

Assessment of Drivers of Continuing Malaria Transmission in Angwa Ward, Mbire District, Mashonaland Central Province, Zimbabwe

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Abbreviations and Acronyms

**ACT** Artemisinin-based combination therapy

**ANC** Antenatal care

**API** Annual parasite incidence

**CDC** Centers for Disease Control and Prevention

**DDT** Dichlorodiphenyltrichloroethane

**DHIS2** District Health Information System

**EHT** Environmental Health Technician

**ELISA** Enzyme-linked immunosorbent assay

**FGD** Focus group discussion

**DHE** District Health Executive

**DMO** District Medical Officer

**HCC** Health Centre Committee

**HLC** Human landing collections

**HMIS** Health Management Information System

**kdr** Knockdown resistance (any of a series of genes involving a mutation in the target site of pyrethroids and DDT, and conferring resistance to these insecticides)

**IMNCI** Integrated Management of Newborn and Childhood Illness

**IRS** Indoor residual spraying

**IPTp** Intermittent preventive treatment in pregnancy

**LLIN** Long-lasting insecticidal net

**LQAS** Lot quality assurance sampling

**M&E** Monitoring and evaluation

**MOHCC** Ministry of Health and Child Care

**MRCZ** Medical Research Council of Zimbabwe

**NIHR** National Institute of Health Research

**NMCP** National Malaria Control Program

**PBO** Piperonyl butoxide

**PCR** Polymerase chain reaction

**PMD** Provincial Medical Director

**PMI** U.S. President’s Malaria Initiative

**PPS** Probability proportional to size

**RDNS** Rapid Disease Notification System

**RDT** Rapid diagnostic test

**SA** Supervision area (for LQAS)

**SBCC** Social and behavior change communication

**VHW** Village Health Worker

**WHO** World Health Organisation

**ZAPIM** Zimbabwe Assistance Program in Malaria

**ZIMSTAT** Zimbabwe National Statistics Agency

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Executive Summary

The Ministry of Health and Child Care estimates that malaria accounts for 20-30% of all outpatient clinic visits and about 10% of hospital admissions in Zimbabwe. Approximately 45-50% of the country’s population is at risk of developing malaria, with the vast majority of cases occurring in just three provinces: Manicaland, Mashonaland East, and Mashonaland Central. A major area of continuing high malaria transmission is Angwa Ward, in Mbire District, Mashonaland Central Province. Angwa is one of nineteen wards located in Mbire District and is situated in the Middle Zambezi Basin, a region of higher average temperatures than most of the country, with potential for flooding during the rainy season-- factors that can promote breeding of Anopheles mosquitoes of the *An. gambiae* complex, the most efficient vectors of malaria in Africa. Despite reported high coverage of routine malaria control interventions over the past five years, Angwa Ward continues to record high annual malaria incidence. These interventions include indoor residual spraying (IRS); distribution of long-lasting insecticidal nets (LLINs); malaria case management; intermittent preventive treatment in pregnancy (IPTp); and regular community-level social and behavior change and communication activities, and education sessions.

Experts have speculated that the continuing high burden of malaria in Angwa may be due to inadequate intervention coverage; adequate coverage but ineffective quality of interventions; good coverage with quality interventions but high transmission due to hyper-endemic conditions; or some other drivers of malaria transmission that need to be identified, such as lifestyles that increase the risk of exposure to malaria mosquitoes. Amidst this speculation, the National Malaria Control Programme of Zimbabwe, with support from the Zimbabwe Assistance Program in Malaria (ZAPIM), conducted an assessment to systematically identify the drivers of high malaria transmission in Angwa Ward. The assessment had seven objectives:

1. Describe malaria trends in Angwa Ward for the period 2012-2017.
2. Describe the socioeconomic and geographic context of Angwa Ward.
3. Describe the health care system in Angwa Ward.
4. Estimate the current coverage, quality, access to, and use of malaria prevention interventions in Angwa Ward, including personal protection outdoors.
5. Characterize the presence of malaria vectors and describe vector bionomics and insecticide resistance patterns in Angwa Ward.
6. Assess people’s knowledge, attitudes, practices, and perceptions regarding malaria and malaria risk in Angwa Ward.
7. Describe the type, quantity, and timing of outdoor activities in Angwa Ward.

The assessment employed five different quantitative and qualitative methods:

1. A desk review that collected information about the local health care system in Angwa and epidemiological data on malaria incidence in the district over the past six years.
2. A household survey using Lot Quality Assurance Sampling (LQAS) and a structured questionnaire to collect information and data from four exclusive sets of respondents: household heads; mothers of children 0-5 months; mothers of children 0-59 months; and another randomly selected member of the household. Information collected included 40 indicators covering malaria protective measures, access to malaria case management services, general knowledge of malaria, and various lifestyles, especially outdoor activities during dark hours.
3. Focus group discussions (FGDs) with men and women in five randomly selected villages in Angwa Ward. These were conducted to assess the community’s attitudes, beliefs, and practices regarding malaria, including access to malaria services and community lifestyles.
4. Key informant interviews were held with the Mbire District Medical Officer, the Nurse-in-Charge of Angwa Clinic, and the Angwa Clinic Environmental Health Technician to ascertain issues in malaria programme management and assess the adequacy of the health system and the coverage and quality of malaria prevention interventions.
5. A mosquito vector bionomics survey to assess the main vector species in the ward, mosquito biting habits, possible breeding sites and their characteristics, residual efficacy of DDT used for IRS, and efficacy of LLINs distributed in recent mass campaigns.

