOF) to US\$1 during the data collection period was used for the calculation of retail absolute mark-ups. Supply Chain Survey data collection took place between 4 June to 29 June 2009 and an average exchange rate 478.059 West African CFA francs (XOF) to US\$1 during the data collection period was used for the calculation of wholesale absolute mark-ups. Historical exchange rates averaged over the specified periods were obtained from <http://www.oanda.com/currency/historical-rates>.

¹¹ Results related to supplier mentions and the description of the sample presented in section 4.1 are not weighted to account for over- and under-sampling in markets; however, results from section 4.2 and onward are weighted, unless otherwise stated.

Of the 760 mentions from private sector outlets, 213 mentioned a non-market supplier, of which 201 specifically named or gave identifiable information about the business, while 12 did not – giving only general descriptions, such as pharmacy, doctor, clinic, etc. Itinerant vendors accounted for 18 mentions. Most of the supplier mentions gathered from private sector outlets (506 of 760) were for markets, only 14 of which named a specific business within a market, while the vast majority mentioned only the market name as the antimalarial source. A further 19 of these market mentions named a market in Togo. Of the remaining 487 mentions for markets in Benin, 264 referred to a market in Cotonou (e.g. Tokpa, Dantokpa, Adjegounle, etc.); 66 referred to a market in Porto-Novo (e.g. Gando, Grand Marché, etc.), 23 to Comé, 19 to Parakou, 17 to Malanville, 15 to Azove, 12 each to Adja-Ouere and Dassa-Zoumé, 11 to Bohicon, 10 to Save, and less than 5 mentions each for markets located in Banikoara, Bassila, Bembereke, Berou Bouay, Bodi, Bougou, Cobly, Djougou, Gamia, Guene, Houegbo, Kaboua, Kandi, Kodowari, Kokoro, Nagayile, Penessoulou, Pobe, Se, Toura (giving a combined total of 32 mentions). There were 6 mentions for a market for which insufficient information was given to identify the specific location. The remaining 23 mentions from private outlets could not be assigned as either market or non-market suppliers due to insufficient identifying information; however, 13 of these mentions were located outside of Benin, either in Togo, Nigeria or Ghana.

Number of terminal wholesalers identified and interviewed

The non-market mentions gathered from private sector outlets (201) and the non-market private sector supplier mentions gathered from public sector outlets (9) with sufficient identifying information comprised 35 unique businesses, 1 of which was the local manufacturer, Pharmaquick, 10 were public sector health facilities (e.g. hospitals, health centres), 1 was listed only as 'aides americaine', and 1 mentioned the NGO Plan Bénin. CAME (or one of its regional depots) received the most supplier mentions, followed by 3 of the 4 registered wholesalers in Benin, GAPOB, UBPHAR, Promo Pharma. A range of different pharmacies were also mentioned as suppliers of antimalarials. Of these 35 non-market terminal wholesalers identified, 28 were located. One of these wholesalers did not meet screening criteria as they did not have antimalarials or RDTs in stock at the time of interview or at any point during the three months prior to the interview, partial interviews were conducted with two wholesalers, and interviews were completed with 25 terminal wholesalers.

The market mentions gathered from private sector (506) and public sector (1) outlets with sufficient identifying information referred to markets located in 30 different cities or towns. Of the 14 mentions that named a specific business within a market, these referred to 8 unique businesses, 2 of which were located (1 each in Azove and Malanville), and both were successfully interviewed. For the mentions within markets where a specific business was not named, attempts were made to sample a selection of wholesalers within each market in numbers that were roughly proportional to the number of mentions each market received. However, because markets do not all operate every day of the week, it was not possible to survey market wholesalers in each of the 30 market towns mentioned. Wholesalers were not surveyed in the markets of Kaboua, Kokoro, Guene and Se; and for other market towns that could not be visited, wholesalers were sampled from markets in other nearby towns to represent them. Supplier mentions for Azove and Kodowari were sampled from the market in Aplahoué; for Toura in Banikoara, for Penessoulou and Nagayile in Bassila; for Berou Bouay and Gamia in Bembereke; for Bodi and Bougou in Djougou; and for Houegbo in Toffo. See Appendix 6.4 for the number of mentions received for each market. Out of the markets mentioned across 30 different cities and towns, markets in 18 towns and cities were visited. To represent these markets, interviews were attempted with 184 market terminal wholesalers, of which 159 were completed, partial interviews were conducted with 12, 10 refused, an appropriate respondent was not available following three visits in 2 wholesalers, and 1 was not interviewed for other reasons.

In summary, attempts were made to locate and interview 219 wholesalers at terminal level (28 non-market and 184 market suppliers); and of these, interviews were completed with 184, partial interviews were conducted with 14, 1 did not meet screening criteria, 10 refused, 7 could not be located, an appropriate respondent was not available in 2 wholesalers, and 1 was not interviewed for other reasons.

Number of intermediate wholesalers identified and interviewed

From the 198 completed or partially completed interviews with terminal wholesalers, 282 supplier mentions were gathered: 90 referred to non-market suppliers and 181 referred to market suppliers. Of the 90 non-market mentions, 42 did not provide sufficient information to identify the suppliers, while the 48 mentions that did do so referred to 13 unique businesses. Five of these businesses were located outside of Benin, (including two foreign manufacturers: Cipla in India and Novartis in Switzerland), one was the local manufacturer, Pharmaquick – all of these being beyond the scope of this study. Of the 7 remaining eligible intermediate-1 wholesalers identified, only 4 could be located, and all had been interviewed or partially interviewed at the previous level.

Among the 181 mentions of market-based suppliers, 22 specifically named a business and 159 mentioned only the market name or location. Nearly two-thirds of these mentions (128), were for a market located in Cotonou (e.g. Tokpa, Dantokpa, Adjegounle, Gbogbanou), 13 mentions were for a market located in Porto-Novo (e.g. Ouando, Grand Marché), 1 for Dassa-Zoumé, 6 for Malanville, 2 for Save, and 1 each for Parakou and Huegbo/Toffo. Markets in all of these towns had been previously visited and 126 interviews with wholesalers had already been attempted, so they were not revisited. Markets in two additional towns, Allada and Glazoué, not previously visited were mentioned by terminal wholesalers, where 3 new interviews were completed in each market. In addition, markets located in countries neighbouring Benin received 25 mentions: 1 in Ghana, 13 in Nigeria and 11 in Togo.

In summary, attempts were made to locate and interview 139 wholesalers at intermediate-1 level (7 non-market and 132 market suppliers), of which 130 had been identified at a previous level (119 were completed or partially completed, 9 refused, an appropriate respondent was not available in 1 wholesalers, and 1 was not interviewed for other reasons), 3 could not be located, and new interviews were completed with 6 wholesalers at this level.

A similar process was followed to identify intermediate-2 and intermediate-3 wholesalers. At intermediate-2 level, 101 wholesalers were identified (1 non-market supplier, CAME; and 100 market suppliers across markets in Cotonou, Porto-Novo, Dassa-Zoumé, Glazoué, Save and Parakou), and attempts had been made to locate and interview all 101 at previous levels (91 were completed or partially completed, 8 refused, an appropriate respondent was not available in 1 wholesalers, and 1 was not interviewed for other reasons), so no new interviews were conducted at this level. At intermediate-3 level, 32 wholesalers were identified (1 non-market, CAME; and 31 market suppliers all in Cotonou), and interviews had been either completed or partially completed with all 32 at previous levels. Therefore, the top of the chain was deemed to have been reached, with a total of 228 wholesalers that sold antimalarials identified, 190 interviews completed (25 non-market and 165 market-based wholesalers), partial interviews conducted with 14 wholesalers (2 non-market and 12 market-based wholesalers). See Table 4.1 for an overview of the wholesalers sampled and interviewed, and Appendix 6.6 for additional details on the sampling of intermediate-2 and intermediate-3 wholesalers.

Table 4.1: Overview of the wholesalers sampled and interviewed

Levels of operation	Initial Sample Size	Number identified at previous level(s)	Number of refusals ¹	Number of duplicates	Number not eligible ²	Number not interviewed for other reasons ³	Number not found	Number of interviews conducted ⁴
Total	228	-	10	0	1	3	10	204
Terminal	219	-	10	0	1	3	7	198
Intermediate-1	139	130	0	0	0	0	3	6
Intermediate-2	101	101	0	0	0	0	0	0
Intermediate-3 ⁵	32	32	0	0	0	0	0	0

1: 9 refusals at intermediate-1 level and 8 at intermediate-2 level previously occurred at terminal level. 2: Outlets not stocking antimalarials or RDTs at the time of the interview or in the preceding 3 months. 3: 2 wholesalers not interviewed for other reasons at intermediate-1 level and 2 at intermediate-2 level previously occurred at terminal level. At terminal level, a suitable respondent was not available in 2 wholesalers and another was not interviewed for an unspecified reason; while at intermediate-1 and intermediate-2 levels, a suitable respondent not available in 1 wholesaler and another was not interviewed for an unspecified reason. 4: This includes both completed and partially 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 or foreign suppliers as top supply sources for antimalarials; and in the case of mentions gathered from market-based wholesalers that supply intermediate-3 wholesalers, the definition is also extended to include the instance where all market mentions refer to the market in which the wholesaler respondent is based, thus ceasing an infinite cycle of self-references and supply chain levels identified. In the ACTwatch protocol, this level was referred to as the primary level where wholesalers who receive supplies directly from manufacturers operated.

4.2. Structure of the private sector distribution chain for antimalarial drugs¹²

The structure of the private commercial sector distribution chain for antimalarials in Benin 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 4.2.1.¹³

- 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.
- Among all wholesalers surveyed, nearly all (99.5%) were observed to sell directly to retailers, and a third (30.2%) supplied antimalarials to retailers only.
- Over two-thirds (69.8%) of all wholesalers were observed to sell to other wholesalers; however, nearly all of these supplied both wholesalers and retailers, and less than 1% of these were observed to supply antimalarials to other wholesalers exclusively.
- Traditional open-air markets located in commercial towns and cities throughout Benin and in regional neighbours (i.e. Nigeria, Togo, and Ghana) were important sources of antimalarial supplies for private sector pharmaceutical retailers and wholesalers. Two-thirds (66.6%) of all supplier mentions gathered from private sector retailers referred to markets located in both large cities and small towns, and several

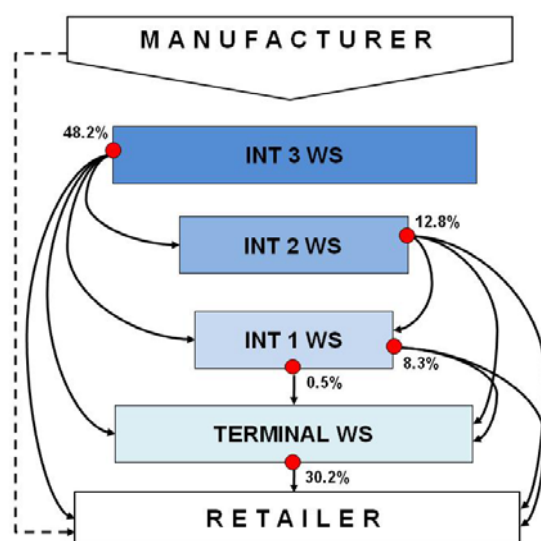
¹² All retail level results presented in this section are not weighted.

¹³ Because market-based wholesalers operating in large commercial centres (i.e. in Cotonou or Porto-Novo) would often mention the same market in which they were located as one of their top two suppliers of antimalarials without naming a specific business, this created an infinite loop of self-referencing which would result in an infinite number of supply chain levels. To avoid this, two conventions were used during the identification of supply chain levels and of mutually exclusive groups: a) if a market wholesaler that operates at multiple supply chain levels refers to another market as its supplier, it was assumed that the reference was arising from the lowest supply chain level to which that wholesaler belonged (e.g. a supplier mention from a wholesaler that operated at intermediate-1 and intermediate-2 levels is assumed to arise from the intermediate-1 level only when assigning the supply chain level within which the mentioned supplier was operating); and b) if a market-based wholesaler refers generically to the market within which it is located as the source of antimalarial supply, this was permitted to contribute to the creation of only 1 additional supply chain level.

also referred to markets in Togo. At wholesale level, 76.4% of all wholesalers interviewed were located in markets, and 60.2% of all wholesalers surveyed reported at least one market-based supplier as their top supply source of antimalarials. However, this differed considerably for wholesalers operating inside and outside of markets: 76.3% of market-based wholesalers reported a market as a top source of antimalarials, while only 4.2% of non-market wholesalers reported such.

- Benin’s public sector procurement agent, CAME, and its regional depots are also important sources of antimalarials for the private sector. At retail level, CAME or one of its regional depots represented 8.2% of all mentions gathered from private sector outlets, and 29.1% of all non-market supplier mentions gathered from private sector outlets. At wholesale level, 9.2% of all those interviewed reported CAME or one of its regional depots as one of their two top antimalarial supply sources. However, CAME was reported as a top antimalarial supply source by 34.8% of non-market wholesalers compared to only 2.2% of market-based wholesalers.
- Businesses were also often supplied with antimalarials by sources outside of Benin. At retail level, 4.2% of all mentions gathered from private sector outlets were for suppliers in Togo, Nigeria or Ghana, and 2.5% specifically referred to a market in Togo. At wholesale level, 19.6% of all wholesalers reported that at least one of their top two antimalarial suppliers was located outside of Benin; however, 22.8% of market-based wholesalers said at least one of their top two suppliers were outside of Benin, while only 8.3% of non-market wholesalers mentioned a supplier outside of Benin.
- Purchasing directly from manufacturers was observed at all levels of the distribution chain. Among public sector outlets, 5.3% of mentions referred to the domestic antimalarial manufacturer, Pharmaquick, as did 4.6% of all mentions gathered from private sector retail outlets (represented by the dashed line in Figure 4.2.1). Among all wholesalers, 10.9% reported a manufacturer as one of their two top antimalarial suppliers, of which 83.0% were supplied by the domestic manufacturer, Pharmaquick, and the remainder were supplied by a foreign manufacturer.

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



WS: wholesaler; INT: intermediate

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

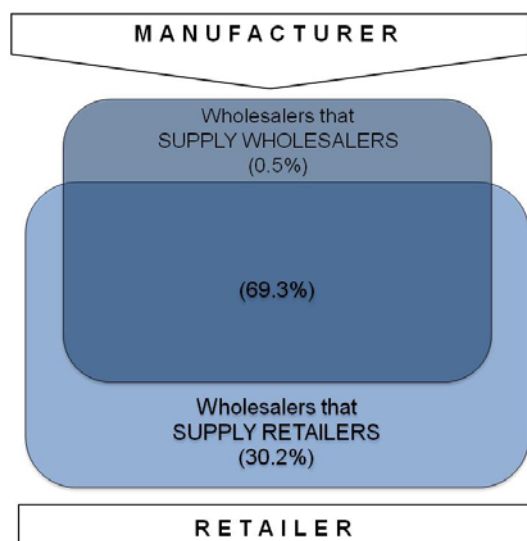
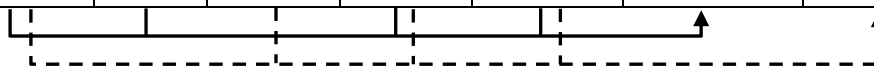


Table 4.2: Defining analytical categories from mutually exclusive wholesaler categories

WHOLESALER CATEGORIES	Total number identified	MUTUALLY EXCLUSIVE CATEGORIES					ANALYTICAL CATEGORIES	
		Supplies int 1, terminal & retailer	Supplies retailer	Supplies terminal	Supplies terminal & retailer	Supplies int 2, int 1, terminal & retailer	Supply Retailers	Supply Wholesalers
% of WS	100%	12.8%	30.2%	0.5%	8.3%	48.2%	99.5%	69.8%
(N)	(218)	(28)	(66)	(1)	(18)	(105)	(217)	(136)



WS: wholesaler, int: intermediate wholesaler

Note: this table presents the number of wholesalers identified which exceeds those interviewed

4.3. Wholesaler characteristics and business practices

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

- Wholesalers had a median of 3 employees and had been in operation for a median of 8 years, but this varied considerably as the IQR ranged from 4 to 15 years of operation. Wholesalers outside of markets were larger and had been in operation longer than market-based wholesalers (median of 7 employees and 14 years vs. 2 employees and 6 years).
- Three-quarters of all wholesalers (76.0%) sold other products alongside pharmaceuticals; however, a greater proportion of those based in markets (83.7%) did so than those operating outside of markets (50.0%). The most common consumer goods stocked by all wholesalers were toiletries (70.1%), household goods (30.6%), and food and drinks (14.6%).