These methods revealed numerous areas of concern vis-à-vis the continuing high incidence of malaria in Angwa Ward.

#### Malaria Trends in Angwa Ward, 2012-2017

Mbire District has one of the highest annual incidence rates in Zimbabwe and recorded the highest district-level incidence nationwide in 2014, while Angwa Ward is one of the five most affected wards in the district. The survey also confirmed that other wards in Mbire District also experience high annual malaria incidence.

#### Socioeconomic and Geographic Context of Angwa Ward

Most respondents had attended school up to at least primary level, but less than a quarter had a secondary education and 15% couldn’t read at all. Most members of the ward belonged to one of the apostolic sects, but only 2.5% were of the Marange Sect that rejects modern medicine. The sects organize numerous all-night outdoor prayer meetings that may expose participants, including children, to increased risk of malaria. Other socioeconomic factors that could limit the reach of malaria education messages were that less than half of the survey respondents had a radio and only 10% owned a television set, despite these two communication channels being a major source of health promotion messages in Zimbabwe.

The vast majority of houses in Angwa have thatched roofs with openings that could allow mosquitoes to enter. They are generally not well screened against mosquitoes and have open windows, eaves and doors with gaps--all potential entry points for mosquitoes.

#### Health Care System in Angwa Ward

The assessment revealed a general lack of health service coverage in Angwa Ward. The ward has just one clinic and 16 trained village health workers (VHWs) covering 51 villages in the ward. Up to 60% of respondents reported that they live two or more hours by foot from the nearest health facility, which helps explain why over two-thirds of respondents use the services of the VHW when they or a family member need medical services. Even so, 40% revealed that they receive care from the VHW only sometimes, probably because the VHW has to cover more than one village. All three clinic-based key informant interviewees said that health care funding was insufficient and often takes a long time to be disbursed.

#### Coverage, Quality, Access, and Use of Malaria Prevention Interventions in Angwa Ward

As expected, the household survey revealed that ownership of LLINs in the ward was well below the official operational (administrative) coverage figures identified during the desk review. The desk review found that the operational coverage of LLINs per sleeping space was 98% in 2017 and 100% in 2016, whereas the household survey indicated that LLIN ownership was 33-45%. The proportion of households owning more than one LLIN ranged from 52-72%, depending on the category of respondents. Households that had at least one LLIN per sleeping space and/or had received IRS ranged from 91-95%, mostly due to the relatively high proportion of households that were reportedly sprayed during the previous IRS campaign. A total of 38% of outdoor sleeping spaces were covered with LLINs. Based on the household survey results, it seems that either not enough LLINs had been distributed per household to cover all sleeping spaces in Angwa, or that the nets given to households had gotten lost or torn or were given away to relatives. For use of LLINs, both the household survey and FGDs revealed that not enough children are being protected. These results should be interpreted within the context of the vector control policy, which indicates that there should be no overlaying of IRS and LLINs within the same community. However Angwa Ward was considered to be a special case as people translocate to the banks of Angwa River to cultivate stream banks. The National Malaria Control Program (NMCP) in May 2016 granted the district permission to cover this population with LLINs, as their temporary rooms/structures were not sprayable. The entomological studies revealed that the brands of nets in the ward, DuraNet and Dawa, were still effective one year after distribution with ≥90% mosquito knockdown after **30 minutes** of exposure to the LLINs.

There was discordance between the IRS coverage levels found in the household survey and the FGDs. The FGD participants expressed serious doubts about the efficacy of IRS. This observation suggests that better education and information about IRS would be beneficial to the community. Meanwhile, the entomological survey of residual DDT efficacy was equivocal, with residual efficacy found to be higher in one village than in the other. This suggests that spray trainers and supervisors should be aware of potential IRS performance issues in the previous campaign. Quality of spraying can be improved through pre-IRS training, enhanced supervision, and regular bioassays during spraying, and can be documented through quality-of-spray monitoring.

The household survey revealed that IPTp coverage for pregnant woman was generally high at 91% for at least a single dose, 82% for at least two doses, and 64% for at least 3 doses. These figures were somewhat lower than the official figures collected in the desk review from the clinic ANC registers of 97%, 94%, and 78% for IPTp 1, 2, and 3, respectively. The FGD participants mentioned that almost all pregnant women receive IPTp.

#### Presence of Malaria Vectors and Insecticide Resistance Patterns in Angwa Ward

A total of 1,299 mosquitoes were collected from the two entomological survey villages. The majority of mosquitoes belonged to the *Anopheles gambiae* complex, with three sibling species identified: *An. gambiae* s.s., *An. Arabiensis*, and the non-malaria vector *An. quadriannulatus*. A limited number of *An. funestus* complex were also identified. Only two mosquito specimens collected were found to be positive for *P. falciparum using* the enzyme-linked immunosorbent assay (ELISA), but neither had fed on humans recently. Observations on biting behavior indicated a preference for outdoor biting entirely between 6 pm and 12 am, with no biting after midnight, probably due to the low temperatures at the time of the survey.

Fifty-three water sources were characterized around the two sampling villages. All of the pools studied contained *Anopheles* larvae, and most were found on riverbeds as backwater pools. This finding of extensive breeding sites during the winter indicates that larval source management could be a useful intervention for controlling transmission during that time of the year.

Residual DDT efficacy testing (DDT used for IRS) revealed a mean mosquito mortality of 88% in one village but only 40% in the other village. This might indicate that the quality of spraying in the latter village was inferior and warrants further investigation and action to improve IRS quality in the future. Finally, mosquito knockdown tests on LLINs distributed during the last campaign in the ward revealed that 98-100% of susceptible mosquitoes were knocked down after 60 minutes of exposure, indicating that the nets were efficacious against susceptible mosquitoes one year after distribution. However, further tests indicated that some *An. gambiae* s.l. from locations around the sample villages showed resistance to permethrin. This finding should be verified, and an assessment should be launched to understand the magnitude of the resistance, as it may have policy implications on deployment of standard LLINs and/or consideration of using LLINs with a synergist or alternate LLINs.

#### Knowledge, Attitudes, Practices, and Perceptions of Malaria and Malaria Risk

There was lack of knowledge on malaria danger signs and recognition of fever as a malaria symptom. Amongst the four groups of people interviewed, the proportion of interviewees who knew at least two malaria danger signs in children ranged from 12% for ‘other household member’ to 29% for ‘mothers of children 0-5 months’ (mean=19.5%). Knowledge of danger signs in adults was even lower, ranging from 3% for ‘mothers of children 0-59 months’ to 10% for ‘other household member’ (mean= 7.3%). The proportion of interviewees recognizing fever as a malaria symptom in children ranged from 12% for ‘other household member’ to 29% for mothers of children 0-5 months (mean=19.5%). Recognition of fever as a malaria symptom in adults was even lower, ranging from 3% for ‘mothers of children 0-59 months’ to 10% for ‘other household member’ (mean=7.3%).

While general knowledge of how to avoid malaria in the community was relatively high, knowledge of malaria symptoms and appropriate health seeking behavior was lower. The low levels of knowledge of malaria signs and symptoms can be explained by low access to malaria information. The proportion of interviewees who had heard or read any malaria message in the previous six months ranged from 34% for ‘other household member’ to 55% for household heads (mean=43%). The proportion of those who had heard or read a malaria message in the previous six months and could recall at least one message was even lower, ranging from 7% for ‘other household member’ and 16% for ‘mothers of children 0-5 months,’ signifying low retention of these messages.

The vast majority of respondents received messages from clinic staff or the VHW, and none mentioned getting messages about malaria from radio, TV, newspaper, posters, road shows, or community meetings.

#### Type, Quantity, and Timing of Outdoor Activities in Angwa Ward

All groups interviewed in the household survey indicated that they spent a lot of time outdoors after 6 pm. Streambank cultivation, which requires sleeping outdoors or in a makeshift open structure at night, was a major activity since low rainfall in the ward is common and most respondents practiced some form of agriculture. The vast majority of respondents also reported being bitten by mosquitoes while guarding crops between 6 pm and 6 am. All-night outdoor prayer meetings for families were also common. Only a single respondent reported using mosquito repellent.

Overall, the assessment team concluded that the picture regarding continued high malaria incidence in Angwa Ward is complex and probably not due to any single factor, such as outdoor nighttime activities without adequate protection against malaria, even though this practice is very common in the area. The people live in proximity to safari areas and experience elephant raids on both food and cash crops during the night. People resort to guarding crops during the night, resulting in increased exposure to malaria mosquitoes. The climate in Angwa Ward and other parts of the Zambezi Valley is more suitable to *An. gambiae* complex mosquitoes, with their preference for temporary pools as breeding sites and propensity to cause malaria outbreaks once the rains come and multiple breeding sites return, than most other parts of Zimbabwe. Angwa Ward benefits from malaria prevention interventions from the MOHCC, but the quality of IRS should be improved and the adequacy and type of the distribution of LLINs should be reviewed. IPTp coverage is good but needs to be increased to meet national targets. Angwa Ward is also an underserved region, as revealed in the socioeconomic part of the household survey and by the less than adequate access to health services revealed in the survey and from the three key informant interviews. Based on these findings, a number of recommendations were made to alleviate the regularly high incidence of malaria in Angwa Ward and improve access to health care services.

# Background

## Malaria in Zimbabwe

Malaria is one of the leading causes of morbidity and mortality in Zimbabwe. It is estimated that malaria accounts for 20-30% of outpatient clinic visits and approximately 10% of hospital admissions [1]. Almost 98% of all malaria cases in Zimbabwe are caused by *Plasmodium falciparum*, the parasite species that causes the most deadly form of malaria and is a major cause of morbidity and mortality [1]. Malaria transmission is affected by climatic changes, especially high seasonal rainfall and variation in temperature and humidity, as well as socioeconomic activities and population movement, among other factors. The climatic conditions may favor mosquito breeding, which in turn can result in increased malaria transmission and subsequent malaria outbreaks in affected areas. While the southern and western parts of Zimbabwe are characterized by relatively low malaria transmission, the northern and eastern regions are typically characterized by more sustained and recurrent transmission.