Table 4.3.1: Years in operation, outlet size and range of products sold, by various wholesaler categories

CHARACTERISTICS		WHOLESALER CATEGORIES				
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS	NON-MARKET WHOLESALERS	MARKET WHOLESALERS
Years in operation	Median	8	7	8	14	6
	IQR	4-15	4-12	4-15	10-19	4-12
	(N)	(182)	(114)	(176)	(22)	(160)
Number of people working at outlet	Median	3	2	3	7	2
	IQR	2-4	2-3	2-4	3.5-12.5	1-3
	(N)	(199)	(121)	(193)	(24)	(175)
Sells other products in addition to pharmaceuticals ¹	%	76.0	85.7	76.0	50.0	83.7
	(N)	(203)	(124)	(197)	(26)	(177)

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

4.3.2. Wholesalers' customers, delivery activities and credit facilities

- Wholesalers mentioned a broad range of antimalarial customer types in both private and public sectors; however, the most frequently mentioned customers were retail customers (96.0%). Less commonly mentioned were other private sector businesses, such as other drug wholesalers (53.8%); private clinics, health centres or dispensaries (31.5%), or general retailers (30.9%); while public sector outlets were the least mentioned customers by wholesalers: public clinics, health centres or dispensaries were mentioned by 19.3%, and public hospitals were mentioned by 12.4%.
- Compared to non-market wholesalers, higher proportions of wholesalers based in markets reported supplying retail customers (99.4% vs. 84.6%), general retailers (36.2% vs. 16.0%), general wholesalers (33.7% vs. 4.0%), and other drug wholesalers (67.0% vs. 8.0%); while more non-market wholesalers reported supplying public hospitals (25.0% vs. 8.0%) and public clinics, health centres and dispensaries (33.3% vs. 14.4%).
- Only a fifth (22.2%) of all wholesalers reported having customers in other countries; although more non-market wholesalers reported having such customers (30.8%) than market-based wholesalers (18.8%). The countries most frequently mentioned included the neighbouring countries Togo (10.4%), Nigeria (10.0%) and Niger (7.3%); and other less frequently mentioned countries included Cameroon, Burkina Faso, Mali, Equatorial Guinea, and Mali.
- A quarter of all wholesalers (26.8%) reported importing antimalarials. This was also higher among market-based wholesalers (29.8%) than non-market wholesalers (16.0%).
- Only 10.9% of all wholesalers reported a manufacturer as one of their two top antimalarial suppliers, of which 83.0% were supplied by the domestic manufacturer, Pharmaquick, and the remainder were supplied by a foreign manufacturer.
- Among all wholesalers, only a few (7.6%) reported delivering antimalarial orders to their customers; however, 19.2% of non-market wholesalers reported delivering orders and only 4.1% of market-based wholesalers reported doing so.
- Half of all wholesalers (55.3%) reported providing credit facilities to their customers; however, a higher proportion of those based in markets (60.0%) reported offering credit than non-market wholesalers (40.0%). The typical credit terms offered by customers also varied: market-based wholesalers offered credit terms for a median of 15 days (IQR 9-20 days); while non-market wholesalers offer longer credit terms with a median of 30 days (IQR 30-30 days)

Table 4.3.2: Wholesalers' Customers, Delivery Activities and Credit facilities, by various wholesaler categories

ANTIMALARIAL CUSTOMER TYPES		WHOLEALER CATEGORIES				
		ALL WHOLESALEERS	SUPPLY WHOLESALEERS	SUPPLY RETAILERS	NON-MARKET WHOLESALEERS	MARKET WHOLESALEERS
Retail Customers (e.g. patients, care-takers)	% (N)	96.0 (203)	95.6 (124)	96.0 (197)	84.6 (26)	99.4 (177)
Retail Outlets						
Pharmacies	% (N)	26.1 (183)	32.5 (113)	26.2 (177)	29.2 (24)	25.0 (159)
General retailers (grocery stores, etc.) ¹	% (N)	30.9 (184)	39.2 (113)	30.7 (178)	16.0 (25)	36.2 (159)
Public clinics, health centres or dispensaries	% (N)	19.3 (179)	20.9 (110)	19.4 (174)	33.3 (24)	14.4 (155)
Private clinics, health centres or dispensaries	% (N)	31.5 (182)	36.2 (111)	31.7 (177)	37.5 (24)	29.5 (158)
Public hospitals	% (N)	12.4 (180)	13.9 (110)	12.5 (175)	25.0 (24)	8.0 (256)
Private hospitals	% (N)	25.5 (184)	32.4 (111)	25.6 (179)	20.8 (24)	27.0 (160)
Wholesale Outlets						
Drug wholesalers	% (N)	53.8 (200)	72.2 ² (123)	54.1 (194)	8.0 (25)	67.0 (175)
General wholesalers ¹	% (N)	26.0 (185)	39.0 (113)	26.1 (179)	4.0 (25)	33.7 (160)
Customers in Other Countries	% (N)	22.2 (180)	24.1 (108)	22.4 (174)	30.8 (26)	18.8 (154)
BUSINESS PRACTICES		SUPPLY WHOLESALEERS	SUPPLY WHOLESALEERS	SUPPLY RETAILERS	NON-MARKET WHOLESALEERS	MARKET WHOLESALEERS
Import antimalarial drugs	% (N)	26.8 (200)	32.0 (122)	26.5 (194)	16.0 (25)	29.8 (175)
Buy directly from antimalarial manufacturers (as one of two top antimalarial suppliers)	% (N)	10.9 (190)	13.0 (116)	10.9 (184)	16.7 (24)	9.2 (166)
Deliver antimalarials to customers	% (N)	7.6 (202)	6.0 (123)	7.6 (196)	19.2 (26)	4.1 (176)
Provided credit to customers in the past 3 months	% (N)	55.3 (201)	60.6 (122)	55.2 (195)	40.0 (25)	60.0 (176)
Most common terms of credit offered in the past 3 months (number of days)	Median IQR (N)	15 10-30 (105)	15 10-20 (62)	15 10-30 (102)	30 30-30 (9)	15 9-20 (96)

1: Some wholesalers interviewed may have understood the question asked to mean customers for 'any medicines' and not specifically antimalarials, or perhaps customers that buy 'any medicines for the management of malaria', which may include antipyretics, vitamins, etc. that are commonly sold by general retailers. 2: 27.8% of wholesalers in this category reported that they did not supply drug wholesalers; however, during the supply chain survey, wholesale respondents identified these particular wholesalers as one of their top two supply sources for antimalarials, or in the case of market-based wholesalers, identified the entire market in which the wholesaler was located as one of their top two supply sources for antimalarials. To remain consistent across indicators, we have chosen to report this indicator as 72.2% rather than 100.0% based on the information reported by the suppliers rather than their customers.

4.4. Licensing & inspection

- Among all wholesalers interviewed, very few reported having any type of license from the DPM. Wholesalers reported having a retail pharmacy licence (8.5%), more than any other type, followed by wholesale pharmacy licenses (1.0%) and pharmaceutical importing licenses (1.0%). Of the few businesses that reported possessing any licence, all were non-market wholesalers.
- When wholesalers reported having any license from the DPM, very few of these were observed to be up-to-date. For example, among all wholesalers, 0.9% were observed to have any up-to-date license, and no wholesaler was observed to possess an up-to-date license permitting the wholesale of medicines.
- Despite this, 15.2% of all wholesalers reported that they had been visited by a pharmaceutical inspector in the year preceding the interview; 59.1% of non-market wholesalers reported having been inspected, while only 3.5% of market-based wholesalers reported having been inspected.

Table 4.4: Licensing & Inspection, by various wholesaler categories

REGISTRATION STATUS		WHOLESALER CATEGORIES				
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS	NON-MARKET WHOLESALERS	MARKET WHOLESALERS
Reported having a license allowing wholesale of pharmaceuticals	% (N)	1.0 (191)	1.3 (122)	1.0 (185)	5.6 (18)	0.0 (173)
Reported having a retail pharmacy license	% (N)	8.5 (193)	0.0 (123)	8.5 (187)	47.4 (19)	0.0 (174)
Reported having an import license	% (N)	1.0 (192)	1.3 (123)	1.0 (186)	5.6 (18)	0.0 (174)
Reported having a manufacturer license	% (N)	0.0 (192)	0.0 (123)	0.0 (186)	0.0 (18)	0.0 (174)
Any up-to-date license from the DPM was observed	% (N)	0.9 (196)	0.0 (122)	0.9 (190)	4.4 (23)	0.0 (173)
An up-to-date wholesale license from the DPM was observed	% (N)	0.0 (196)	0.0 (122)	0.0 (190)	0.0 (23)	0.0 (173)
Any business license or certificate of registration was observed	% (N)	0.2 (195)	0.0 (122)	0.2 (189)	0.0 (21)	0.2 (174)
Reported they had been visited by a pharmaceutical inspector in the past year	% (N)	15.2 (189)	5.2 (117)	15.1 (184)	59.1 (22)	3.5 (167)

4.5. Knowledge, qualifications and training

- Half of all wholesalers interviewed (53.6%) were able to correctly identify AL as the government recommended first-line treatment for uncomplicated *Pf* malaria; in addition, 0.9% mentioned the alternative first-line treatment, ASAQ, while 25.9% of all wholesalers responded that they did not know the recommended treatment.
- However, the proportion of wholesalers identifying an ACT as the most effective medication for treating uncomplicated malaria was slightly lower (32.7% for children and 28.9% for adults). Chloroquine was most commonly mentioned as the most effective antimalarial among all wholesalers (38.7% for adults and 48.9% for children), and AL was the second most commonly mentioned (23.0% for adults and 22.6% for children), followed by SP (11.6% for adults and 14.1% for children).
- Nearly a third (28.7%) of all wholesalers reported employing staff with health qualifications; the most commonly reported health qualifications were pharmacy dispensers (18.9%), followed by pharmacists (17.8%), nurses/midwives (8.9%), and health care aides (8.7%).
- Very few wholesalers indicated that staff had participated in in-service training related to malaria treatment in the past 2 years was low (3.6% of all wholesalers interviewed).
- Large differences were observed across non-market and market wholesaler categories with respect to health qualifications, training and knowledge: compared to market-based wholesalers, higher proportions of non-market wholesalers correctly identified the recommended first-line treatment (76.9% vs. 48.5%), identified an ACT as the most effective antimalarial for adults (57.7% vs. 20.0%) and for children (61.5% vs. 23.6%), employed a member of staff with health qualifications (92.3% vs. 2.8%) and had staff who received training related to malaria treatment in the past two years (16.7% v. 0.0%).

Table 4.5: Wholesalers' knowledge, qualifications and training, by various wholesaler categories

HEALTH QUALIFICATIONS, TRAINING AND KNOWLEDGE		WHOLESALER CATEGORIES				
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS	NON-MARKET WHOLESALERS	MARKET WHOLESALERS
Employ a member of staff with health qualifications ¹	% (N)	28.7 (142)	7.7 (91)	28.9 (139)	92.3 (26)	2.8 (116)
Employ staff who participated in in-service training related to malaria treatment in the past 2 years	% (N)	3.6 (200)	0.0 (123)	3.6 (194)	16.7 (24)	0.0 (176)
Identify any ACT as the most effective medication for treating uncomplicated <i>Pf</i> malaria in adults	% (N)	28.9 (196)	24.5 (118)	28.9 (190)	57.7 (26)	20.0 (170)
Identify any ACT as the most effective medication for treating uncomplicated <i>Pf</i> malaria in children	% (N)	32.7 (194)	28.0 (117)	32.6 (188)	61.5 (26)	23.6 (168)
Correctly identify the government recommended first line treatment for uncomplicated <i>Pf</i> malaria	% (N)	55.1 (196)	53.0 (118)	55.2 (191)	76.9 (26)	48.5 (170)

1: Health qualifications included pharmacist, pharmacy technician, pharmacy assistant, medical doctor, nurse, midwife, pharmacy dispenser, health care aide

4.6. Storage of antimalarial drugs

- All wholesalers were observed to store antimalarials in a dry area; although fewer were observed to keep them out of direct sunlight (93.1%) or keep them off the floor (98.4%). Overall, 91.8% of all wholesalers surveyed met all of these conditions for good storage of antimalarials.
- All wholesalers operating outside of markets were observed to store antimalarials out of direct sunlight, while this was observed among only 90.1% of market-based wholesalers; however a higher proportion of market-based wholesalers (99.5%) stored their antimalarials off the floor compared to non-market wholesalers (95.8%).

Table 4.6: Wholesalers' storage practices, by various wholesaler categories

STORAGE		WHOLESALER CATEGORIES				
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS	NON-MARKET WHOLESALERS	MARKET WHOLESALERS
Store antimalarials in a dry area	% (N)	100.0 (154)	100.0 (93)	100.0 (151)	100.0 (24)	100.0 (130)
Store antimalarials out of direct sunlight	% (N)	93.1 (154)	89.5 (93)	93.1 (151)	100.0 (24)	90.1 (130)
Store antimalarials off the floor	% (N)	98.4 (154)	97.6 (93)	98.4 (151)	95.8 (24)	99.5 (130)
Store antimalarials in a dry area, out of direct sunlight & off the floor	% (N)	91.8 (154)	87.5 (93)	91.7 (151)	95.8 (24)	89.9 (130)

4.7. Availability of antimalarials & RDTs

- Nearly all wholesalers surveyed (97.7%) had at least one antimalarial in stock at the time of interview, and a similar proportion (97.5%) stocked a nAT.
- However, less than half (46.8%) of all wholesalers surveyed had an ACT in stock at the time of interview, and a similar proportion (46.6%) reported having had at least one ACT in stock throughout the three month period prior to interview.
- A similar proportion of all wholesalers (46.5%) stocked AL and/or ASAQ, the recommended and alternative first-line treatments for uncomplicated *Pf* malaria; 44.1% stocked AL and 15.9% stocked ASAQ.
- A higher proportion of all wholesalers had WHO prequalified ACTs in stock (43.9%) than non-WHO prequalified ACTs (24.7%), which was also observed across different levels of the distribution chain.
- Oral AMTs were stocked by 6.5% of all wholesalers, and 10.5% of all wholesalers stocked a non-oral AMT product (i.e. injectable or suppository).
- Compared to wholesalers operating inside markets, a higher proportion of non-market wholesalers stocked ACTs (74.1% vs. 38.4%), WHO prequalified ACTs (74.1% vs. 34.6%), non-WHO prequalified ACTs (59.3% vs. 14.0%), oral AMTs (25.9% vs. 0.5%), and non-oral AMTs (44.4% vs. 0.0%).
- The most frequently observed antimalarials were quinine (accounting for 20.6% of all antimalarial products stocked by wholesalers), followed closely by the first-line antimalarial, AL (accounting for 20.5%). SP accounted for another 16.6% and chloroquine for 9.7%, while ASAQ only accounted for 5.7%. 73.4% of all the observed quinine was in tablet form, while 26.1% was in injectable dosage form.
- AL and ASAQ accounted for the majority of ACT products observed to be stocked by all wholesalers (54.2% and 15.5%, respectively); the next most frequently observed ACT was dihydroartemisinin-piperazine (DHA+PP), accounting for 11.7% of all ACT products stocked.
- RDTs were stocked by only 4.4% of all wholesalers; 18.5% of non-market wholesalers reported stocking RDTs, while no market-based wholesalers stocked RDTs.

Table 4.7: Antimalarial & RDT availability, by various wholesaler categories

AVAILABILITY		WHOLESALER CATEGORIES				
		ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS	NON-MARKET WHOLESALERS	MARKET WHOLESALERS
Had antimalarials in stock	% (N)	97.7 (204)	99.4 (125)	97.7 (198)	92.6 (27)	99.3 (177)
Had ACT in stock	% (N)	46.8 (204)	45.5 (125)	46.9 (198)	74.1 (27)	38.4 (177)
Always had at least one ACT in stock over the past 3 months	% (N)	46.6 (204)	45.2 (125)	46.7 (198)	74.1 (27)	38.1 (177)
Had WHO prequalified ACT in stock	% (N)	43.9 (204)	41.5 (125)	44.0 (198)	74.1 (27)	34.6 (177)
Had non-WHO prequalified ACT in stock	% (N)	24.7 (204)	20.0 (125)	24.8 (198)	59.3 (27)	14.0 (177)
Had oral AMT in stock	% (N)	6.5 (204)	4.3 (125)	6.6 (198)	25.9 (27)	0.5 (177)
Had non-oral AMT in stock	% (N)	10.5 (204)	5.0 (125)	10.5 (198)	44.4 (27)	0.0 (177)
Had nAT in stock	% (N)	97.5 (204)	99.4 (125)	97.5 (198)	92.6 (27)	99.1 (177)
Had RDT in stock	% (N)	4.4 (204)	1.2 (125)	4.4 (198)	18.5 (27)	0.0 (177)

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 all wholesalers (n=201), the median number of adult equivalent treatment doses (AETDs) sold the week preceding the survey was highest for nATs (222.1, IQR 21.3-1104.1), most of which were sold in tablet form; and because the proportion of all wholesalers stocking other types of antimalarials was much lower than for nATs, the median number of AETDs sold for ACTs and AMTs among all wholesalers was very low: 0.0 (IQR 0.0-45.0) for ACTs, and 0.0 (IQR 0.0-0.0) for AMTs. (Table 4.8.1)
- However, when ACTs were stocked by wholesalers, their typical sales volume during the week preceding the survey was 47.5 AETDs (IQR 7.3-86.4). The typical sales volume of WHO prequalified ACTs among all wholesalers that stocked them (23.8 AETDs, IQR 7.5-63.8) was larger than that for non-WHO prequalified ACTs (7.5 AETDs, IQR 0.0-50.0). (Table 4.8.2)
- When AMTs were stocked by wholesalers, their typical sales volume was still low but varied considerably: the median number of AETDs sold was 0.0 (IQR 0.0-101.4); however, tablet and oral liquid AMT dosage forms typically sold in greater volumes than injectable AMT dosage forms (9.4 AETDs for tablets vs. 17.2 AETDs for oral liquids vs. 0.0 AETDs for injectables). The typical volumes of AMT sold by wholesalers supplying other wholesalers (133.7 AETDs, IQR 75.8-144.9) was considerably higher than the typical AMT volumes sold by wholesalers supplying retailers (0.0 AETDs, IQR 0.0-101.4). (Table 4.8.2)
- Among all wholesalers, 36.9% reported selling any ACT during the week preceding the survey, 34.3% reported selling WHO prequalified ACTs, 17.4% sold non-WHO prequalified ACTs, 5.4% sold AMTs, and 84.4% sold nATs.
- Among all wholesalers who had antimalarials in stock at the time of interview (n=199), the top selling antimalarial was quinine for 34.1% of wholesalers, SP for 30.2%, and chloroquine for 25.0%. The recommended first-line treatment for uncomplicated malaria, AL, was the fourth most frequently mentioned top selling antimalarial; however, this was the case for only 4.2% of all wholesalers. In addition, AL was the top selling antimalarial for 12.0% of non-market wholesalers, but only 2.0% of market-based wholesalers.¹⁴
- When wholesalers stocked and sold ACTs, wholesalers operating outside of markets tended to sell larger volumes of ACTs (150.2 AETDs, IQR 0.0-529.1) than market-based wholesalers (36.6 AETDs, IQR 20.8-55.0); however, the reverse was observed with respect to nATs: the typical sales volume among non-market wholesalers was 92.0 AETDs (IQR 7.2-1272.8) and 254.0 AETDs (IQR 30.0-1104.1) for market-based wholesalers.
- RDTs were rarely stocked by wholesalers. Those who did stock RDTs and provided sales volume information were all public sector facilities, and the volume of tests sold during the week preceding the interview was very low: 0 tests (IQR 0-0).