Approximately 45-50% of the country’s population is still at risk of developing malaria, with about 83% of cases occurring in just three northern and eastern provinces: Manicaland, Mashonaland East, and Mashonaland Central [2]. One of the transmission hot spots in Mashonaland Central is Mbire District, which is located in the north of the country near the borders with Zambia and Mozambique. This investigation focused on Angwa Ward, one of the most affected wards in the district. Data from the Zimbabwe District Health Information System (DHIS2) shows that, in 2015, the national annual parasite incidence (API) for malaria was approximately 29/1,000 population, with three districts—Mbire and Mutoko in Mashonaland East Province and Nyanga in Manicaland Province--reporting an API above 200 per 1,000. By comparison, 28 districts in the country, particularly those in the southwest and the central highlands, reported an API below 5/1,000 and have started implementing pre-elimination activities [1].

*Anopheles arabiensis*, a member of the *Anopheles gambiae* complex, is one of the major vectors of malaria transmission in Zimbabwe, especially in the drier savannah areas [3]. This species feeds on both humans and animals, and feeds and rests indoors and outdoors. In the wetter parts of Zimbabwe, especially the eastern areas bordering Mozambique, *Anopheles funestus* is the predominant vector. Previous comprehensive vector distribution surveys did not detect the presence of *An. funestus* to any great extent (4). Although it seemed to be in decline in the eastern regions, *Anopheles funestus* appears to be resurging, mainly due to resistance to pyrethroids used for IRS from 2001 to 2013, particularly in the two high malaria incidence districts of Mutare and Mutasa. In Mbire District and other areas in the Zambezi Valley, both *An. Arabiensis* and *An. gambiae s.s.* have been found.

## Profile of Angwa Ward and Mbire District

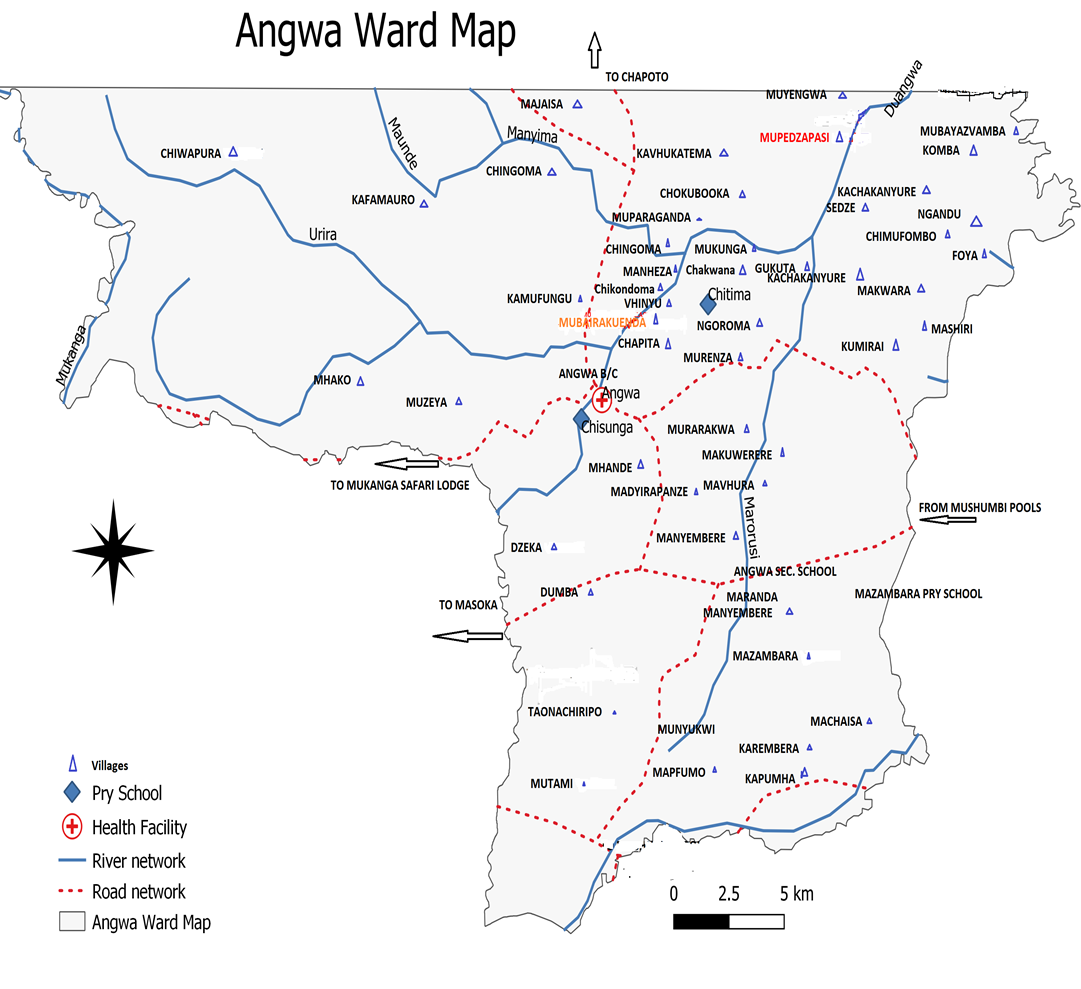
Angwa is one of nineteen wards in Mbire District, Mashonaland Central Province, which is situated along the Zimbabwe-Mozambique border. A large part of Mbire District, including Angwa, is located in the Middle Zambezi Basin. This dry region is designated primarily as Natural Region IV (NR IV), and is one of the five natural regions of Zimbabwe (also commonly known as agro-ecological zones). NR IV is generally found in the low-lying areas in the north and south of the country. The region is characterized by annual rainfall of 450-650 mm, severe dry spells during the rainy season, and frequent seasonal droughts. The district also records very high temperatures (sometimes exceeding 40°C) with a mean annual temperature of 25°C. Mbire District experiences frequent localized flooding, greatly influenced by high rainfall in the large upstream catchment area for the local rivers, with backflow from the downstream Cahora Bassa Dam in Mozambique. The district’s major rivers— Angwa, Manyame, and Musengezi-- contribute greatly to flooding, making Mbire one of the most flood-prone areas in the country [3]. Overall, these climatic conditions strongly favor the breeding of malaria vectors [4].

Figure 1: Map of Zimbabwe showing location of Angwa Ward, Mbire District



Source: Map produced by ZAPIM, March 2019, using QGIS- OSGeo4W-3.4.1**.**

Figure 2: Map of Angwa Ward



Source: Map produced by ZAPIM, March 2019, using QGIS- OSGeo4W-3.4.1.

Angwa Ward is one of the poorest wards in the country. According to the Zimbabwe Poverty Atlas 2011/2012 compiled by the Zimbabwe National Statistics Agency (ZIMSTAT), Mbire District had an average poverty prevalence of 81%, with Angwa Ward recording the second highest poverty prevalence in the district, at 89%. In an assessment of the 2010 feeding programme in Mbire District, Angwa was ranked as one of the two most food-insecure wards in the district [5]. Mbire is largely a communal farming livelihood zone, dominated by rain-fed agriculture of both food and cash crops [6]. Cotton has historically been a key cash crop, providing households with a reliable source of income; however, fluctuating international markets and generally low prices for cotton have resulted in farmers looking to alternatives, including groundnuts. Although land in NR IV, including Mbire, is considered unsuitable for dryland cropping without irrigation, smallholder farmers grow drought-tolerant varieties of maize, sorghum, pearl millet *(mhunga),* and finger millet *(rapoko*). Generally, NR IV is quite suitable for cattle rearing and for wildlife. Cattle and smaller livestock are also important sources of income, though diseases, especially nagana (animal trypanosomiasis), which is transmitted by the tsetse fly, remain a challenge. The abundant wildlife creates hazards for both crops and people, but also provides employment opportunities and income for some communities through the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE).

## Malaria Situation in Angwa Ward

Despite reportedly high coverage of routine malaria control interventions, Mbire District continues to report high annual malaria transmission. One of the areas contributing to this high incidence is Angwa Ward, which experienced an increase from 146 cases/1,000 population in 2012 to 731 cases/1,000 population in 2015 [7]. While there has been a subsequent decrease in incidence, malaria transmission persists in Angwa Ward, with an incidence of 94/1,000 population in 2017.

## Status of Implementation of Malaria Prevention and Control Activities in Angwa Ward from Desk Review and as Per National Policy

The desk review conducted as part of this assessment revealed that over the past five years, the NMCP and partners have implemented a wide array of malaria prevention and control interventions in Angwa Ward, with the following programmatic results reported:

* **Intermittent preventive treatment in pregnancy with sulfadoxine-pyrimethamine (Fansidar®):** IPTp has been deployed as a prevention strategy in Angwa Ward since 2012. The percentages of women who receive IPTp are reported according to the number of doses received. The target is for pregnant women to receive at least three doses, given at least four weeks apart until delivery. According to the DHIS2, IPTp3 coverage has increased gradually from 9% in 2012 to 78% in 2017. This is still below the national-level target of 85% coverage.
* **Indoor residual spraying:** Between 2013 and 2015, reported IRS coverage was relatively high, ranging from 89-95% of targeted rooms sprayed. This fell just short of the NMCP’s target IRS coverage level of 95%, but was consistently higher than the WHO target of 80% (although it should be noted that the WHO target and indicator specifies structures and not rooms, the latter being the primary unit of measure used by Zimbabwe). The reported proportion of the population protected by IRS was also high in 2013, 2014, 2015, and 2017, ranging from 85-99%. In 2012 and 2016, the proportions of the population protected were 83% and 77%, respectively.
* **Long-lasting insecticidal nets:** Since 2016, a combination of IRS and distribution of LLINs has been used as for vector control in Angwa due to special circumstances, such as the presence of un-sprayable housing structures and the prevalent practice of sleeping outdoors or adjacent to cultivated fields. The desk review found that the ownership of LLINs in Angwa is currently 58% amongst households that are already covered by IRS. This is very similar to the national figure of 58% of households owning at least one LLIN and 51% owning one LLIN per sleeping space [7]. Although LLIN ownership is below the national target of 85%, it should be noted that the current national policy (as well as the WHO guidelines) recommends that people living in high malaria transmission areas should use either a net or IRS. IRS, however, intentionally remains the primary and more widely available intervention in Angwa. LLINs are therefore expected to provide additional protection to those in unsprayable structures or those sleeping outdoors.
* **Vector bionomics:** Prior to this assessment, no formal entomological studies had been conducted in Angwa Ward during the past five years.
* **Case management**: Health facility- and community-level case management in Angwa Ward, including use of rapid diagnostic tests (RDTs) and treatment with artemisinin-combination therapy (ACTs), is guided by the national policy. Although it is difficult to determine the level of access to health care among those afflicted with malaria, once identified at any level, the policy states that 100% of suspected cases should be tested with an RDT or microscopy and all cases of uncomplicated malaria given ACTs. Cases of severe malaria should be given pre-referral rectal artesunate by VHWs or parenteral artesunate at Angwa Clinic before referral to the nearest hospital for further management. However, it has been noted that very few cases of severe malaria have been administered rectal artesunate because severe cases usually bypass the community level and go straight to the health facility. As a result of infrequent use, Angwa Ward, like other parts of the country, has been experiencing expiry of rectal artesunate stock.
* **Community mobilization and social and behavior change communication (SBCC)**: Over the past five years, the Angwa Clinic staff have conducted regular community social and behavior change communication activities, such as IRS sensitization sessions, LLIN sensitization, and net-hanging campaigns, as well as community mobilization to provide general malaria information and education sessions in the ward.