¹⁴The 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), by various wholesaler categories

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALER CATEGORIES				
			ALL WHOLESALERS N=201 ³	SUPPLY WHOLESALERS N=123	SUPPLY RETAILERS N=195	NON-MARKET WHOLESALERS N=26	MARKET WHOLESALERS N=175
All ACT	All	Median	0.0	0.0	0.0	1.5	0.0
		IQR	0.0-45.0	0.0-47.5	0.0-47.5	0.0-358.8	0.0-22.5
	Tablet	Median	0.0	0.0	0.0	1.5	0.0
		IQR	0.0-35.0	0.0-36.6	0.0-35.0	0.0-336.9	0.0-22.5
	Oral liquid	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-21.9	0.0-0.0
WHO prequalified ACT	All products were tablets	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-22.5	0.0-23.8	0.0-22.5	0.0-215.0	0.0-21.5
Non-WHO prequalified ACT	All	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-35.1	0.0-0.0
	Tablet	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-11.9	0.0-0.0
	Oral liquid	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-21.9	0.0-0.0
AMT	All	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
	Tablet	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
	Oral liquid	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
	Injectable	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
nAT	All	Median	222.1	335.0	244.2	84.2	254.0
		IQR	21.3-1104.1	71.4-1145.4	21.3-1104.1	2.0-1272.8	30.0-1104.1
	Tablet	Median	141.9	254.0	141.9	21.9	165.5
		IQR	9.5-809.5	39.5-984.1	9.5-809.5	0.0-641.3	22.1-896.8
	Oral liquid	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-15.3	0.0-120.0	0.0-15.3	0.0-0.0	0.0-70.1
	Injectable	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
			ALL WHOLESALERS N=201	SUPPLY WHOLESALERS N=123	SUPPLY RETAILERS N=195	NON-MARKET WHOLESALERS N=26	MARKET WHOLESALERS N=175
RDT ⁴ (per unit)		Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria; 2 The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however, because so few wholesalers and retailers stocked suppositories or granules, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. 3 For antimalarials: there were a total of 201 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, 218 wholesalers were identified, of which 190 were interviewed successfully and 11 were partially interviewed but included an audit. Two of these wholesalers did not stock antimalarials at the time of interview but did so in the three months prior to interview, so their sales volumes were set as 0 for all antimalarial categories. Of the remaining, 3 were partially interviewed but did not include an audit, 10 refused, 3 were not screened because a respondent was not available or for other reasons, and 1 did not stock antimalarials at the time of the survey or during the three months prior to the visit (Table 1). These 17 wholesalers were excluded from the volumes analysis. Overall, there were a total of 1518 antimalarials audited, and 359 (23.67%) had missing sales volumes that were imputed using the *mi impute pmm* command. 4 For RDTs: Of the 201 wholesalers completely or partially interviewed from whom stocking information was collected, 8 reported stocking RDTs and inventory data were collected on 4 observed products. Of these, information on sales volume was not provided for 1 product from 1 wholesaler; however imputation was not performed as there were too few observations to reliably perform linear regression. Sales volumes were set as missing for the other 4 wholesalers who reported stocking RDTs but from whom inventory data were not collected. Therefore for RDTs, median sales volumes at the level supplying retail outlets are estimated based on the sample of 3 products from 3 wholesalers for which volumes were not missing.

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

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALE CATEGORIES ³				
			ALL WHOLESALERS	SUPPLY WHOLESALERS	SUPPLY RETAILERS	NON-MARKET WHOLESALERS	MARKET WHOLESALERS
All ACT	All	Median	47.5	47.5	47.5	150.2	36.6
		IQR	7.3-86.4	21.5-55.0	7.3-86.4	0.0-529.1	20.8-55.0
		(n)	(74)	(49)	(72)	(20)	(54)
	Tablet	Median	36.6	36.6	36.6	55.5	35.0
		IQR	7.0-63.8	21.5-55.0	7.0-63.8	0.0-467.5	20.8-55.0
		(n)	(74)	(49)	(72)	(20)	(54)
Oral liquid	Median	7.9	103.2	7.9	0.0	7.9	
	IQR	0.0-103.2	7.9-153.4	0.0-103.2	0.0-147.1	7.9-7.9	
	(n)	(19)	(8)	(19)	(15)	(4)	
WHO prequalified ACT	All products were tablets	Median	23.8	36.6	23.8	20.0	26.3
		IQR	7.5-63.8	21.5-55.0	7.5-63.8	0.0-292.5	20.8-55.0
		(n)	(67)	(43)	(66)	(20)	(47)
Non-WHO prequalified ACT	All	Median	7.5	11.5	7.5	33.0	7.5
		IQR	0.0-50.0	2.5-50.0	0.0-50.0	0.0-176.5	2.0-30.2
		(n)	(35)	(21)	(34)	(16)	(19)
	Tablet	Median	7.5	7.8	7.5	6.8	7.5
		IQR	0.0-30.0	2.5-50.0	0.0-30.0	0.0-40.8	2.0-11.2
		(n)	(35)	(21)	(34)	(16)	(19)
Oral liquid	Median	7.9	103.2	7.9	0.0	7.9	
	IQR	0.0-103.2	7.9-153.4	0.0-103.2	0.0-147.1	7.9-7.9	
	(n)	(19)	(8)	(19)	(15)	(4)	
AMT	All	Median	0.0	133.7	0.0	0.0	8.7
		IQR	0.0-101.4	75.8-144.9	0.0-101.4	0.0-101.4	8.7-12.5
		(n)	(16)	(6)	(16)	(14)	(2)
	Tablet	Median	9.4	64.4	9.4	9.4	8.7
		IQR	0.0-64.4	31.9-839.9	0.0-64.4	0.0-64.4	8.7-12.5
		(n)	(9)	(5)	(9)	(7)	(2)
Oral liquid	Median	17.2	22.5	17.2	17.2	-	
	IQR	5.9-40.9	11.9-59.3	5.9-40.9	5.9-40.9	-	
	(n)	(4)	(3)	(4)	(4)	-	
Injectable	Median	0.0	51.3	0.0	0.0	-	
	IQR	0.0-51.3	26.4-353.3	0.0-51.3	0.0-51.3	-	
	(n)	(12)	(4)	(12)	(12)	-	
nAT	All	Median	244.2	335.0	244.2	92.0	254.0
		IQR	22.1-1104.1	71.4-1145.4	22.1-1104.1	7.2-1272.8	30.0-1104.1
		(n)	(197)	(123)	(191)	(25)	(172)
	Tablet	Median	143.9	254.0	143.9	32.0	171.0
		IQR	16.7-858.9	45.0-984.1	16.7-858.9	2.0-750.1	23.3-896.8
		(n)	(188)	(120)	(183)	(24)	(164)
Oral liquid	Median	70.1	120.0	70.1	1.9	120.0	
	IQR	2.2-120.0	19.0-120.0	2.2-120.0	0.0-259.7	8.0-120.0	
	(n)	(89)	(56)	(84)	(8)	(81)	
Injectable	Median	133.3	250.0	133.3	42.4	250.0	
	IQR	0.0-264.5	72.1-264.5	0.0-264.5	0.0-264.5	39.7-250.0	
	(n)	(37)	(17)	(37)	(21)	(16)	
RDT (units)		Median	0	-	0	0	-
		IQR	0-0	-	0-0	0-0	-
		(n)	(3)	-	(3)	(3)	-

¹ ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. ² The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesalers and retailers stocked granules or suppositories or granules, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. ³ (n) is the number of wholesalers at a given level who stocked antimalarials for corresponding drug category or who stocked RDT.

4.9. Purchase price of antimalarials and RDTs

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

- Among all wholesalers, median purchase prices per AETD were highest for AMTs (US\$ 13.17, IQR 7.31-20.11), followed by ACTs (US\$ 5.82, IQR 3.92-11.35), then nATs (US\$ 1.24, IQR 0.48-3.63).
- However, unlike ACTs and nATs where the majority of observed products audited among all wholesalers were tablets, most of the AMT products observed were injectables, thus driving up the overall median purchase price for AMTs. Looking at tablets only, the median purchase price of AMTs (US\$ 5.91, IQR: 4.35-6.47) was more similar to that for ACT tablets (US\$ 4.85, IQR: 3.13-6.90); although both were considerably higher than the median purchase price paid by wholesalers for nAT tablets (US\$0.79, IQR: 0.42-2.28).
- Across distribution chain levels, the median priced paid by wholesalers supplying other wholesalers to purchase ACTs and AMTs tended to lower than the typical prices paid by wholesalers supplying retailers. For example, the median purchase price for ACTs paid by wholesalers supplying wholesalers was US\$ 4.57 (IQR: 2.54-10.25), while among those supplying retailers, it was US\$ 5.82 (IQR: 3.92-11.35)
- Wholesalers based in markets tended to have paid lower prices to purchase ACTs and nATs overall. For nATs, this was the case across all dosage forms. For ACTs, this was driven by the much lower price paid by market-based wholesalers to purchase WHO prequalified ACTs, all of which were in tablet form. While the median prices paid to purchase non-WHO prequalified ACTs did not differ across these wholesaler types regardless of dosage form, market-based wholesalers paid a median purchase price of US\$ 2.09 (IQR: 1.88-3.18) for prequalified ACTs compared to the median price of US\$ 4.80 (IQR: 1.26-6.53) paid by non-market wholesalers. This difference arises because all of the WHO prequalified ACT among market wholesalers was AL; while among non-market wholesalers, 80.0% was AL and 20.0% was ASAQ, which have a large difference in median purchase price (AL: US\$ 2.30 vs. ASAQ: US\$ 8.88). Furthermore, a greater proportion of AL observed among market wholesalers was branded as Coartem (87.6%) compared to non-market wholesalers (51.5%), which itself had a lower median purchase price (US\$ 2.09, IQR: 1.26-2.51) compared to AL not branded as Coartem (US\$ 4.57, IQR: 3.92-6.34).
- As expected, the median purchase price varied across dosage forms, and within each antimalarial category tablets attracted the lowest median purchase prices per AETD, followed by oral liquid formulations, and then by injectable dosage forms.
- At retail level, pharmacies tended to have paid the highest prices to purchase ACTs (US\$ 7.12, IQR: 5.71-13.55), followed by other more informal private outlets (US\$ 2.49, IQR: 2.07-2.49); while the median purchase prices were similar among private health facilities (US\$ 1.24, IQR: 1.24-7.61) and public health facilities (US\$ 1.24, IQR: 1.24-1.24)¹⁵. Similar to wholesale level, these differences across retail outlet types were largely driven by the types of ACTs being stocked. For example, 93.5% and 98.1% of the ACT products observed among public health facilities and other private outlets were AL, while this was

¹⁵ The 'private health facility' analytical category includes both private for-profit and not-for-profit health facilities. As such, the overall median purchase price for ACT (US\$ 1.24) reflects the typical purchase price among not-for-profit facilities, as does the lower bound of the IQR (US\$ 1.24); while upper bound of the IQR (US\$ 7.61) reflects the typical purchase price among for-profit health facilities.

74.0% at private health facilities and 47.6% at pharmacies who stocked a broader range of ACTs, such as dihydroartemisinin+piperaquine, AS+SP and ASAQ. In addition, virtually all of the AL observed at public health facilities and other private outlets was branded as Coartem, which had a median purchase price of US\$ 1.24 (IQR 1.24-1.24) at public health facilities and US\$ 2.49 (IQR 2.07-2.49) at other private outlets; while the median purchase price of Coartem at pharmacies was US\$ 6.47 (IQR 6.47-6.47).

- Across the different retail outlet categories, pharmacies also tended to pay the highest purchase prices for nATs, while other private outlets, such as market stalls, paid the lowest purchase prices for nATs.
- Retail-level median purchase prices for nATs ranged from US\$ 0.31 (IQR 0.29-0.80) in other private outlets, such as market stalls, to US\$ 4.41 (IQR 0.81-9.52) in pharmacies, and for AMT, purchase prices ranged from US\$ 2.49 (IQR 0.00-4.03) in public health facilities to US\$ 18.55 (IQR 15.52-40.53) in pharmacies. Price data on oral AMTs were limited at retail level; however in pharmacies, prices for oral AMTs were comparable to prices for ACT across dosage forms. For example, the median purchase price in pharmacies was US\$ 6.34 for ACT tablets and US\$ 5.91 for AMT tablets.
- In general, median purchase prices across antimalarial category and dosage forms paid by pharmacies were consistently higher than the purchase prices paid by non-market wholesalers; while the purchase prices paid by other private outlets, such as market stalls, were similarly consistent with the purchase prices of market-based wholesalers.
- Regarding first-line treatments for uncomplicated *Pf* malaria, the median purchase price per AETD at wholesale level for AL was US\$ 4.40 (IQR 2.30-12.05), but differed between wholesalers based in markets (US\$ 2.09, IQR 1.95-7.94) and non-market wholesalers (US\$ 5.09, IQR 3.93-12.17) for the reasons described above. However, the purchase price for AL was still considerably higher than the median price for SP (US\$ 0.60, IQR 0.31-0.78), the antimalarial with the highest number of AETDs distributed. At retail level, median purchase prices for AL ranged from US\$ 1.24 (IQR 1.24-1.24) in public health facilities to US\$ 6.47 (IQR 4.93-14.54) in pharmacies; while median purchase prices for SP ranged from US\$ 0.09 (IQR 0.00-0.60) in public health facilities to US\$ 0.77 (IQR 0.74-1.63) in pharmacies.
- RDTs were rarely stocked by wholesalers, and RDT purchase price information was obtained from only 3 public health facilities identified as sources of antimalarials for private sector outlets. Because these public sector suppliers receive RDTs free of charge through the public sector distribution chain, the median purchase price for RDTs is US\$ 0.00 (IQR: 0.00-0.00). No corresponding price information was obtained from private sector wholesalers.

Table 4.9.1: Purchase price per AETD/RDT (US\$), wholesale level, by various wholesaler categories

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALER CATEGORIES				
			ALL WHOLESALERS N=199	SUPPLY WHOLESALERS N=123	SUPPLY RETAILERS N=193	NON-MARKET WHOLESALERS N=25	MARKET WHOLESALERS N=174
All ACT	All	Median	5.82	4.57	5.82	6.18	2.09
		IQR	3.92-11.35	2.54-10.25	3.92-11.35	4.50-11.35	1.88-13.95
		(n)	(393)	(209)	(391)	(298)	(95)
Tablet	Tablet	Median	4.85	4.19	4.85	5.58	2.09
		IQR	3.13-6.90	2.23-5.65	3.13-6.90	4.12-7.44	1.67-5.23
		(n)	(322)	(174)	(320)	(235)	(87)
Oral liquid	Oral liquid	Median	14.41	12.55	14.41	14.41	15.06
		IQR	12.55-17.07	11.35-16.47	12.55-17.07	12.55-17.07	13.95-20.08
		(n)	(56)	(26)	(56)	(49)	(7)
WHO prequalified ACT	All products were tablets	Median	3.18	2.51	3.18	4.80	2.09
		IQR	1.88-6.34	2.09-4.80	1.88-6.34	1.26-6.53	1.88-3.18
		(n)	(127)	(74)	(126)	(63)	(64)
Non WHO prequalified ACT	All	Median	6.44	5.49	6.44	6.43	7.95
		IQR	4.63-12.55	3.98-11.47	4.63-12.55	4.63-12.10	1.51-20.08
		(n)	(266)	(135)	(265)	(235)	(31)
Tablet	Tablet	Median	5.65	4.53	5.65	5.65	5.23
		IQR	4.19-7.95	3.43-5.84	4.19-7.95	4.28-7.69	0.90-8.16
		(n)	(195)	(100)	(194)	(172)	(23)
Oral liquid	Oral liquid	Median	14.41	12.55	14.41	14.41	15.06
		IQR	12.55-17.07	11.35-16.47	12.55-17.07	12.55-17.07	13.95-20.08
		(n)	(56)	(26)	(56)	(49)	(7)
AMT	All	Median	13.17	11.46	13.17	13.17	4.69
		IQR	7.31-20.11	6.47-13.77	7.31-20.11	7.31-20.13	4.69-4.69
		(n)	(81)	(49)	(81)	(80)	(1)
Tablet	Tablet	Median	5.91	4.39	5.91	5.91	4.69
		IQR	4.35-6.47	4.07-6.47	4.35-6.47	4.35-6.47	4.69-4.69
		(n)	(16)	(11)	(16)	(15)	(1)
Oral liquid	Oral liquid	Median	12.05	12.05	12.05	12.05	-
		IQR	12.03-15.48	12.03-12.05	12.03-15.48	12.03-15.48	-
		(n)	(6)	(5)	(6)	(6)	-
Injectable	Injectable	Median	20.16	15.02	20.16	20.16	-
		IQR	14.99-31.16	12.79-31.16	14.99-31.16	14.99-31.16	-
		(n)	(39)	(18)	(39)	(39)	-
nAT	All	Median	1.24	1.21	1.24	2.97	0.75
		IQR	0.48-3.63	0.48-2.98	0.48-3.63	0.74-7.67	0.25-1.84
		(n)	(735)	(486)	(716)	(243)	(492)
Tablet	Tablet	Median	0.79	0.79	0.79	1.55	0.75
		IQR	0.42-2.28	0.42-2.11	0.42-2.28	0.56-4.78	0.22-1.71
		(n)	(528)	(359)	(513)	(135)	(393)
Oral liquid	Oral liquid	Median	2.75	1.88	2.75	4.52	0.50
		IQR	0.47-7.67	0.39-4.67	0.47-7.67	2.56-7.82	0.27-3.14
		(n)	(120)	(71)	(116)	(39)	(81)
Injectable	Injectable	Median	4.69	7.12	4.69	5.12	2.56
		IQR	1.30-11.18	2.35-21.90	1.30-11.18	2.02-14.50	0.69-8.57
		(n)	(85)	(54)	(85)	(68)	(17)
RDT (per unit) ³		Median	0.00	-	0.00	0.00	-
		IQR	(0.00-0.00)	-	(0.00-0.00)	(0.00-0.00)	-
		(n)	(3)	-	(3)	(3)	-

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for median price reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesalers and retailers stocked granules or suppositories, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. 3 The three RDT wholesalers that provided price information were all public sector health facilities that received RDTs from their suppliers and dispensed them free of charge.

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

ANTIMALARIAL TYPE ¹ Formulation ²			RETAILER CATEGORIES ³			
			PHARMACIES N=28	PRIVATE HEALTH FACILITIES N=63	OTHER PRIVATE OUTLETS ⁴ N=337	PUBLIC HEALTH FACILITIES N=124
All ACT	All	Median	7.12	1.24	2.49	1.24
		IQR	5.71-13.55	1.24-7.61	2.07-2.49	1.24-1.24
		(n)	(304)	(25)	(10)	(329)
	Tablet	Median	6.34	1.24	2.49	1.24
		IQR	5.54-7.87	1.24-5.97	2.07-2.49	1.24-1.24
		(n)	(232)	(20)	(9)	(328)
	Oral liquid	Median	15.28	14.09	7.73	14.09
		IQR	13.80-16.90	14.09-14.11	7.73-7.73	14.09-14.09
		(n)	(67)	(5)	(1)	(1)
WHO prequalified ACT	All products were tablets	Median	-	-	-	1.66
		IQR	-	-	-	0.00-1.66
		(n)	-	-	-	(14)
Non WHO prequalified ACT	All	Median	7.12	1.24	2.49	1.24
		IQR	5.71-13.55	1.24-7.61	2.07-2.49	1.24-1.24
		(n)	(304)	(25)	(10)	(315)
	Tablet	Median	6.34	1.24	2.49	1.24
		IQR	5.54-7.87	1.24-5.97	2.07-2.49	1.24-1.24
		(n)	(232)	(20)	(9)	(314)
	Oral liquid	Median	15.28	14.09	7.73	14.09
		IQR	13.80-16.90	14.09-14.11	7.73-7.73	14.09-14.09
		(n)	(67)	(5)	(1)	(1)
AMT	All	Median	18.55	12.42	-	2.49
		IQR	15.52-40.53	12.42-17.40	-	0.00-4.03
		(n)	(56)	(6)	-	(5)
	Tablet	Median	5.91	12.42	-	4.03
		IQR	5.86-6.36	12.42-12.42	-	4.03-4.03
		(n)	(6)	(1)	-	(1)
	Oral liquid	Median	15.73	-	-	-
		IQR	15.73-15.73	-	-	-
		(n)	(1)	-	-	-
	Injectable	Median	22.13	26.55	-	2.49
		IQR	20.19-66.82	17.40-26.60	-	0.00-2.49
		(n)	(32)	(5)	-	(4)
nAT	All	Median	4.41	2.61	0.31	2.58
		IQR	0.81-9.52	0.26-5.66	0.16-0.99	0.68-4.70
		(n)	(152)	(158)	(612)	(296)
	Tablet	Median	1.53	0.93	0.23	2.26
		IQR	0.74-4.22	0.21-2.61	0.16-0.47	0.17-2.58
		(n)	(94)	(118)	(549)	(181)
	Oral liquid	Median	8.48	8.70	1.12	-
		IQR	5.49-8.55	8.70-8.70	0.83-1.86	-
		(n)	(29)	(1)	(59)	-
	Injectable	Median	15.34	8.70	11.96	4.79
		IQR	5.68-21.62	5.22-11.46	3.50-17.40	4.35-7.66
		(n)	(29)	(39)	(4)	(115)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for median price reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesalers and retailers stocked granules or suppositories, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. 3 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. 4 Other private outlets include boutiques in and out of markets, stalls in and out of markets, and itinerant medicine sellers (hawkers). Note: 22 of 5233 (0.4%) purchase price observations (4 in pharmacies, 4 in private health facilities, 6 in other private outlet types, 8 in public health facilities) were set to missing due to mark-ups in excess of 1000% which were likely due to errors during data collection.

4.10. Price mark-ups on antimalarials and RDTs

4.10.1. Percent Mark-Ups on Antimalarials and RDTs

In general, the percentage mark-up is calculated as the difference between the selling price and the purchase price, divided by the purchase price. It captures both the costs of doing business and profit to the seller. Because wholesalers vary their prices, minimum, maximum and mid mark-ups were calculated using data on minimum and maximum selling price charged for one unit by wholesalers. The wholesale percent mid mark-up was calculated as the difference between the average wholesale selling price (i.e. the mid-point between the maximum and minimum wholesale selling price) and wholesale purchase price, divided by wholesale purchase price. The retail percent mark-up was calculated using the retail selling price and purchase price collected during the ACTwatch Outlet Survey.¹⁶

- Among all wholesalers, median percent mark-ups were similar and generally consistent across antimalarial type and dosage form, ranging from 31.0% to 36.0%, largely reflecting what is permitted by the existing price regulations. The median percent mark-up on WHO prequalified ACTs among all wholesalers was slightly lower at 25.0%, as was the median percent mark-up on tablet nATs (29.2%).
- Percent mark-ups among wholesalers supplying other wholesalers, wholesaler supplying retailers and non-market wholesalers exhibited the same pattern described above; however, the typical mark-ups applied by market-based wholesalers tended to be considerably lower. Among these wholesalers, the mid percent mark-up on non-WHO prequalified ACTs was 8.3% (IQR 1.9-16.3), 14.9% (IQR 7.5-25.0) on prequalified ACT, and 19.4% (IQR 11.1-31.3) on nAT.
- Wholesalers reported varying their mark-up on 18.4% of all observed products depending on the volume being purchased (based on the 1451 observations where mark-up data were obtained); however, wholesalers based in markets varied their mark-up on 46.0% of observed products, while non-market wholesalers varied their mark-ups on only 2.7% of observed products. Overall, the difference between the highest and lowest median mark-ups was around 10% points for ACTs, 11% points for AMTs, and 8% points for nATs.
- Among private sector retail outlets, percent mark-ups varied across retailer type and sometimes also across antimalarial category. Pharmacies were observed to apply mark-ups of approximately 31% across all antimalarial categories, which is in line with the existing price regulations. Private health facilities applied mark-ups of about 33% on ACTs and AMTs, and higher mark-ups on nATs (median of 66.7%). Other private outlets, such as market stalls, were observed to apply the lowest mark-ups among private sector retailers, with a median of 16.7% on ACTs and 42.9% on nATs. Retail percent mark-ups on nAT injectables also tended to be higher than mark-ups on nAT tablets and oral liquids in both private health facilities and other private outlets, such as market stalls.
- In public health facilities, the median percent mark-up on ACT tablets was 0.0% (IQR 0.0-0.0); and a mark-up of approximately 50% was consistently applied to all other types of antimalarials (i.e. ACT oral liquids, and all other non-ACTs).
- Regarding first-line treatment for uncomplicated *Pf* malaria, the median percent mark-up for AL among all wholesalers was 30.9% (IQR 15.0-36.0), but ranged from 13.6% (IQR 5.3-22.2) among market-based wholesalers to 33.0% (IQR 30.9-36.0) among non-market wholesalers. At retail level, the median percent mark-up for AL ranged from a high of 33.3% (IQR 33.3-100.0) at private health facilities, to a low of 16.7% (IQR -20.0-33.3) at other private outlets, such as market stalls.

¹⁶ Negative percent mark-ups were recorded in several cases, for which there are several possible explanations: (1) data collection errors (e.g. antimalarials bought in relatively large pack sizes and sold by individual unit were sometimes subject to errors); (2) some businesses may have sold products at lower prices than at which they were bought to deal with slow moving products or because the purchase price has increased and the business was still selling the 'old' product at the 'old' price.

- For SP, the antimalarial with the highest number of AETDs distributed, the wholesale median mid percent mark-up observed was similar to AL: 33.0% (IQR 18.1-36.0) among all wholesalers, 36.0% (IQR 31.3-36.0) among non-market wholesalers, and 18.2% (IQR 11.1-37.5) among market-based wholesalers. At retail level, mark-ups ranged from 31.0% (IQR 30.6-31.8) at pharmacies to 50.0% (IQR 50.0-531.3) at private health facilities.
- RDTs were rarely stocked by wholesalers, and RDT mark-up information was obtained from only 3 public health facilities identified as sources of antimalarials for private sector outlets. Because these public sector suppliers receive RDTs free of charge through the public sector distribution chain, the median percent mark-up for RDTs is 0.0% (IQR: 0.0-0.0). No corresponding price information was obtained from private sector wholesalers.

Table 4.10.1.1a: Percent price mark-ups on antimalarials and RDTs, wholesale level, by supply chain level category (%)

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALE CATEGORIES								
			ALL WHOLESALERS N=199			SUPPLY WHOLESALERS N=123			SUPPLY RETAILERS N=193		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
All ACT	All	Median	31.0	31.0	31.0	36.0	36.0	36.0	31.0	31.0	31.0
		IQR	25.0-36.0	20.0-36.0	30.0-36.0	15.0-36.0	11.1-36.0	20.0-36.0	25.0-36.0	20.0-36.0	30.0-36.0
		(n)		(378)		(202)		(377)			
	Tablet	Median	31.0	31.0	31.0	36.0	36.0	36.0	31.0	31.0	31.0
		IQR	20.0-36.0	17.9-36.0	22.2-36.0	15.0-36.0	11.1-36.0	20.0-36.0	20.0-36.0	17.9-36.0	22.2-36.0
		(n)		(308)		(168)		(307)			
	Oral liquid	Median	33.0	33.0	33.0	36.0	36.0	36.0	33.0	33.0	33.0
		IQR	30.9-36.0	30.9-36.0	30.9-36.0	8.3-36.0	8.3-36.0	8.3-36.0	30.9-36.0	30.9-36.0	30.9-36.0
		(n)		(55)		(25)		(55)			
WHO prequalified ACT	All products were tablets	Median	25.0	20.0	30.8	22.2	14.9	30.0	25.0	20.0	30.8
		IQR	12.5-36.0	9.1-33.0	13.3-36.0	12.5-36.0	9.1-36.0	13.3-36.0	12.5-36.0	9.1-33.0	13.3-36.0
		(n)		(118)		(73)		(118)			
Non WHO prequalified ACT	All	Median	33.0	33.0	33.0	36.0	36.0	36.0	33.0	33.0	33.0
		IQR	30.9-36.0	30.9-36.0	30.9-36.0	36.0-36.0	36.0-36.0	36.0-36.0	30.9-36.0	30.9-36.0	30.9-36.0
		(n)		(260)		(129)		(259)			
	Tablet	Median	33.0	33.0	33.0	36.0	36.0	36.0	33.0	33.0	33.0
		IQR	30.9-36.0	30.9-36.0	30.9-36.0	36.0-36.0	36.0-36.0	36.0-36.0	30.9-36.0	30.9-36.0	30.9-36.0
		(n)		(190)		(95)		(189)			
	Oral liquid	Median	33.0	33.0	33.0	36.0	36.0	36.0	33.0	33.0	33.0
		IQR	30.9-36.0	30.9-36.0	30.9-36.0	8.3-36.0	8.3-36.0	8.3-36.0	30.9-36.0	30.9-36.0	30.9-36.0
		(n)		(55)		(25)		(55)			

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALE CATEGORIES									
			ALL WHOLESALERS N=199			SUPPLY WHOLESALERS N=123			SUPPLY RETAILERS N=193			
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH	
AMT	All	Median	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
		IQR	31.2-36.0	31.2-36.0	31.2-36.0	36.0-36.0	36.0-36.0	36.0-36.0	31.2-36.0	31.2-36.0	31.2-36.0	31.2-36.0
		(n)		(81)			(49)			(81)		
	Tablet	Median	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
	IQR	30.9-36.0	30.9-36.0	30.9-36.0	36.0-36.0	36.0-36.0	36.0-36.0	30.9-36.0	30.9-36.0	30.9-36.0	30.9-36.0	
	(n)		(16)			(11)			(16)			
	Oral liquid	Median	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	
	IQR	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	
	(n)		(6)			(5)			(6)			
	Injectable	Median	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	
	IQR	31.0-36.0	31.0-36.0	31.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	31.0-36.0	31.0-36.0	31.0-36.0	31.0-36.0	
	(n)		(39)			(18)			(39)			
nAT	All	Median	31.0	30.8	32.5	29.2	25.0	33.3	31.0	30.8	32.7	
		IQR	16.7-36.0	14.3-36.0	18.1-36.0	14.7-36.0	12.5-36.0	16.7-36.0	16.7-36.0	14.3-36.0	18.1-36.0	
		(n)		(733)			(480)			(714)		
	Tablet	Median	29.2	25.0	30.9	25.0	21.7	28.6	29.2	25.0	30.9	
	IQR	15.4-36.0	12.5-36.0	17.6-36.0	14.3-36.0	11.8-36.0	16.7-36.0	15.4-36.0	12.5-36.0	17.6-36.0		
	(n)		(530)			(356)			(515)			
	Oral liquid	Median	33.0	31.3	33.0	36.0	33.3	36.0	33.0	31.3	33.0	
	IQR	16.6-36.0	16.4-36.0	20.0-36.0	13.0-36.0	10.3-36.0	14.3-36.2	16.6-36.0	16.4-36.0	20.0-36.0		
	(n)		(117)			(69)			(113)			
	Injectable	Median	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	
	IQR	22.7-36.0	20.4-36.0	27.3-36.0	22.7-36.0	20.4-36.0	27.3-36.0	22.7-36.0	20.4-36.0	27.3-36.0		
	(n)		(84)			(53)			(84)			
RDT (per unit) ³		Median	0.0	0.0	0.0	-	-	-	0.0	0.0	0.0	
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	-	-	-	0.0-0.0	0.0-0.0	0.0-0.0	
		(n)		(3)			-			(3)		

¹ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. ²The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesalers and retailers stocked granules or suppositories, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. ³The three RDT wholesalers that provided price information were all public sector health facilities that received RDTs from their suppliers and dispensed them free of charge.

Table 4.10.1.1b: Percent price mark-ups on antimalarials and RDTs, wholesale level, by non-market vs. market category (%)

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALE CATEGORIES								
			ALL WHOLESALERS N=199			NON-MARKET WHOLESALERS N=25			MARKET WHOLESALERS N=174		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
All ACT	All	Median IQR (n)	31.0 25.0-36.0	31.0 20.0-36.0 (378)	31.0 30.0-36.0	33.0 30.9-36.0	33.0 30.9-36.0 (286)	33.0 30.9-36.0	13.3 5.3-25.0	10.0 5.0-16.7 (92)	14.3 5.3-30.0
	Tablet	Median IQR (n)	31.0 20.0-36.0	31.0 17.9-36.0 (308)	31.0 22.2-36.0	33.0 30.9-36.0	33.0 30.9-36.0 (224)	33.0 30.9-36.0	14.3 6.4-25.0	10.0 5.3-20.0 (84)	16.3 6.4-33.3
	Oral liquid	Median IQR (n)	33.0 30.9-36.0	33.0 30.9-36.0 (55)	33.0 30.9-36.0	33.0 30.9-36.0	33.0 30.9-36.0 (48)	33.0 30.9-36.0	7.4 0.0-8.3	7.4 0.0-8.3 (7)	7.4 0.0-8.3
WHO prequalified ACT	All products were tablets	Median IQR (n)	25.0 12.5-36.0	20.0 9.1-33.0 (118)	30.8 13.3-36.0	31.0 30.8-36.0	31.0 30.8-36.0 (55)	31.0 30.8-36.0	14.9 7.5-25.0	10.0 6.4-16.7 (63)	18.2 9.1-33.3
Non WHO prequalified ACT	All	Median IQR (n)	33.0 30.9-36.0	33.0 30.9-36.0 (260)	33.0 30.9-36.0	33.0 30.9-36.0	33.0 30.9-36.0 (231)	33.0 30.9-36.0	8.3 1.9-16.3	7.4 1.9-16.3 (29)	8.3 1.9-16.3
	Tablet	Median IQR (n)	33.0 30.9-36.0	33.0 30.9-36.0 (190)	33.0 30.9-36.0	33.0 30.9-36.0	33.0 30.9-36.0 (169)	33.0 30.9-36.0	9.1 5.3-33.3	8.3 4.0-33.3 (21)	12.8 5.3-33.3
	Oral liquid	Median IQR (n)	33.0 30.9-36.0	33.0 30.9-36.0 (55)	33.0 30.9-36.0	33.0 30.9-36.0	33.0 30.9-36.0 (48)	33.0 30.9-36.0	7.4 0.0-8.3	7.4 0.0-8.3 (7)	7.4 0.0-8.3

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLEALER CATEGORIES								
			ALL WHOLESALERS N=199			NON-MARKET WHOLESALERS N=25			MARKET WHOLESALERS N=174		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
AMT	All	Median	36.0	36.0	36.0	36.0	36.0	36.0	19.6	14.3	25.0
		IQR	31.2-36.0	31.2-36.0	31.2-36.0	31.2-36.0	31.2-36.0	31.2-36.0	19.6-19.6	14.3-14.3	25.0-25.0
		(n)		(81)			(80)		(1)		
	Tablet	Median	36.0	36.0	36.0	36.0	36.0	36.0	19.6	14.3	25.0
	IQR	30.9-36.0	30.9-36.0	30.9-36.0	30.9-36.0	30.9-36.0	30.9-36.0	19.6-19.6	14.3-14.3	25.0-25.0	
	(n)		(16)			(15)		(1)			
	Oral liquid	Median	36.0	36.0	36.0	36.0	36.0	36.0	-	-	-
	IQR	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	-	-	-
	(n)		(6)			(6)		-	-	-	
	Injectable	Median	36.0	36.0	36.0	36.0	36.0	36.0	-	-	-
	IQR	31.0-36.0	31.0-36.0	31.0-36.0	31.0-36.0	31.0-36.0	31.0-36.0	31.0-36.0	-	-	-
	(n)		(39)			(39)		-	-	-	
nAT	All	Median	31.0	30.8	32.5	36.0	36.0	36.0	19.4	16.7	22.2
		IQR	16.7-36.0	14.3-36.0	18.1-36.0	31.0-36.0	31.0-36.0	31.0-36.0	11.1-31.3	10.3-25.0	11.1-33.3
		(n)		(733)			(255)		(478)		
	Tablet	Median	29.2	25.0	30.9	35.9	35.9	35.9	19.4	16.7	23.1
	IQR	15.4-36.0	12.5-36.0	17.6-36.0	31.0-36.0	31.0-36.0	31.0-36.0	11.9-30.0	11.1-25.0	14.3-33.3	
	(n)		(530)			(146)		(384)			
	Oral liquid	Median	33.0	31.3	33.0	35.9	35.9	35.9	20.0	16.7	25.0
	IQR	16.6-36.0	16.4-36.0	20.0-36.0	30.9-36.0	30.9-36.0	30.9-36.0	10.0-50.0	7.1-33.3	10.0-66.7	
	(n)		(117)			(39)		(78)			
	Injectable	Median	36.0	36.0	36.0	36.0	36.0	36.0	18.2	18.2	18.2
	IQR	22.7-36.0	20.4-36.0	27.3-36.0	36.0-36.0	36.0-36.0	36.0-36.0	36.0-36.0	-88.0-20.9	-88.0-18.2	-88.0-23.6
	(n)		(84)			(69)		(15)			
RDT (per unit) ³		Median	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	-	-	-
		(n)		(3)			(3)		-	-	-

¹ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. ²The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesalers and retailers stocked granules or suppositories, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. ³The three RDT wholesalers that provided price information were all public sector health facilities that received RDTs from their suppliers and dispensed them free of charge.