# Study Rationale, Aim, and Objectives

Notable progress has been made in reducing the malaria burden in Zimbabwe over the past decade. This has been achieved through the implementation of WHO-recommended malaria interventions such as vector control; case management; SBCC; and surveillance, monitoring and evaluation (SM&E). Despite reportedly high coverage and uptake of these interventions, some areas in Zimbabwe, including Angwa Ward, continue to experience relatively high levels of transmission. This is of particular concern to the NMCP and partners and has led to much debate and speculation that the continuing high burden of malaria in these areas may be the result of 1) inadequate intervention coverage; 2) adequate coverage but ineffective quality of the recommended interventions; or 3) other drivers of malaria transmission that NMCP needs to identify and address, such as unidentified aspects of the lifestyles and/or livelihoods of the community that are increasing the risk of malaria.

Based on these suppositions, NMCP, with support from the U.S. President’s Malaria Initiative (PMI) and ZAPIM, conducted an assessment to systematically identify the factors that are driving high malaria transmission in Angwa Ward despite reported high levels of intervention coverage. VectorLink, Africa University, and the National Institute of Health Research (NIHR) conducted the entomological aspects of the assessment, with the Africa University laboratory analyzing the mosquitoes. The results provide evidence for implementing required programmatic decisions and for addressing similar situations in other areas of the country and beyond.

## Objectives of the Assessment

1. Describe malaria trends in Angwa Ward for the period 2012-2017.
2. Describe the socioeconomic and geographic context of Angwa Ward.
3. Describe the health care system in Angwa Ward.
4. Estimate the current coverage, quality, access, and use of malaria prevention interventions in Angwa Ward, including personal protection outdoors.
5. Characterize the presence of malaria vectors and describe vector bionomics and insecticide resistance patterns in Angwa Ward.
6. Assess the knowledge, attitudes, practices, and perceptions of malaria and malaria risk in Angwa Ward.
7. Describe the type, quantity and timing of outdoor activities in Angwa Ward.

# Assessment Organization and Methodology

## Desk Review

A desk review was undertaken to obtain information on IRS, LLIN, and IPTp coverage in Angwa Ward and to describe the local health care system in terms of health workforce, commodity stock status, and the extent of supportive supervision for health workers at the facility and community levels. A structured desk review template was used to extract information from health facility registers, including the Integrated Management of Neonatal and Childhood Illnesses (IMNCI) and outpatient department (OPD) registers used to record patient symptoms, tests, diagnoses, and treatments; the antenatal care (ANC) register used to record information on treatment given during pregnancy, including IPTp; and the data aggregation form (T5). The desk review also assessed the overall malaria situation in Mbire District and Angwa Ward over the past six years (2012–2017), from an epidemiologic perspective.

## Household Interviews

Quantitative data collection aspect for this assessment consisted of household interviews using Lot Quality Assurance Sampling. This is a method of evaluating a programme by analysing data collected from a small sample (a “lot”) in a specific geographic area. For this assessment, the designated survey area consisted of all villages located in Angwa Ward (in LQAS parlance, this is called a catchment area). For data collection, the catchment area was divided into five “lots,” also called supervision areas (SAs), with 19 villages sampled in each SA. Nineteen was chosen as the sample size for each supervision area because that is the number determined to be the minimum sample size where the *alpha* or *beta* errors are less than 10%. When the data from all of the SAs in the survey are tallied together, it is possible to create point estimates and confidence intervals for a series of 40 indicators covering Angwa Ward. The advantages of this methodology include the following:

* Sampling procedures and analysis are relatively simple, and local managers and health workers can use the results immediately;
* Data from individual SAs can be combined to assess coverage for the whole catchment area; and
* A small sample can help determine whether or not a given supervision area has reached a predetermined level of coverage.