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

ANTIMALARIAL TYPE ¹ Formulation ²			RETAILER CATEGORIES ³			
			PHARMACIES N=28	PRIVATE HEALTH FACILITIES N=62	OTHER PRIVATE OUTLETS ⁴ N=350	PUBLIC HEALTH FACILITIES N=120
All ACT	All	Median	30.9	33.3	16.7	0.0
		IQR (n)	30.9-31.0 (307)	22.5-83.3 (23)	-20.0-33.3 (10)	0.0-0.0 (276)
	Tablet	Median	30.9	33.3	16.7	0.0
		IQR (n)	30.8-31.0 (231)	22.5-100.0 (18)	-20.0-33.3 (9)	0.0-0.0 (275)
	Oral liquid	Median	30.9	37.0	7.1	47.1
		IQR (n)	30.9-31.0 (67)	25.5-37.3 (5)	7.1-7.1 (1)	47.1-47.1 (1)
WHO prequalified ACT	All products were tablets	Median	-	-	-	0.0
		IQR (n)	-	-	-	0.0-33.3 (9)
Non WHO prequalified ACT	All	Median	30.9	33.3	16.7	0.0
		IQR (n)	30.9-31.0 (307)	22.5-83.3 (23)	-20.0-33.3 (10)	0.0-0.0 (267)
	Tablet	Median	30.9	33.3	16.7	0.0
		IQR (n)	30.8-31.0 (231)	22.5-100.0 (18)	-20.0-33.3 (9)	0.0-0.0 (266)
	Oral liquid	Median	30.9	37.0	7.1	47.1
		IQR (n)	30.9-31.0 (67)	25.5-37.3 (5)	7.1-7.1 (1)	47.1-47.1 (1)
AMT	All	Median	30.9	33.5	-	50.0
		IQR (n)	30.8-31.0 (55)	33.5-33.5 (6)	-	50.0-50.0 (4)
	Tablet	Median	30.9	33.5	-	50.0
		IQR (n)	30.9-31.0 (6)	33.5-33.5 (1)	-	50.0-50.0 (1)
	Oral liquid	Median	30.8	-	-	-
		IQR (n)	30.8-30.8 (1)	-	-	-
	Injectable	Median	30.9	25.0	-	50.0
		IQR (n)	30.5-31.0 (31)	21.7-42.9 (5)	-	50.0-50.0 (3)
nAT	All	Median	31.0	66.7	42.9	50.0
		IQR (n)	30.7-32.0 (152)	33.3-100.0 (157)	25.0-66.7 (625)	31.2-73.2 (281)
	Tablet	Median	31.0	50.0	40.0	43.6
		IQR (n)	30.8-33.1 (94)	42.9-100.0 (118)	25.0-78.6 (562)	3.1-68.4 (169)
	Oral liquid	Median	30.8	28.6	37.5	-
		IQR (n)	30.8-31.1 (29)	28.6-28.6 (1)	20.0-66.7 (59)	-
	Injectable	Median	30.8	73.9	87.5	50.0
		IQR (n)	30.7-32.2 (29)	33.3-100.0 (38)	55.6-275.0 (4)	42.9-81.8 (112)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesaler and retailers stocked suppositories, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. 3 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. 4 Other private outlets include boutiques in and out of markets, stalls in and out of markets, and itinerant medicine sellers (hawkers). Note: 22 of 5233 (0.4%) mark-up observations (4 in pharmacies, 4 in private health facilities, 6 in other private outlet types, 8 in public health facilities) were set to missing due to mark-ups in excess of 1000% which were likely due to errors during data collection.

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. As with the percent mark-up, 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.

- At wholesale level, median mid absolute mark-ups among all wholesalers were highest on AMTs (US\$ 4.33, IQR: 2.33-6.31), followed by ACTs (US\$ 1.70, IQR: 0.98-2.82), and then nATs (US\$ 0.22, IQR: 0.10-1.05), generally corresponding to differences in median purchase price (i.e. because percent mark-ups did not vary considerably across antimalarial category, higher purchase price led to higher absolute mark-ups).
- Similar to what was already noted in section 4.9 on wholesale purchase prices, AMTs tended to have the highest absolute mark-ups overall, because compared to other antimalarial drug types, costly injectable products constituted a greater proportion of all observed AMT products. However, median absolute mark-ups were similar on AMT and ACT tablets (US\$ 1.57 vs. US\$ 1.56, respectively) and oral liquids (US\$ 4.33 vs. US\$ 4.48, respectively).
- Absolute mark-ups applied within the same antimalarial category and dosage form were not observed to vary considerably across different levels of the wholesale supply chain. However, consistent with the observed differences in wholesale purchase price and percent mark-up noted across non-market and market wholesaler categories, absolute mark-ups also varied considerably across these particular wholesaler groups. Considering tablet dosage forms only, the median absolute mark-up on ACTs was US\$ 1.74 (IQR 1.29-2.22) among non-market wholesalers vs. US\$ 0.31 (IQR 0.15-0.63) among market-based wholesalers, and US\$ 0.32 (IQR 0.19-1.58) on nATs among non-market wholesalers vs. US\$ 0.12 (IQR 0.05-0.33) among market-based wholesalers.
- At retail level, median absolute mark-ups varied in line with observed differences in purchase prices and percent mark-ups across outlet and product type. Within antimalarial categories, injectable products attracted the highest absolute mark-ups, followed by oral liquids, and then tablets. Also, within the same antimalarial category and dosage form, pharmacy and private health facilities tended to apply higher absolute mark-ups than other private outlets, such as market stalls. For example, the median absolute mark-up on nAT tablets was US\$ 0.48 (IQR 0.23-1.33) in pharmacies, US\$ 0.71 (IQR 0.10-1.31) in private health facilities, and US\$ 0.10 (IQR 0.05-0.21) in other private outlets.
- Regarding, AL, the first-line treatment for uncomplicated *Pf* malaria, the absolute mark-up among all wholesalers was US\$ 1.28 (IQR 0.38-2.12), but tended to be higher among non-market wholesalers (US\$ 1.74, IQR 1.24-4.22) than among market-based wholesalers (US\$ 0.31, IQR 0.13-0.63). Across retailer types, the median absolute mark-up was US\$ 2.00 (IQR 1.43-4.72) in pharmacies; US\$ 1.24 (IQR 0.41-1.24) in private health facilities; and \$0.41 (IQR -0.41-0.41) in other private outlets, such as market stalls.

- For SP, the antimalarial with the highest number of AETDs distributed, the median absolute wholesale mark-up was US\$ 0.18 (IQR 0.08-0.27) among all wholesalers, but also tended to be higher among non-market wholesalers (US\$ 0.24, IQR 0.19-0.51) than among market-based wholesalers (US\$ 0.08, IQR 0.02-0.13). At retail level, the median absolute mark-up on SP was highest at pharmacies (US\$ 0.24, IQR 0.22-0.50), followed by other private outlets (US\$ 0.15, IQR 0.10-0.21), and lowest in private health facilities (US\$ 0.10, IQR 0.10-0.44).
- RDTs were rarely stocked by wholesalers, and RDT mark-up information was obtained from only 3 public health facilities identified as sources of antimalarials for private sector outlets. Because these public sector suppliers receive RDTs free of charge through the public sector distribution chain, the median absolute mark-up for RDTs is US\$ 0.00 (IQR: 0.00-0.00). No corresponding price information was obtained from private sector wholesalers.

Table 4.10.2.1a: Absolute price mark ups on antimalarials and RDTs, wholesale level, by supply chain level category (US\$)

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALE CATEGORIES								
			ALL WHOLESALERS N=199			SUPPLY WHOLESALERS N=123			SUPPLY RETAILERS N=193		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
All ACT	All	Median	1.70	1.70	1.70	1.43	1.43	1.43	1.70	1.70	1.70
		IQR	0.98-2.82	0.98-2.82	1.02-2.82	0.42-2.03	0.42-2.03	0.47-2.03	0.98-2.82	0.98-2.82	1.02-2.82
		(n)		(378)		(202)		(377)			
	Tablet	Median	1.56	1.56	1.56	1.23	1.23	1.23	1.56	1.56	1.56
		IQR	0.63-2.04	0.63-2.04	0.84-2.04	0.38-1.70	0.26-1.70	0.42-1.70	0.63-2.04	0.63-2.04	0.84-2.04
		(n)		(308)		(168)		(307)			
	Oral liquid	Median	4.48	4.48	4.48	4.08	4.08	4.08	4.48	4.48	4.48
		IQR	4.08-5.92	4.08-5.92	4.08-5.92	1.67-4.52	1.67-4.52	1.67-4.52	4.08-5.92	4.08-5.92	4.08-5.92
		(n)		(55)		(25)		(55)			
WHO prequalified ACT	All products were tablets	Median	0.63	0.63	0.84	0.52	0.42	0.63	0.63	0.63	0.84
		IQR	0.26-1.83	0.21-1.83	0.31-1.83	0.19-1.64	0.19-1.64	0.21-1.64	0.26-1.83	0.21-1.83	0.31-1.83
		(n)		(118)		(73)		(118)			
Non WHO prequalified ACT	All	Median	1.95	1.95	1.95	1.62	1.62	1.62	1.95	1.95	1.95
		IQR	1.33-4.01	1.33-4.01	1.33-4.01	1.09-2.47	1.09-2.47	1.09-2.47	1.33-4.01	1.33-4.01	1.33-4.01
		(n)		(260)		(129)		(259)			
	Tablet	Median	1.67	1.67	1.67	1.51	1.51	1.51	1.67	1.67	1.67
		IQR	1.26-2.22	1.26-2.22	1.26-2.22	0.91-2.01	0.91-2.01	0.98-2.01	1.26-2.22	1.26-2.22	1.26-2.22
		(n)		(190)		(95)		(189)			
	Oral liquid	Median	4.48	4.48	4.48	4.08	4.08	4.08	4.48	4.48	4.48
		IQR	4.08-5.92	4.08-5.92	4.08-5.92	1.67-4.52	1.67-4.52	1.67-4.52	4.08-5.92	4.08-5.92	4.08-5.92
		(n)		(55)		(25)		(55)			

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALE CATEGORIES								
			ALL WHOLESALERS N=199			SUPPLY WHOLESALERS N=123			SUPPLY RETAILERS N=193		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
AMT	All	Median	4.33	4.33	4.33	4.13	4.13	4.13	4.33	4.33	4.33
		IQR	2.33-6.31	2.33-6.31	2.33-6.31	2.33-4.96	2.33-4.96	2.33-4.96	2.33-6.31	2.33-6.31	2.33-6.31
		(n)		(81)			(49)		(81)		
	Tablet	Median	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
	IQR	1.14-2.24	1.14-2.24	1.14-2.24	1.46-2.33	1.46-2.33	1.46-2.33	1.14-2.24	1.14-2.24	1.14-2.24	
	(n)		(16)			(11)		(16)			
	Oral liquid	Median	4.33	4.33	4.33	4.34	4.34	4.34	4.33	4.33	4.33
	IQR	4.20-4.34	4.20-4.34	4.20-4.34	4.33-4.34	4.33-4.34	4.33-4.34	4.20-4.34	4.20-4.34	4.20-4.34	
	(n)		(6)			(5)		(6)			
	Injectable	Median	6.33	6.33	6.33	5.41	5.41	5.41	6.33	6.33	6.33
	IQR	4.74-10.69	4.74-10.69	4.74-10.69	4.61-11.22	4.61-11.22	4.61-11.22	4.74-10.69	4.74-10.69	4.74-10.69	
	(n)		(39)			(18)		(39)			
nAT	All	Median	0.22	0.21	0.23	0.19	0.18	0.20	0.22	0.21	0.23
		IQR	0.10-1.05	0.08-1.05	0.10-1.05	0.09-0.85	0.08-0.85	0.10-0.85	0.10-1.05	0.08-1.05	0.11-1.05
		(n)		(719)			(473)		(700)		
	Tablet	Median	0.18	0.18	0.19	0.16	0.16	0.18	0.18	0.18	0.19
	IQR	0.08-0.46	0.06-0.40	0.10-0.53	0.08-0.44	0.05-0.40	0.10-0.53	0.08-0.46	0.06-0.40	0.10-0.53	
	(n)		(518)			(351)		(503)			
	Oral liquid	Median	0.57	0.57	0.63	0.20	0.16	0.24	0.57	0.57	0.63
	IQR	0.12-1.68	0.08-1.68	0.16-1.68	0.12-0.99	0.08-0.99	0.16-0.99	0.12-1.68	0.08-1.68	0.16-1.68	
	(n)		(116)			(68)		(112)			
	Injectable	Median	1.45	1.45	1.45	1.59	1.59	1.59	1.45	1.45	1.45
	IQR	0.16-3.94	0.16-3.94	0.18-3.94	0.16-7.69	0.13-7.69	0.19-7.69	0.16-3.94	0.16-3.94	0.18-3.94	
	(n)		(83)			(52)		(83)			
RDT (per unit) ³		Median	0.00	0.00	0.00	-	-	-	0.00	0.00	0.00
		IQR	0.00-0.00	0.00-0.00	0.00-0.00	-	-	-	0.00-0.00	0.00-0.00	0.00-0.00
		(n)		(3)			-		(3)		

¹ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. ²The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesalers and retailers stocked granules or suppositories, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. ³The three RDT wholesalers that provided price information were all public sector health facilities that received RDTs from their suppliers and dispensed them free of charge.

Table 4.10.2.1b: Absolute price mark ups on antimalarials and RDTs, wholesale level, by non-market vs. market category (US\$)

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALE CATEGORIES								
			ALL WHOLESALERS N=199			NON-MARKET WHOLESALERS N=25			MARKET WHOLESALERS N=174		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
All ACT	All	Median	1.70	1.70	1.70	1.97	1.97	1.97	0.31	0.21	0.42
		IQR	0.98-2.82	0.98-2.82	1.02-2.82	1.44-3.81	1.44-3.81	1.44-3.81	0.15-0.63	0.13-0.42	0.15-0.71
		(n)		(378)		(286)		(92)			
	Tablet	Median	1.56	1.56	1.56	1.74	1.74	1.74	0.31	0.21	0.42
		IQR	0.63-2.04	0.63-2.04	0.84-2.04	1.29-2.22	1.29-2.22	1.29-2.22	0.15-0.63	0.13-0.42	0.15-0.63
		(n)		(308)		(224)		(84)			
	Oral liquid	Median	4.48	4.48	4.48	4.52	4.52	4.52	1.12	1.12	1.12
		IQR	4.08-5.92	4.08-5.92	4.08-5.92	4.23-5.92	4.23-5.92	4.23-5.92	0.00-1.67	0.00-1.67	0.00-1.67
		(n)		(55)		(48)		(7)			
WHO prequalified ACT	All products were tablets	Median	0.63	0.63	0.84	1.73	1.73	1.73	0.31	0.21	0.42
		IQR	0.26-1.83	0.21-1.83	0.31-1.83	1.13-2.13	1.13-2.13	1.13-2.13	0.16-0.63	0.13-0.42	0.17-0.63
		(n)		(118)		(55)		(63)			
Non WHO prequalified ACT	All	Median	1.95	1.95	1.95	2.01	2.01	2.01	0.42	0.42	0.42
		IQR	1.33-4.01	1.33-4.01	1.33-4.01	1.48-4.08	1.48-4.08	1.48-4.08	0.15-1.12	0.15-1.12	0.15-1.12
		(n)		(260)		(231)		(29)			
	Tablet	Median	1.67	1.67	1.67	1.74	1.74	1.74	0.42	0.26	0.42
		IQR	1.26-2.22	1.26-2.22	1.26-2.22	1.41-2.22	1.41-2.22	1.41-2.22	0.15-0.47	0.15-0.47	0.15-0.67
		(n)		(190)		(169)		(21)			
	Oral liquid	Median	4.48	4.48	4.48	4.52	4.52	4.52	1.12	1.12	1.12
		IQR	4.08-5.92	4.08-5.92	4.08-5.92	4.23-5.92	4.23-5.92	4.23-5.92	0.00-1.67	0.00-1.67	0.00-1.67
		(n)		(55)		(48)		(7)			

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALE CATEGORIES								
			ALL WHOLESALERS N=199			NON-MARKET WHOLESALERS N=25			MARKET WHOLESALERS N=174		
			MID	LOW	HIGH	MID	LOW	HIGH	MID	LOW	HIGH
AMT	All	Median	4.33	4.33	4.33	4.33	4.33	4.33	0.92	0.67	1.17
		IQR	2.33-6.31	2.33-6.31	2.33-6.31	2.33-6.32	2.33-6.32	2.33-6.32	0.92-0.92	0.67-0.67	1.17-1.17
		(n)		(81)			(80)		(1)		
	Tablet	Median	1.57	1.57	1.57	1.57	1.57	1.57	0.92	0.67	1.17
	IQR	1.14-2.24	1.14-2.24	1.14-2.24	1.14-2.24	1.14-2.24	1.14-2.24	0.92-0.92	0.67-0.67	1.17-1.17	
	(n)		(16)			(15)		(1)			
	Oral liquid	Median	4.33	4.33	4.33	4.33	4.33	4.33	-	-	-
	IQR	4.20-4.34	4.20-4.34	4.20-4.34	4.20-4.34	4.20-4.34	4.20-4.34	4.20-4.34	-	-	-
	(n)		(6)			(6)		-			
	Injectable	Median	6.33	6.33	6.33	6.33	6.33	6.33	-	-	-
	IQR	4.74-10.69	4.74-10.69	4.74-10.69	4.74-10.69	4.74-10.69	4.74-10.69	4.74-10.69	-	-	-
	(n)		(39)			(39)		-			
nAT	All	Median	0.22	0.21	0.23	0.86	0.86	0.86	0.12	0.10	0.13
		IQR	0.10-1.05	0.08-1.05	0.10-1.05	0.21-2.72	0.21-2.72	0.21-2.72	0.05-0.33	0.04-0.26	0.05-0.40
		(n)		(719)			(242)		(477)		
	Tablet	Median	0.18	0.18	0.19	0.32	0.32	0.32	0.11	0.09	0.13
	IQR	0.08-0.46	0.06-0.40	0.10-0.53	0.19-1.58	0.19-1.58	0.19-1.58	0.05-0.33	0.04-0.26	0.05-0.40	
	(n)		(518)			(134)		(384)			
	Oral liquid	Median	0.57	0.57	0.63	1.47	1.47	1.47	0.12	0.08	0.16
	IQR	0.12-1.68	0.08-1.68	0.16-1.68	0.71-2.64	0.71-2.64	0.71-2.64	0.08-0.20	0.08-0.16	0.08-0.24	
	(n)		(116)			(39)		(77)			
	Injectable	Median	1.45	1.45	1.45	1.84	1.84	1.84	0.13	0.13	0.13
	IQR	0.16-3.94	0.16-3.94	0.18-3.94	0.39-7.89	0.39-7.89	0.39-7.89	-0.56-0.16	-0.56-0.13	-0.56-0.19	
	(n)		(83)			(68)		(15)			
RDT (per unit) ³		Median	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
		IQR	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00	-	-	-
		(n)		(3)			(3)		-		

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesalers and retailers stocked granules or suppositories, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. 3 The three RDT wholesalers that provided price information were all public sector health facilities that received RDTs from their suppliers and dispensed them free of charge.

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

ANTIMALARIAL TYPE ¹ Formulation ²			RETAILER CATEGORIES ³			
			PHARMACIES N=28	PRIVATE HEALTH FACILITIES N=63	OTHER PRIVATE OUTLETS ⁴ N=336	PUBLIC HEALTH FACILITIES N=122
All ACT	All	Median	2.20	1.24	0.41	0.00
		IQR	1.72-4.18	0.41-1.71	-0.41-0.41	0.00-0.00
		(n)	(304)	(25)	(10)	(327)
	Tablet	Median	1.95	1.24	0.41	0.00
		IQR	1.52-2.44	0.41-1.71	-0.41-0.41	0.00-0.00
		(n)	(232)	(20)	(9)	(326)
	Oral liquid	Median	5.17	5.22	0.55	6.63
		IQR	4.30-5.30	4.42-5.25	0.55-0.55	6.63-6.63
		(n)	(67)	(5)	(1)	(1)
WHO prequalified ACT	All products were tablets	Median	-	-	-	0.83
		IQR	-	-	-	0.00-1.66
		(n)	-	-	-	(14)
Non WHO prequalified ACT	All	Median	2.20	1.24	0.41	0.00
		IQR	1.72-4.18	0.41-1.71	-0.41-0.41	0.00-0.00
		(n)	(304)	(25)	(10)	(313)
	Tablet	Median	1.95	1.24	0.41	0.00
		IQR	1.52-2.44	0.41-1.71	-0.41-0.41	0.00-0.00
		(n)	(232)	(20)	(9)	(312)
	Oral liquid	Median	5.17	5.22	0.55	6.63
		IQR	4.30-5.30	4.42-5.25	0.55-0.55	6.63-6.63
		(n)	(67)	(5)	(1)	(1)
AMT	All	Median	5.47	4.16	-	2.01
		IQR	2.21-6.26	4.16-4.47	-	1.24-3.73
		(n)	(55)	(6)	-	(5)
	Tablet	Median	1.83	4.16	-	2.01
		IQR	1.82-1.96	4.16-4.16	-	2.01-2.01
		(n)	(6)	(1)	-	(1)
	Oral liquid	Median	4.85	-	-	-
		IQR	4.85-4.85	-	-	-
		(n)	(1)	-	-	-
	Injectable	Median	6.23	7.46	-	3.73
		IQR	5.05-12.97	5.77-7.46	-	1.24-3.73
		(n)	(31)	(5)	-	(4)
nAT	All	Median	1.31	1.31	0.13	1.31
		IQR	0.25-2.61	0.21-3.70	0.07-0.34	0.31-2.89
		(n)	(152)	(156)	(611)	(291)
	Tablet	Median	0.48	0.71	0.10	0.68
		IQR	0.23-1.33	0.10-1.31	0.05-0.21	0.08-1.31
		(n)	(94)	(118)	(548)	(177)
	Oral liquid	Median	2.61	2.49	0.50	-
		IQR	1.47-2.61	2.49-2.49	0.31-0.66	-
		(n)	(29)	(1)	(59)	-
	Injectable	Median	3.70	6.53	3.26	3.48
		IQR	1.75-6.53	3.70-13.22	1.94-47.85	2.18-5.66
		(n)	(29)	(37)	(4)	(114)

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules); however because so few wholesalers and retailers stocked suppositories, and so few of these product types were observed during the audit, results are not presented separately for these categories in this table, but are instead provided in the appendix. 3 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. 4 Other private outlets include boutiques in and out of markets, stalls in and out of markets, and itinerant medicine sellers (hawkers). Note: 22 of 5233 (0.4%) mark-up observations (4 in pharmacies, 4 in private health facilities, 6 in other private outlet types, 8 in public health facilities) were set to missing due to mark-ups in excess of 1000% which were likely due to errors during data collection.

5. Discussion

Supply Chain Structure and Wholesaler Characteristics

Two distinct parallel private sector distribution chains for antimalarials in Benin: A majority (76%) of the wholesalers identified through this study were located within traditional open markets in Benin, and this group of wholesalers was observed to be considerably different from wholesalers operating outside of these markets in many ways (see below). Because of these differences, it appears that two parallel distribution chains for antimalarials, and pharmaceuticals in general, exist in Benin: one chain that is dominated by non-market wholesalers that largely supply antimalarials to public sector facilities and more ‘formal’ types of private retail outlets, such as pharmacies, rural outpost pharmacies, and private health facilities; and another chain dominated by market-based wholesalers who supply other market-based wholesalers and more ‘informal’ types of private retail outlets, such as market stalls, boutiques and itinerant medicine vendors. There are a number of possible explanations for this division: Informal retailers are not permitted to purchase stock from registered wholesalers; these retailers may also be attracted by the lower purchase prices offered by informal wholesalers (see below). A number of our results demonstrate this division: In terms of supplier mentions collected from private sector retail outlets, out of 156 sufficiently detailed mentions for suppliers located in Benin gathered from the more formal types of retailers, only 5 (3.2%) mentioned markets. In contrast, 435 (85.1%) mentioned markets out of 511 sufficiently detailed supplier mentions collected from less formal types of outlets. Compared to wholesalers operating outside of markets, more market-based wholesalers reported being supplied by other market wholesalers (76.3% vs. 4.2%), and to supply antimalarials to less formal types of outlets, such as general retailers (36.2% vs. 16.0%).

Few wholesalers in Benin purchase antimalarials directly from manufacturers: Purchasing antimalarials directly from manufacturers was observed at all levels of the distribution chain; however, few businesses mentioned a manufacturer as a top supplier of antimalarials. At retail level, only 5.3% of supplier mentions gathered from public sector outlets and 4.6% gathered from private sector retail outlets referred to an antimalarial manufacturer. At wholesale level, 16.7% of non-market and 9.2% of market-based wholesalers reported a manufacturer as one of their top two antimalarial suppliers. Part of this may be explained by the fact that, of the two domestic pharmaceutical manufacturers, only one produces antimalarials (but not ACTs). Also, the costs associated with establishing relationships with foreign suppliers and manufacturers and poor prospect of making good returns on these investments, given Benin’s relatively small population and size of the pharmaceutical market, may render importing unattractive for many wholesalers.

The most likely number of steps varies across formal and informal distribution chains: Although we observed antimalarial wholesalers to operate over 4 overlapping levels, indicating a maximum of 5 supply chain steps from manufacturer to retailer, the dichotomy between market and non-market wholesalers, the low number of wholesalers purchasing directly from manufacturers, and the large number of different market locations identified by private retail outlets as their terminal level suppliers, all suggest that the number of distribution chain steps from manufacturer to retailer that antimalarials are likely to pass through is different across the formal and informal distribution chains. Because more non-market wholesalers reported delivering orders to customers and also operate regional depots, antimalarials distributed through the more ‘formal’ distribution chain are likely to pass through 2-3 steps between manufacturer to retailer (manufacturer → registered wholesaler based in Cotonou → [regional depot or wholesaler] → retailer). Given the large number of market-to-market transactions noted, antimalarials distributed through the less ‘formal’

distribution chain are like to pass through 3-4 steps (manufacturer → registered or large market-based wholesaler in Cotonou → [intermediate market-based wholesaler in Cotonou/Porto-Novo] → regional market-based wholesaler → retailer).

Interactions across private and public sectors were commonly observed: Apart from CAME's key function as Benin's public sector procurement agent, our findings clearly illustrate the important role it also plays as a major supplier of antimalarials to private sector wholesalers and retailers. Among private sector retailers, CAME (either its headquarters in Cotonou or its regional depots) received more supplier mentions than the three large registered wholesalers distributing antimalarials (GAPOB, UBPHAR and PromoPharma), accounting for 8.2% of all supplier mentions (both market and non-market) and 29.1% of all *non-market* supplier mentions gathered from private sector outlets. At wholesale level, 9.2% of all those interviewed reported CAME or one of its regional depots as one of their two top antimalarial supply sources. However comparing across the two parallel distribution chains, CAME was reported as a top antimalarial supply source by 34.8% of non-market wholesalers and by only 2.2% of market-based wholesalers. Most of the other public-private interactions were observed at lower levels of the supply chain (i.e. terminal wholesaler mentions). For example, 6.7% of all supplier mentions collected from public sector outlets referred to the domestic manufacturer, Pharmaquick; 5.3% referred to one of the four registered private sector wholesalers, UBPHAR; and 1.3% of mentions referred to registered pharmacies as antimalarials suppliers. Regarding terminal wholesaler mentions collected from private sector outlets, 5.0% of all mentions referred to public sector health facilities (e.g. hospitals, health centres), as suppliers of antimalarials. While this may seem to indicate leakage of public sector antimalarials to the private sector, it is important to note here that public facilities generate revenues by charging for medicines dispensed to patients; and although wholesaling of medicines by public health facilities is not permitted, some small retail outlets, such as boutiques, stalls or small private clinics, may only purchase antimalarials in very small quantities, which may be much less conspicuous as wholesale purchases. Above terminal wholesaler level, no instances of public-private interactions were observed; however, 12.4% and 19.3% of all wholesalers did report public hospitals and other public health facilities, such as clinics, health centres and dispensaries, as customers for antimalarials.

Few wholesalers deliver orders for antimalarials to their customers: Only 7.6% of all wholesalers surveyed reported delivering antimalarials to their customers; however, there was a considerable difference between the proportion of non-market wholesalers that delivered (19.2%) and market-based wholesalers (4.1%). Non-market wholesalers tended to be larger enterprises with more employees than market-based wholesalers (median of 7 vs. 2 employees), so it is unlikely for market-based wholesalers to have sufficient staff to make deliveries. Given that retailers mentioned 30 different markets across Benin as their top source of antimalarials and also the highly concentrated nature of the formal antimalarial wholesale sector (i.e. the four registered wholesalers are located in Cotonou, of which only two have regional depots), it is also likely that retailers who prefer to purchase antimalarials from markets do so because it is more convenient, as these markets may be nearer to their place of business and because most less formal retail outlets also sell other goods alongside antimalarials, minimising the transaction costs related to restocking.

Credit facilities are being offered by half of all wholesalers: However, fewer non-market wholesalers (40.0%) reported offering credit to customers (with median credit terms of 30 days, IQR 30-30 days) than market-based wholesalers (60.0%), who offered median credit terms of 15 days (IQR 9-20 days). This is consistent with what has been observed among market traders in other commercial sectors in Benin. [19]

Availability and Volumes

nATs continue to be more available and sold in greater volumes than ACTs, and ACTs are more likely to be channelled through the formal distribution chain than through the informal chain: Although overall wholesale availability of ACTs was low (47% availability among all wholesalers), more non-market wholesalers stocked ACTs than market-based wholesalers (74.1% vs. 38.4%); and non-market wholesalers tended to sell ACTs in much greater volumes than market-based wholesalers. For example, when wholesalers stocked and sold ACTs, typical sales volumes for ACTs among wholesalers operating outside of markets were 150.2 AETDs (IQR 0.0-529.1) compared to 36.6 AETDs (IQR 20.8-55.0) among market-based wholesalers. Conversely, although most non-market and market-based wholesalers stocked nATs (92.6% and 99.1%); they differed considerably in terms of volumes being sold. The typical sales volume of nATs among non-market wholesalers during the week preceding the survey (92.0 AETDs, IQR 7.2-1272.8) was nearly a third of that observed among market-based wholesalers (254.0 AETDs, IQR 30.0-1104.1). Market share data at retail level from the ACTwatch Outlet Survey conducted at the same time as the Supply Chain Study shows similar patterns, where virtually all of the private sector ACT market share was dispensed through more formal outlets, including pharmacies and private health facilities; while half of the private sector nAT market share was distributed through informal retailers, such as general stores, market stalls and itinerant vendors. [20]

Availability and volumes sold of oral AMTs are low, and are mainly channelled through the formal private distribution chain: Oral AMTs were stocked by 25.9% of non-market wholesalers, but only among 0.5% of market-based wholesalers. This is consistent with findings from the ACTwatch Outlet Survey which found that oral AMTs were stocked only by pharmacies (37.1%) and a few private health facilities. [20] It is of particular concern that these types of antimalarials continue to be distributed through more formal types of wholesalers and retailers as oral AMTs have been banned in Benin since 2006.

RDTs are not available or frequently sold in Benin: RDTs were stocked by only 4.4% of all wholesalers, of whom none were based in markets. Sales volume data was collected only from public health facilities, but indicated that very few RDTs were being dispensed in the public sector (i.e. all facilities reported no tests sold during the week prior to interview). However, unpublished ACTwatch Supply Chain data from in-depth interviews conducted at the time of data collection describe that distribution of RDTs had only recently begun in the public sector, and that the policy requiring confirmation of malaria prior to treatment with ACTs had not been fully implemented.

Price and Mark-ups

Market wholesalers apply lower percent mark-ups than non-market wholesalers: Non-market wholesalers applied percent mark-ups on antimalarials that were largely consistent by what is allowed by price setting regulation (i.e. 36% on purchase prices). Market-based wholesalers, however, applied mark-ups that were considerably lower, ranging from a median of 13.3% (IQR 5.3-25.0) on ACT, to 19.4% (IQR 11.1-31.3) on nAT. At retail level, pharmacies were observed to apply mark-ups of approximately 31% across all antimalarial

categories, as permitted by regulation. Other private outlets, such as market stalls, were observed to apply the lowest mark-ups among private sector retailers, with a median of 16.7% on ACTs and 42.9% on nATs. A related study of key informants conducted in Benin found widespread agreement that private wholesalers, registered pharmacies, and rural outpost pharmacies respected the established pricing regime. [8] In addition, our results show that informal wholesalers and retailers clearly do not, as they operate outside of the existing pharmaceutical sector regulatory framework. The intensely competitive environment of markets no doubt contributes to the lower percent mark-ups observed in market-based wholesalers. In addition, the formal sector pricing regime is designed to allow sufficient margins that cover costs and generate modest profits, but informal wholesalers and retailers have smaller operating costs since most do not employ pharmacists or pay licensing fees, and likely have lower building maintenance expenses, and consequently can afford to apply lower percent mark-ups. Given that 70% of antimalarials in Benin are distributed to end-users through more formal types of outlets, such as pharmacies and public and private health facilities [20], which are in turn supplied by more formal types of wholesalers, the lower prices offered by informal wholesalers and retailers may also serve to attract and retain customers from more formal types of businesses.

Purchase prices for ACTs distributed through the informal chain are lower than in the formal chain: Our observations related to antimalarial purchase prices at wholesale and retail levels further reinforce the distinction between the formal and informal distribution chains for antimalarials operating in Benin. Across all antimalarial categories and dosage forms, prices paid by more formal retail outlets tended to be more characteristic of what one would expect to pay when purchasing from more formal wholesale suppliers (i.e. non-market wholesalers); while informal retail outlets tended to purchase antimalarials at prices that were more characteristic of market-based wholesalers. For example, non-market wholesalers paid a median purchase price of US\$ 5.58 per AETD of ACT in tablet form, and retail pharmacies paid a median price of US\$ 6.34. In contrast, market-based wholesalers paid a median purchase price of US\$ 2.09 per AETD of ACT in tablet form, and other private retail outlets, such as market stalls, paid a median purchase price of US\$ 2.49. As noted in the results, these differences in purchase price were driven by the ACT product mix stocked by each group of wholesalers and retailers and the typical prices of these products. Compared to market-based wholesalers, non-market wholesalers carried a much broader range of ACT products (41 vs. 11 different brands) and also stocked a higher proportion of more expensive ACTs. In addition, a higher proportion of ACT products stocked by market-based wholesalers than non-market wholesalers was branded as Coartem (60.0% vs. 9.6%), which itself had a lower purchase price compared to other ACTs. At retail level, a similar pattern was observed when comparing registered pharmacies and informal retail outlets: pharmacies stocked a broad range of ACT products, of which 8.7% was Coartem; while virtually all ACT observed among informal retail outlets (98%) was Coartem. In terms of retail purchase price, pharmacies paid a median of US\$ 6.47 (IQR 6.47-6.47), while informal retail outlets paid US\$ 2.49 (IQR 2.07-2.49). This relatively cheap Coartem being purchased by more informal types of wholesalers and retailers potentially indicates leakage of public sector Coartem to the informal sector, and package size data related to these lower priced products may support this assertion: 68.2% of the Coartem among market-based wholesalers and 79.1% of Coartem among other private retailers, such as market stalls were packaged in sizes not of the standard commercial packaging, but of those normally restricted for distribution in the public sector in Benin and other countries at the time of data collection (i.e. paediatric dosages). Also, the median purchase price of Coartem at public health facilities (US\$ 1.24, IQR 1.24-1.24) is more consistent with that seen among informal wholesalers and retailers. Such leakage has been documented by previous studies. [21]

Purchase prices for first-line treatment continue to be many times higher than for SP: At wholesale and retail levels and across both formal and informal distribution chains, the median purchase price of the government recommended first-line treatment, AL, was several times higher than that for SP. And because percent mark-ups are fairly consistent across antimalarial drug categories within each of the two parallel distribution chains, these differences in purchase prices persist as products flow down their respective supply chains and will be reflected in end-user prices in the private sector, affecting end-user affordability and demand. This difference in price may be exacerbated by the fact that all ACT must be imported into the country, whether legally or not.

Possible explanations for the prominence of the informal sector in antimalarial wholesaling in Benin

Traditional markets are integral to commerce in Benin: Given the central role that traditional markets play in the trading of commodities and household goods in West Africa and also the high burden of malaria in Benin, it is not surprising that the types of firms common to these markets are also prominent in the trading of antimalarials. [22] The ACTwatch Outlet Survey showed that 70% of all the outlets censused which had at least one antimalarial in stock were informal retailers, businesses that are not necessarily specialised in medicine sales, but may also sell a wide range of commonly purchased goods. [20] As mentioned above, because most types of goods can be purchased in these markets, it may minimise the transaction costs when informal retailers need to restock.