The delineation of supervision areas was conducted in consultation with NMCP using standard selection criteria that have been used by ZIMSTAT and the MOHCC for other surveys in Angwa Ward. The selection criteria included:

* Proximity of villages to each other;
* Access relative to the river (villages in a given SA were located on one side of the Angwa River); and
* Geographical position (e.g., in relation to physical features, such as forests with wild animals).

The selection of sample interview locations for each SA was based on probability proportional to size (PPS) sampling, which is a way of selecting interview locations according to the population size. The Provincial Medical Director’s Office, through the Environmental Health Department,made available an updated list of villages and the population size for each village under each SA. Using this information, a sampling frame was created and locations were selected for 19 sets of interviews in each SA. Table 1 shows the number of sets of interviews for each village.

Table 1: Distribution of Interview Sets per SA Using Probability Proportional to Size Sampling

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of Interview Sets per Village | Villages in SA1 | Villages in SA2 | Villages in SA3 | Villages in SA4 | Villages in SA5 |
| One | Mubairakuenda  Dzeka  Kafamauro  Dumba  Makuwerere  Murarakwa | Chingoma | Foya  Sedze  Mupedzapasi | Musarutya  Taonachiripo | Kachakanure  Kumirai  Makwara  Mutyoraringa |
| Two | Mhako  Chapita  Chiwapura  Muzeya  Kamufunga | Mackenzie  Vhinyu  Majaisi  Nyahungwe | Kavhukatema  Chimufombo  Chokubooka  Mashiri  Muyengwa  Mubayazvamba  Komba  Ngandu | Mapfumo  Mutami  Karembera  Kapumha | Mavhura  Murenza  Gukuta  Chakwana  Ngoroma  Maranda |
| Three | Mhande | Manheza  Chikondoma |  | Manyembere  Machaisa  Munyukwi | Mukunga |
| Four |  | Muparaganda |  |  |  |
| **Total sets per SA** | **19** | **19** | **19** | **19** | **19** |

A structured questionnaire was used to collect data during the household interviews. There were four respondent groups for interviews, for a total of 76 interviews per supervision area. The target was to have 19 of each type of respondent group in each SA. The interview groups were mutually exclusive (one interview permitted per household) and interviewees from the four groups were administered independent questionnaires. The respondent groups and criteria for participation were as follows:

1. *Household heads:* Any randomly selected household head (man or woman) over 18 years old. They should have resided within the catchment area for the previous three months.
2. *Mothers of children 0-5 months:* Any randomly selected mother with a child aged 0 to 5 months who had resided within the area for the previous three months. This group was interviewed specifically on issues related to pregnancy, in particular IPTp.
3. *Mothers of children 0-59 months:* This was a separate group of mothers from the one above. Their interviews focused mainly on malaria knowledge and care seeking behavior for the children.
4. *Other randomly selected household members aged 18 years and older who are not household heads:* This group focused mainly on the lifestyles and outdoor activities of community members who were not heads of households.

## Focus Group Discussions

#### Site Selection

Community member FGDs were conducted in six randomly selected villages, including one from each of the five supervision areas delineated for the LQAS household survey plus one additional village. The villages were Kavhukatema, Makuwerere, Vhinyu, Kachakanyure, Chitima, and Mutami. An additional FGD was conducted with the VHWs and Health Centre Committee (HCC) members at Angwa Clinic.

#### Meetings

FGDs were carried out to assess the community attitudes, knowledge, beliefs, and practices regarding malaria (including access to malaria services and community lifestyle patterns), in Angwa Ward. Two FGDs were conducted in each of the six selected villages, one with men and the other with women. An additional FGD was conducted with a combined group of VHWs randomly selected from each village, and two Health Centre Committee (HCC) members from Angwa Clinic. Each FGD had 8 to -12 participants. VHWs from the selected villages were asked to help in the recruitment of community member participants using the following criteria: men and women over 18 years old; should have resided in the catchment area for the past six months; should be from different households; and should not have participated in the household survey interviews.

#### Data Collection Plan

Community member participants were invited to a common meeting place in the village, preferably central but away from interference. Written informed consent to participate was obtained. The participants were at liberty not to use their real names in the FGDs if they wished to remain anonymous. Refreshments were provided after the session. An FGD guide was used by the data collectors to help guide discussion with the participants. Each FGD session was timed to last 60-90 minutes. The FGDs were recorded using audio devices. Two data collectors led the FGD, with one serving as the moderator and the other recording on the audio equipment and taking backup notes. The FGDs focused on the following discussion themes:

1. Knowledge, attitudes, practices, and perceptions in relation to malaria;
2. Access to malaria services;
3. Religious and cultural beliefs in relation to malaria in Angwa Ward; and
4. Socioeconomic activities and lifestyles during the day and at night among the Angwa community.

## Key Informant Interviews

To elicit further details about health care delivery in Angwa Ward and coverage of malaria prevention and treatment services, key informant interviews were conducted with three individuals:

1. The District Medical Officer (DMO), who has been working in Mbire District for five years;
2. The Nurse-in-Charge, who has been running Angwa Clinic for three years; and
3. The Angwa Clinic Environmental Health Technician (EHT).