Considerable barriers to entry into the formal wholesale market: Current registration requirements for pharmaceutical wholesaling likely prevent many would-be wholesalers from entering the market. Considering that 4.2% of firms in Benin used banks to finance investments in 2009 [1], the requirements to maintain operating capital of approximately US\$ 190,000 and to stock 90% of all registered pharmaceutical products in Benin render start-up costs too high for most. Also, as the majority of pharmaceutical wholesaler stock needs to be imported, the relatively small size of Benin's pharmaceutical market may not permit new entrants sufficient market share to place orders large enough to make importing viable. The requirement for wholesalers to be owned and managed by a pharmacist may also be challenging¹⁷, as in 2010 there were 280 registered pharmacists in the country, and already 196 registered pharmacies which are also required to be owned by a pharmacist. [23] These barriers to entry may be reflected in our finding that non-market wholesalers had been in operation for a median of 14 years, while those operating in markets had been operating for a median of 6 years, and also at the time of the study, there were only 3 registered wholesalers active in Benin (and all were wholesaling antimalarials), in addition to CAME. As a result, Benin's formal wholesale sector is highly concentrated.

Limited coverage of the formal distribution chain: The highly concentrated nature of the formal *private sector* distribution chain in Benin is also likely to limit the expansion of more formal retail outlet types in underserved rural areas. To demonstrate, all of Benin's formal wholesalers are located in Cotonou (although two operate depots in several regional commercial centres), and more than half of all pharmacies registered in 2009 were also located in the south of the country, either in Cotonou or Porto-Novo. [8] In the formal private sector, rural outpost pharmacies were created to improve access to medicines in rural areas; however, because these types of outlets are required to purchase stock solely from the registered pharmacy

¹⁷ Registered wholesalers do not necessarily have to be owned by a single pharmacist; groups of pharmacists may also be part owners of such wholesaler businesses.

with which it has signed an agreement, the low likelihood of finding such a pharmacy conveniently located provides little incentive for rural outpost pharmacies to open in the areas that need them most. Furthermore, as antimalarial purchase prices in pharmacies were observed to be considerably higher than those seen in other less formal types of suppliers, poorer patients typical of rural areas are also more likely to purchase cheaper antimalarials from informal outlets, making rural outpost pharmacies less viable enterprises. This is potentially reflected in the Outlet Survey finding that only 0.2% of all private outlets screened were rural outpost pharmacies. [20]

Porous border and proximity to pharmaceutical markets in neighbouring countries facilitates illegal importing: Although most antimalarials, including the recommended first-line treatment, must be imported into Benin, the high transaction costs of importing potentially make it difficult for more formal wholesalers to import antimalarials. For example, only 8.3% of non-market wholesalers reported a foreign supplier as one of their top two sources of antimalarials. On the other hand, 22.8% of market-based wholesalers had at least one of their top two suppliers located outside of Benin, in Nigeria, Togo or Ghana, possibly reflecting the relative ease of illegally importing antimalarials into the country. A small percentage of retailers in Benin also reported foreign suppliers in Togo, Nigeria and Ghana as one of their top two antimalarial supply sources. As a further challenge to ensuring the safety of medicines, these illegally imported products may not be registered for sale in Benin and their quality cannot be ascertained as they bypass the existing inspection regime.

Challenging conditions for regulatory enforcement: As is clear from our findings, the informal distribution chain for antimalarials operates outside of the current regulatory framework. However, our observations from within the more formal antimalarial distribution chain, particularly the low number of businesses that had recently been inspected and that were observed to have an up-to-date wholesale license, may indicate insufficient capacity within the DPM to enforce existing regulations. Such conditions may make it difficult to implement any reforms designed to improve the distribution chain.

Possible targets for informal sector intervention: Apart from all of the challenges identified above, our results show that the formal distribution chain for antimalarials is functioning in terms of the current price setting regime, the requirement to employ a staff member with health-related qualifications, and knowledge of the recommended treatment for uncomplicated malaria. However, these findings are also more likely to be affected by reporting bias, as respondents from more formal wholesale businesses have a stronger incentive to provide favourable responses. But it is also clear that the informal antimalarial distribution chain cannot be ignored; and results from this study have identified some potential gaps where action may help improve access to effective treatment. For example, given that 99% of market-based wholesalers reported selling antimalarials directly to retail customers, and that clear deficits in knowledge and attitudes regarding ACTs and malaria treatment were identified, training for market-based wholesalers is an obvious intervention. These types of activities have been attempted in several countries, most notably among drug vendors in Nigeria commonly found operating in markets, called PPMVs. [24] Trade associations of medicine vendors have also been the focus of several interventions in West Africa. In some markets in Nigeria, for example, prospective entrants must first register with the existing trade association and have their premises inspected for suitability, while others share best practices in pharmaceutical management and assist in the dissemination of information on counterfeiting, changes in regulation or treatment policy, etc. [24] Unpublished ACTwatch Supply Chain data from in-depth interviews in Benin suggest that such a trade

association exists in one of the large Cotonou markets, and that one of its key functions is to act as a pseudo-self-regulator, by scanning the market for banned or expired product, and imposing penalties on vendors found to be in transgression (e.g. forced closures).

Conclusion

This report has presented a number of important new insights into the market for antimalarial drugs in Benin. There were two distinct private sector distribution chains for antimalarials, one dominated by more formal wholesalers serving registered pharmacies and private health facilities, and another dominated by less formal wholesalers, largely based in traditional markets, serving less formal types of medicine retailers, such as market stalls, boutiques and itinerant vendors. A number of factors, including Benin's current regulatory environment, have likely contributed to this division. Wholesaler in the two distribution chains were observed to differ considerably in a number of respects, such as in the knowledge of recommended first-line treatment for uncomplicated malaria; however, most wholesalers in both distribution chains were not observed to have an up-to-date license permitting the wholesale of antimalarials. Availability of different antimalarials also differed across the two distribution chains. Overall, oral AMTs were stocked by few wholesalers; but availability of ACTs was also relatively low, particularly among wholesalers based in markets. nATs were ubiquitous among all types of wholesaler and were being sold in larger quantities than ACTs. Percent mark-ups on antimalarials among more formal wholesalers and retailers were consistent with existing price setting regulations; but among less formal wholesale and retail businesses, percent mark-ups were less consistent and were considerably lower for ACTs. RDTs were rarely available at wholesale level.

6. Appendices

6.1. Supplemental tables for suppository and granule dosage forms

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

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLESALER CATEGORIES				
			ALL WHOLESALEERS N=201 ³	SUPPLY WHOLESALEERS N=123	SUPPLY RETAILERS N=195	NON-MARKET WHOLESALEERS N=26	MARKET WHOLESALEERS N=175
All ACT	All	Median	0.0	0.0	0.0	1.5	0.0
		IQR	0.0-45.0	0.0-47.5	0.0-47.5	0.0-358.8	0.0-22.5
	Suppository	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
	Granule	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
Non-WHO prequalified ACT	All	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-35.1	0.0-0.0
	Suppository	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
	Granule	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
AMT	All	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
	Suppository	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
	Granule	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
nAT	All	Median	222.1	335.0	244.2	84.2	254.0
		IQR	21.3-1104.1	71.4-1145.4	21.3-1104.1	2.0-1272.8	30.0-1104.1
	Suppository	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0
	Granule	Median	0.0	0.0	0.0	0.0	0.0
		IQR	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-0.0

¹ ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria; ² The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules). ³ For antimalarials: there were a total of 201 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, 218 wholesalers were identified, of which 190 were interviewed successfully and 11 were partially interviewed but included an audit. Two of these wholesalers did not stock antimalarials at the time of interview but did so in the three months prior to interview, so their sales volumes were set as 0 for all antimalarial categories. Of the remaining, 3 were partially interviewed but did not include an audit, 10 refused, 3 were not screened because a respondent was not available or for other reasons, and 1 did not stock antimalarials at the time of the survey or during the three months prior to the visit (Table 1). These 17 wholesalers were excluded from the volumes analysis. Overall, there were a total of 1518 antimalarials audited, and 359 (23.67%) had missing sales volumes that were imputed using the `mi impute pmm` command.

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

ANTIMALARIAL TYPE ¹ Formulation ²			WHOLEALER CATEGORIES ³				
			ALL WHOLEALERS	SUPPLY WHOLEALERS	SUPPLY RETAILERS	NON-MARKET WHOLEALERS	MARKET WHOLEALERS
All ACT	All	Median	47.5	47.5	47.5	150.2	36.6
		IQR	7.3-86.4	21.5-55.0	7.3-86.4	0.0-529.1	20.8-55.0
		(n)	(74)	(49)	(72)	(20)	(54)
	Suppository	Median	10.0	70.0	10.0	10.0	-
		IQR	0.0-70.0	10.0-411.3	0.0-70.0	0.0-70.0	-
		(n)	(5)	(3)	(5)	(5)	-
Granule	Median	4.8	11.1	4.8	3.7	11.1	
	IQR	0.0-11.1	11.1-15.0	0.0-11.1	0.0-10.1	11.1-11.1	
	(n)	(9)	(4)	(9)	(8)	(1)	
Non-WHO prequalified ACT	All	Median	7.5	11.5	7.5	33.0	7.5
		IQR	0.0-50.0	2.5-50.0	0.0-50.0	0.0-176.5	2.0-30.2
		(n)	(35)	(21)	(34)	(16)	(19)
	Suppository	Median	10.0	70.0	10.0	10.0	-
		IQR	0.0-70.0	10.0-411.3	0.0-70.0	0.0-70.0	-
		(n)	(5)	(3)	(5)	(5)	-
Granule	Median	4.8	11.1	4.8	3.7	11.1	
	IQR	0.0-11.1	11.1-15.0	0.0-11.1	0.0-10.1	11.1-11.1	
	(n)	(9)	(4)	(9)	(8)	(1)	
AMT	All	Median	0.0	133.7	0.0	0.0	8.7
		IQR	0.0-101.4	75.8-144.9	0.0-101.4	0.0-101.4	8.7-12.5
		(n)	(16)	(6)	(16)	(14)	(2)
	Suppository	Median	13.5	31.4	13.5	13.5	-
		IQR	0.0-31.4	27.0-138.2	0.0-31.4	0.0-31.4	-
		(n)	(6)	(3)	(6)	(6)	-
Granule	Median	-	-	-	-	-	
	IQR	-	-	-	-	-	
	(n)	-	-	-	-	-	
nAT	All	Median	244.2	335.0	244.2	92.0	254.0
		IQR	22.1-1104.1	71.4-1145.4	22.1-1104.1	7.2-1272.8	30.0-1104.1
		(n)	(197)	(123)	(191)	(25)	(172)
	Suppository	Median	5642.9	5642.9	5642.9	5642.9	5.0
		IQR	5642.9-5642.9	5642.9-5642.9	5642.9-5642.9	5642.9-5642.9	5.0-5.0
		(n)	(2)	(2)	(2)	(1)	(1)
Granule	Median	-	-	-	-	-	
	IQR	-	-	-	-	-	
	(n)	-	-	-	-	-	

1 ACT: artemisinin-based combination therapy; AMT: artemisinin monotherapy; nAT: non artemisinin therapy; RDT: Rapid diagnostic test for malaria. 2 The values for median number of AETDs sold reported for 'all' formulations include all dosage forms (tablets, suppositories, oral liquids, injectables and granules). 3 (n) is the number of wholesalers at a given level who stocked antimalarials for corresponding drug category or who stocked RDT.

6.2. Range of health and non-health retail outlets selling pharmaceutical drugs in Nigeria

Public Health Facilities	N	Description
Referral hospital (<i>Hôpital de zone</i> , or larger)	9	Government-run health facilities that provide prescription medicine following medical consultation or diagnosis. Fees are usually charged for consultations and medicines.
Commune health centre	21	Arrondissement health centres are the first-level of facility-based public health care, and are usually staffed by nurses, a midwife, and auxiliary staff. They usually include a dispensary and maternity, although these facilities may also exist on their own.
Arrondissement health centre	116	
Dispensary	15	Commune health centres -the next level -are usually staffed by a doctor, nurses, and midwives. Across Benin's 34 health zones, there is an average of 2 communes per zone.
Maternity	10	Health-zone level hospitals and the national referral hospital in Cotonou receive first-level referral services and typically staffed with a surgeon and offer specialist health practitioners.
Village health unit (and smaller)	11	
Village health unit (and smaller)	11	Village health units are staffed by voluntary community health workers and are linked to an arrondissement or communal health centre.
Private, not for profit facilities	N	Description
Non-Governmental Organization (NGO) hospital / health centre	42	These facilities provide prescription medicine following medical consultation or diagnosis. They are usually staffed with qualified health practitioners, though some smaller clinics run by NGOs have less well qualified staff.
Missionary hospital / clinic	5	
Private for profit facilities	N	Description
Private hospital / clinic	118	These are non-governmental health facilities. Private clinics are smaller than hospitals and many of them are not registered with the Ministry of Health. They provide consultations and examinations, and sell prescription medicines at commercial prices.
Pharmacies	N	Description
Pharmacy	115	Registered pharmacies are licensed by the Ministry of Health and sell prescription medicine at commercial prices. They outlets are staffed by qualified health practitioners, with oversight/supervision provided by a pharmacist. They sell all classes of drugs and are highly regulated.
Rural outpost pharmacy (<i>Dépôt pharmaceutique</i>)	3	Rural outpost pharmacies are smaller pharmacies that are affiliated with and supplied by larger pharmacies in towns and urban areas. These small "sister" pharmacies are located in remote and rural areas and act as extensions of the larger pharmacies.
General Retailers	N	Description
Boutique (outside a market)	396	Businesses/points of sale which sell fast moving consumer goods (e.g. food, household products), in addition to some medicines (most often antipyretics). Drugs sold at these locations are not regulated. Boutiques are more formal structures than stalls, ranging from lockable-steel structures in markets, to outlets located in an arcade of shops, or occupying the ground floor of a house.
Boutique (in a market)	37	
Stalls	N	Description
Stall (outside a market)	526	Stalls sell a variety of products that are displayed on tables (for example, on the roadside or in populated areas). They sell fast moving consumer goods and sometimes medicines, which are usually antipyretics. Drugs sold at these locations are not regulated.
Stall (in a market)	165	
Itinerant drug vendors	N	Description
Hawkers	81	Itinerant salesmen who often sell products of unknown origin, including medicines.

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

Antimalarial Category	Dose used for calculating 1 AETD (mg to treat a 60kg adult)	Generic product used for AETD mg dose value for combination therapies	Notes	Source
Amodiaquine	1800mg			WHO Use of Antimalarials, 2001
Amodiaquine-Sulfadoxine-Pyrimethamine	1800mg	Amodiaquine		WHO Model Formulary, 2008
Arteether	1050mg			WHO Use of Antimalarials, 2001
Artemether	960mg			WHO Use of Antimalarials, 2001
Artemether-Lumefantrine	480mg	Artemether		WHO Model Formulary, 2008
Artemisinin-Naphthoquine	2400mg	Artemisinin	Manufacturer Guidelines for this product are 1000mg Artemisinin in a single dose. Such a short ACT regimen is highly suspect. This treatment dose is based upon the WHO Artemisinin-MQ recommendation of a total dose of 40mg/kg.	WHO Use of Antimalarials, 2001
Artemisinin-Piperaquine	576mg	Artemisinin	Treatment dose based on Artemisinin-Piperaquine-Primaquine value, below.	As below
Artemisinin-Piperaquine-Primaquine	576mg	Artemisinin		Tangpukdee, N. et al. 2008. Efficacy of <i>Artequick</i> 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 (<i>Winthrop/Coarsucam – Sanofi Aventis</i>)
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 (<i>Artequin Adult – Mepha</i>)
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 (<i>Co-arinat – Dafra</i>)
Atovaquone-Proguanil	3000mg	Atovaquone		Manufacturer Guidelines (<i>Malanil – GSK</i>)
Chloroquine	1500mg			WHO Model Formulary, 2008
Chloroquine-Sulfadoxine-Pyrimethamine	1500mg	Chloroquine		WHO Model Formulary, 2008
Chlorproguanil-Dapsone	360mg	Chlorproguanil		Manufacturer Guidelines (<i>LapDap – GSK</i>)
Dihydroartemisinin	480mg			Manufacturer Guidelines (<i>Cotecxin – Holleypharm; MALUether – Euromedi</i>)

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 (<i>Duo-cotexin – Holleypharm</i>)
Dihydroartemisinin-Piperaquine-Trimethoprim	256mg	Dihydroartemisinin		Manufacturer Guidelines (<i>Artecxin – Medicare Pharma; Artecorm – Ctonghe</i>)
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 (<i>Dalasin – Adams Pharma</i>)
Dihydroartemisinin-Mefloquine	360mg	Dihydroartemisinin		Manufacturer Guidelines (<i>Meflodisin – Adams Pharma</i>)
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 (<i>Halfan – GSK</i>)

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 (<i>Plaquenil – Sanofi Aventis</i>)
Mefloquine	1000mg			WHO Use of Antimalarials, 2001
Mefloquine-Sulfadoxine-Primethamine	1000mg	Mefloquine		WHO Use of Antimalarials, 2001
Primaquine	45mg		This dose is for the gametocytocidal treatment of <i>P. falciparum</i> .	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 (<i>Quinimax – Sanofi Aventis</i>)
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-Primethamine	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-Primethamine	1500mg	Sulfadoxine		WHO Model Formulary, 2008

6.4. Rationale & method to calculate wholesale-level weights and applying weights to calculate indicators

In Benin, traditional markets that are common throughout West Africa are important sources of antimalarial wholesaling. Many of the businesses selling antimalarials in these markets tend to be concentrated in Cotonou and Porto-Novo, but also in a number of smaller regional towns. When retailers and wholesalers in Benin were asked about their top two antimalarial supply sources, respondents commonly indicated that they purchased antimalarials from such markets, and often did not name a specific vendor in the market as their supply source, giving just the market name as the source of antimalarials. In a minority of instances, respondents would mention the name of the market vendor, and in some of these cases, data collectors were able to identify the specific vendor.

For the mentions within markets where a specific business was not named, it was difficult to ascertain which and how many wholesalers needed to be interviewed in a given market. In addition, some potential wholesaler respondents were reluctant to participate in the study due to political and regulatory sensitivities surrounding medicine-selling in markets. To address these issues, attempts were made to sample as wide a selection of wholesalers that was possible within each market visited, often with the assistance of local leaders or PSI/Benin staff responsible for working with market wholesalers who accompanied data collection teams to try to foster goodwill in the marketplace and encourage participation among vendors. Also, because markets do not all operate every day of the week, it was not possible to survey market wholesalers in each of the market towns mentioned, in which case wholesalers were sampled from markets in nearby towns to represent them. Ideally, the number of wholesalers interviewed in a particular market would be proportional to the number of mentions each market received; however, for the reasons mentioned above, this was not always the case. Therefore, summary measures that include observations from markets were adjusted to account for over- or under-sampling of market wholesalers that may have occurred.¹⁸

To assess whether over- or under-sampling of market wholesalers had occurred, data on sources of antimalarial supply (i.e. two top antimalarial wholesalers) collected both from antimalarial retailers and wholesalers were used to assess the frequency with which market versus non-market wholesalers were mentioned, and the frequency with which different markets were mentioned. These data on number of supplier mentions were used to calculate analytical weights that adjusted summary measures presented in this report to account for the over- or under-sampling of wholesalers in markets.

The general approach to calculating and applying weights is as follows (Table 6.4):

1. Using the total combined list of supplier mentions gathered from both retailers and wholesalers (A), proportions of specific non-market and all market supplier mentions were calculated (B). Among market supplier mentions, similar proportions were calculated for individual markets by dividing the number of mentions for a particular market by the total number of supplier mentions (market and non-market)(B). [Note: supplier mentions from respondents that did not provide sufficient information to identify a business or market were removed from the total list of supplier mentions for the calculation of weights as it was impossible to classify these mentions as either market or non-market wholesalers. At retail level, many of these were ambulatory antimalarial vendors; as these were so difficult to identify, this group of wholesalers is likely to be under-represented in the data presented.]
2. This distribution of mentions was generally preserved when considering the number of suppliers required for market categories (E) and subsequent weights to account for over- and under-sampling across different markets (F).

¹⁸ Apart from Benin and Nigeria, traditional markets did not appear to be important sources of antimalarial wholesaling in the remaining ACTwatch countries, so weights were not used in the calculation of summary measures. In Nigeria, while markets were commonly mentioned as sources of antimalarial wholesale suppliers, specific businesses were named in nearly all mentions. Unnamed market wholesalers were not mentioned by other wholesalers, and only mentioned by a small minority of retailers. As such, weights were not used in the calculation of summary measures in Nigeria.

3. For non-market wholesalers, individual weights were always set to 1 as it was assumed that no over- or under-sampling took place for non-market suppliers (however, it is possible that some under-sampling of non-market suppliers did take place where it was not possible to identify mentioned wholesalers; but, this was relatively rare)(F1).
4. Using the total number of non-market wholesalers *actually* interviewed as a fixed base (C1 and E1) and the frequency distribution of total mentions (B), the total number of *all* wholesalers *needed* (E22) was calculated by dividing the number of non-market wholesalers *actually* interviewed (C1) by the proportion that non-market wholesalers represented in the overall frequency distribution of all mentions (B1).
5. The number of wholesalers *needed* in each market was then determined by multiplying the total number of *all* wholesalers *needed* (E22) by the proportion of mentions for a given market relative to the total number of all mentions (B_{market}).
6. Market-specific weights were calculated for wholesalers operating in these markets as the number of wholesalers *needed* (E_{market}) divided by the *actual* number of market wholesalers interviewed (C_{market}). In the one market where wholesalers were under-sampled, this produced a weight greater than 1 to ensure greater representation of these particular observations in the calculation of summary measures; weights were less than 1 where oversampling of market wholesalers occurred.
7. When calculating summary measures, weights were applied using the 'aweights' command in Stata. To obtain weighted medians, observations (e.g. price) were arranged in ascending order and from the cumulative sum of weights, the weighted median equals the value corresponding to the cumulative sum of weights that is half of the total sum of weights. For weighted proportions, observations from binary measures are first multiplied by the weight, and then summed across all observations. The total is then divided by the total sum of weights to give the weighted proportion.

Although some of the wholesalers identified through the 'bottom-up' sampling approach operated on different levels of the supply chain, only one set of weights was developed for the calculation of summary measures for the three analytical groupings of wholesalers (i.e. 'all wholesalers', 'wholesalers supplying wholesalers' and 'wholesalers supplying retailers'). For non-market wholesalers, as these businesses were automatically assigned a weight of 1, their weight would be the same regardless of supply chain level. For wholesaler mentions in markets, the majority of these were non-specific mentions (i.e. the respondent asked to identify their top two suppliers did not specify a business or would buy from any wholesaler in the market); and because such non-specific market wholesaler mentions were common both at terminal and intermediate wholesaler levels, it was impossible to categorise any market wholesalers selected and interviewed to represent these unnamed market mentions as either 'wholesalers supplying retailers' and/or 'wholesalers supplying wholesalers'. Therefore, for each of the identified markets, all market wholesalers interviewed as part of this study, whether they were specifically identified by a customer or not, were assigned the same market-specific weight for analysis regardless of analytical wholesaler grouping.

Table 6.4: Supplier mentions by non-market vs. market, and table of wholesale-level analytical weights

Market location	Number of market mentions collected during the Outlet Survey	Number of market mentions collected during the Supply Chain Survey	Total combined specific non-market and all market mentions (A)	Frequency distribution of mentions (B)	Total number of wholesalers interviewed (C)	Frequency distribution of wholesalers interviewed (D)	Total number of wholesalers needed (E)	Market-specific weight normalised to non-market weight of 1 (F)	Row no.
<i>Non-market wholesalers</i>	<i>N/A</i>	<i>N/A</i>	218	25.4%	28	14.0%	28.00	1	(1)
Adja-Ouere	12	0	12	1.4%	6	2.7%	1.71	0.2844	(2)
Allada	0	1	1	0.1%	3	1.4%	0.14	0.0474	(3)
Aplahoué (including Azove, Kodowari)	16	0	16	1.9%	4	1.8%	2.28	0.5688	(4)
Banikoara (including Toura)	2	0	2	0.2%	4	1.8%	0.28	0.0711	(5)
Bassila (including Penessoulou, Nagayile)	5	0	5	0.6%	11	5.0%	0.71	0.0646	(6)
Bembereke (including Berou Bouay, Gamia)	3	0	3	0.4%	2	0.9%	0.43	0.2133	(7)
Bohicon	11	0	11	1.3%	16	7.2%	1.56	0.0978	(8)
Cobly	3	0	3	0.4%	4	1.8%	0.43	0.1067	(9)
Comé	23	0	23	2.7%	5	2.3%	3.27	0.6541	(10)
Cotonou	264	132	396	46.2%	31	14.0%	56.31	1.8165	(11)
Dassa-Zoumé	12	1	13	1.5%	10	4.5%	1.85	0.1849	(12)
Djougou (including Bodi, Bougou)	4	0	4	0.5%	2	0.9%	0.57	0.2844	(13)
Glazoué	0	3	3	0.4%	3	1.4%	0.43	0.1422	(14)
Kandi	1	0	1	0.1%	2	0.9%	0.14	0.0711	(15)
Malanville	17	6	23	2.7%	5	2.3%	3.27	0.6541	(16)
Parakou	19	1	20	2.3%	12	5.4%	2.84	0.2370	(17)
Pobe	4	0	4	0.5%	3	1.4%	0.57	0.1896	(18)
Porto-Novo	66	13	79	9.2%	49	22.1%	11.23	0.2293	(19)
Save	10	5	15	1.8%	10	4.5%	2.13	0.2133	(20)
Toffo (including Houegbo)	4	1	5	0.6%	9	4.1%	0.71	0.0790	(21)
Total	476	163	857	100.0%	218	100.0%	121.89		(22)

During the Outlet Survey, two or fewer supplier mentions named markets Kaboua, Kokoro, Guene, and Se; however, interviews were not conducted in these markets or in other markets to represent them.

6.5. Rationale & method to calculate retail-level weights and applying weights to calculate indicators

Study design

During the second ACTwatch Outlet Survey in Benin, a one-stage probability proportional to size (PPS) technique was used to select 19 *Arrondissements* from the 547 in Benin, with the *Arrondissement* population as the measure of size. The average *Arrondissement* population size was 12,388. No stratification was employed in Benin.

Booster Sample

A booster sample of public health facilities (PHFs) aimed to enumerate all PHFs in the *Commune* in which a selected *Arrondissement* fell. *Communes* are the next highest administrative area after the *Arrondissement*. The average population size of *Communes* visited for the PHF booster sample was 131,482. For the booster sample, PHFs included referral hospitals, health centers, and health posts, but excluded Community Health Workers.

A booster sample of Part-one Pharmacies (POPs) comprised a simple random sample of approximately two-thirds of POPs in the *Department* in which a selected *Arrondissement* fell, excluding those already enumerated in the selected *Arrondissement*. Benin is divided into 12 *Departments*, with an average population size of 564,675. All *Departments* were visited during this survey (that is, at least one selected *Arrondissement* fell in each *Department*).

Weighting approach

Weights were calculated differently for PHFs, POPs, and other outlet types, and were specific to analysis type, but generally involved the inverse of the selection probability and corresponding population size. The exception to this method was for POPs in analysis involving the booster sample, where a sampling fraction was used to mirror the booster sampling approach. For other outlet types we used *Arrondissement* population sizes for non-PHF, and for analysis involving only the non-booster sample (i.e. estimation of volumes); *Commune* populations were used for PHF outlet types where analysis included the booster sample (availability and price).

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. Non-PHF non-POP outlets enumerated in a selected *Arrondissement*;

$$Weight_i = \frac{\text{Benin Population}}{19 \times \text{Arrondissement Population}}$$

- ii. All PHFs enumerated in a *Commune*;

$$Weight_i = \frac{\text{Benin Population}}{18 \times \text{Commune Population}}$$

- iii. All POPs enumerated in a *Department*;

$$Weight_i = \frac{\text{Number of POPs listed in sample frame for Department}}{\text{Number of POPs visited in the Department}}$$

Volumes analysis:

- i. All outlets enumerated in a selected *Arrondissement* (non-booster sample);

$$Weight_i = \frac{\text{Benin Population}}{19 \times \text{Arrondissement Population}}$$

where the Total Benin Population = 6,776,099; and the selected *Arrondissements* fall within 18 distinct *Communes*.

Data provided for weight estimation

- i. Population size by *Arrondissement* with information on *Commune* and *Departement* (Ref: 3rd Recensement General de la Population et de l'Habitation (RGPH, 2002))
- ii. A list of the 19 selected *Arrondissements*
- iii. List of registered pharmacies (POPs) by *Departement* (Ref: National Order of Pharmacists of Benin, 2009)

Tables

The tables on the following pages list the population figures and sampling frame POP counts used to calculate weights. Note that Table 6.5.3 and Table 6.5.4 are identical. Both have been included here for completeness, as weighting is often discussed in terms of the type of analysis being conducted and whether or not the booster sample is included in the analysis.

Table 6.5.1: PHF weights by *Commune* for availability and price estimates

<i>Commune</i>	<i>Commune Population</i>	<i>Benin Population</i>	<i>Weight (Availability and Price)</i>
Cotonou	665,100	6,776,009	0.57
Porto Novo	223,552	6,776,009	1.68
Toffo	74,717	6,776,009	5.04
Karimama	39,579	6,776,009	9.51
Bonou	29,656	6,776,009	12.69
Djakotomey	96,732	6,776,009	3.89
Abomey-Calavi	307,745	6,776,009	1.22
Bembereke	94,580	6,776,009	3.98
Save	67,753	6,776,009	5.56
Ouesse	96,850	6,776,009	3.89
Dassa-Zoume	93,967	6,776,009	4.01
Bohicon	113,091	6,776,009	3.33
Bassila	71,511	6,776,009	5.26
Pobe	82,910	6,776,009	4.54
Grand PoPo	40,335	6,776,009	9.33
Perere	42,891	6,776,009	8.78
Boucuombe	60,568	6,776,009	6.22
Banikoara	165,138	6,776,009	2.28

Table 6.5.2: POP weights by *Department* for availability and price estimates

<i>Departement</i>	<i>Total POPs in Departement (Sample frame)</i>	<i>Number of POPs visited</i>	<i>Weight (Availability and Price)</i>
Littoral	87	48	1.81
Oueme	33	23	1.43
Atlantique	22	18	1.22
Alibori	3	2	1.50
Couffo	3	2	1.50
Borgou	13	9	1.44
Colines	4	3	1.33
Zou	7	5	1.40
Donga	3	2	1.50
Plateau	3	2	1.50
Mono	4	3	1.33
Atacora	1	1	1.00

Table 6.5.3: Non-PHF non-POP weights by *Arrondissement* for availability and price estimates

<i>Arrondissement</i>	<i>Arrondissement Population</i>	<i>Benin Population</i>	<i>Weight (Availability and Price)</i>
1 st Arrondissement	55,413	6,776,009	6.44
2 nd Arrondissement	45,035	6,776,009	7.92
9 th Arrondissement	61,585	6,776,009	5.79
Argu	5,148	6,776,009	69.28
Birini-Lafia	9,946	6,776,009	35.86
Bonou	7,787	6,776,009	45.80
Djakotomey I	8,379	6,776,009	42.56
Godomey	153,447	6,776,009	2.32
Gomia	22,301	6,776,009	15.99
Kaboua	11,500	6,776,009	31.01
Kilibo	10,616	6,776,009	33.59
Kpingni	6,677	6,776,009	53.42
Lissezoun	3,821	6,776,009	93.34
Penessoulou	17,394	6,776,009	20.50
Pobe	33,249	6,776,009	10.73
Sazoue	3,422	6,776,009	104.22
Sontou	4,583	6,776,009	77.82
Tabota	8,811	6,776,009	40.48
Toura	13,110	6,776,009	27.20

Table 6.5.4: All non-booster outlet weights by *Arrondissement* for volume estimates

<i>Arrondissement</i>	<i>Arrondissement Population</i>	<i>Benin Population</i>	<i>Weight (Volume)</i>
1 st Arrondissement	55,413	6,776,009	6.44
2 nd Arrondissement	45,035	6,776,009	7.92
9 th Arrondissement	61,585	6,776,009	5.79
Argu	5,148	6,776,009	69.28
Birini-Lafia	9,946	6,776,009	35.86
Bonou	7,787	6,776,009	45.80
Djakotomey I	8,379	6,776,009	42.56
Godomey	153,447	6,776,009	2.32
Gomia	22,301	6,776,009	15.99
Kaboua	11,500	6,776,009	31.01
Kilibo	10,616	6,776,009	33.59
Kpingni	6,677	6,776,009	53.42
Lissezoun	3,821	6,776,009	93.34
Penessoulou	17,394	6,776,009	20.50
Pobe	33,249	6,776,009	10.73
Sazoue	3,422	6,776,009	104.22
Sontou	4,583	6,776,009	77.82
Tabota	8,811	6,776,009	40.48
Toura	13,110	6,776,009	27.20

6.6. Additional details on the sampling of intermediate-2 and intermediate-3 wholesalers

Identification of intermediate-2 wholesalers

From the 125 completed or partially completed interviews with intermediate-1 wholesalers, 123 mentions were gathered, of which 30 were mentions for non-market suppliers and 93 were for market-based suppliers. Among the non-market supplier mentions, 22 did not provide sufficient information to identify the business, while the remaining 8 that did so referred to 4 unique business: 2 were foreign manufacturers (Cipla in India, Novartis in Switzerland); 1 was the local manufacturer, Pharmaquick; and the fourth and only eligible non-market supplier mentioned at this level was CAME, which was identified and interviewed at a previous level.

Of the 93 mentions for market-based suppliers, only 8 provided sufficient information to identify the business; however, only 1 of these suppliers could be located, but refused to participate. The remaining 85 mentions where only the market name or location was provided, nearly two-thirds of these (71) were for a market located in Cotonou (e.g. Tokpa, Dantokpa, Adjegounle, Gbogbanou), 13 mentions were for a market located in Porto-Novo (e.g. Ouando, Grand Marché), 1 was for Dassa-Zoumé, 3 were for Glazoue, 3 were for Save, and 1 was for Parakou. Markets in all of these towns had been previously visited and 100 interviews with wholesalers had already been attempted, so were not revisited. Of these, 80 interviews were completed, 10 were partially completed, 8 refused, a suitable respondent was not available in 1, and 1 was not interviewed for other reasons. An additional 7 mentions were for markets in Nigeria, Ghana and Togo.

In summary, attempts were made to locate and interview 101 wholesalers at intermediate-2 level (1 non-market and 100 market suppliers); and of these, interviews were completed with 81, partial interviews were conducted with 10, 8 refused, an appropriate respondent was not available in 1 wholesalers, and 1 was not interviewed for other reasons.

Identification of intermediate-3 wholesalers

From the 90 completed or partially completed interviews with intermediate-2 wholesalers, 37 mentions were gathered, of which 14 were mentions for non-market suppliers and 23 were for market-based suppliers. Among the non-market supplier mentions, 9 did not provide sufficient information to identify the business, while the remaining 5 that did so referred to 2 unique business: 1 was the local manufacturer, Pharmaquick; and the other and only eligible non-market supplier mentioned at this level was CAME, which was identified and interviewed at a previous level.

Of the 23 mentions for market-based suppliers, only 3 provided some information to identify the businesses, all of which were located in Cotonou; however, the information provided was insufficient. 19 of the remaining 20 mentions that listed the market name or location referred to a market located in Cotonou (e.g. Tokpa, Dantokpa, Adjegounle, Gbogbanou), and 1 referred to a market in Lagos, Nigeria. As the markets in Cotonou had been visited at previous levels and interviews had already been attempted with 31 wholesalers, new interviews were not conducted. Of these 31 interviews conducted at a previous level, 28 were completed and 3 were partially completed.

In summary, attempts were made to locate and interview 32 wholesalers at intermediate-3 level (1 non-market and 31 market suppliers); and of these, interviews were completed with 29, and partial interviews were conducted with 3. The 39 supplier mentions gathered from these 32 intermediate-3 wholesalers all referred to manufacturers, foreign sources, or in the case of mentions gathered from market-based intermediate-3 wholesalers in Cotonou, they all referred to markets in Cotonou. Therefore, no new interviews were conducted at this level and the top of the chain was deemed to have been reached, with a total of 218 wholesalers that sold antimalarials identified (28 non-market and 190 market-based wholesalers), partial interviews were conducted with 14 wholesalers (2 non-market and 12 market-based wholesalers) and 190 interviews completed (25 non-market and 165 market-based wholesalers).

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