The key informant interviews focused on the following topics:

1. Malaria programme management;
2. Malaria programme funding;
3. Adequacy of malaria prevention and diagnosis in the health care system;
4. Contributing factors to continued malaria transmission in Angwa;
5. Adequacy and malaria training status of the health workforce;
6. SBCC activities and availability of information and education materials in the community;
7. Health information systems;
8. Medicines availability;
9. Coverage, quality, access, and use of malaria prevention interventions;
10. Barriers to net use; and
11. Suggestions for improving services.

## Vector Bionomics

### Mosquito Species Collected

During the cold, dry season (May to July 2018), two teams collected mosquitoes simultaneously for four and five days on three separate occasions from two villages situated along the Angwa River: Mubairakuenda Village near the Angwa River Bridge, and Mupedzapasi, which is located about 15 kilometers downstream near the border with Mozambique. *Anopheles* mosquitoes were collected both indoors and outdoors using the pyrethrum spray collection (PSC) technique [8], while a battery-powered Prokopack aspirator (PPA) was used to sample indoor resting mosquitoes. Pit shelters were used for sampling outdoor resting mosquitoes and exit window traps were used to collect mosquitoes exiting houses. Twenty-five houses were randomly selected for PSC and PPA from each village. Five pit shelters, strategically dug at each village, were monitored per field trip, while ten exit window traps were set for two consecutive days at randomly selected houses at the two villages. Three field trips were done, occurring in May, June, and July 2018. Further, clay pots with a small amount of clean water were introduced as an additional mosquito collection method to determine their usefulness in vector surveillance. Four clay pots were set out over two consecutive nights at each village, two indoors and two outdoors.

After collection, the mosquitoes were sorted, counted, and a preliminary morphological identification was made of the *Anopheles* species. The specimens were further identified under a stereomicroscope using morphological keys [9]. The abdominal condition of female *Anopheles* mosquitoes was determined by the naked eye and assigned to one of four categories: unfed, freshly-fed, half-gravid, and gravid. All specimens were preserved individually in Eppendorf tubes containing silica gel after cutting the abdomen from the head and thorax for species identification using available molecular protocols [10].

The involvement of various *Anopheles* species in malaria transmission was assessed using the ELISA test for *Plasmodium falciparum* sporozoite infection [11]. The head and thorax of each dried female mosquito was tested for *P. falciparum* at the Africa University (AU) laboratory in Mutare. Laboratory-reared *An. arabiensis* were used for negative controls in the assays. All readings were analyzed at 405 nm and recorded with a plate reader 30 minutes after adding the substrate used to visualize the reaction of certain enzymes in immunosorbent assays. Samples were considered positive once absorbance values exceeded twice the mean of seven negative controls. False positives were eliminated by applying the boiling method described by Durnez *et al.* [12].

### Mosquito Biting and Resting Habits

Centres for Disease Control and Prevention (CDC) light traps were set alongside a human bait as proxy for human landing collections (HLC) during the mosquito collection exercise described above. The HLC proxy was used to monitor vector behavior during the night from 6 pm to 6 am, simultaneously indoors and outdoors. The human bait slept under an untreated mosquito net for protection. The data collectors used mouth aspirators to collect mosquitoes from the CDC light trap hourly throughout the nights, from indoors and outdoors, for two consecutive nights per survey trip. Captured mosquitoes were placed in paper cups, with a new cup used for every hour. This method was used as proxy to the standard HLC method, which the Medical Research Council of Zimbabwe (MRCZ) does not approve for ethical reasons.

### Characterization of Water Bodies and Larval Habitats

The water bodies in which larvae of *Anopheles* mosquitoes breed vary in physicochemical characteristics that determine vector oviposition, survival, and spatial distribution. In Angwa Ward, mosquito breeding habitats are expected to vary with season, with breeding habitats consisting of scattered rainwater pools on high ground in the rainy season and backwaters along the rivers during the dry season.

A descriptive cross-sectional study was conducted at Mubairakuenda and Mupedzapasi villages during the dry winter months of May to June 2018. The study involved describing the breeding habitats of malaria vectors in the ward, including the nature, origins, and distribution of mosquito breeding pools. Physical characteristics of the pools that were assessed included the level of pollution and environmental factors such as exposure to the sun and the presence of aquatic vegetation, debris, and algae. Water pH was the only abiotic variable that was measured on site for some water pools. Turbidity and salinity could not be measured due to equipment failure.

The assessment also focused on the extent to which anopheline and culicine larvae were found in the available water bodies. This information is vital for possible larval control during the dry season. The standard WHO dipping method was used to collect larvae and pupae using a 250 ml dipper. A minimum of 10 dips per pool was used to estimate the density of larvae, both early (1st and 2nd instar) and late (3rd and 4th instar) larvae, in each pool. Pupae were also recorded when present.

### Residual Efficacy of DDT Used for IRS in Angwa Ward

Houses at Mubairakuenda and Mupedzapasi were sprayed during the routine IRS campaign in October 2017 using a 75% water dispersible formulation of DDT with a target dose of 2 gm/m2. Nine months after spraying, the residual efficacy of DDT was assessed using the standard WHO plastic cone bioassay tests [13]. Five sprayed houses were randomly selected per village. The cone bioassay tests were done using susceptible, laboratory-bred *An. arabiensis* (KGB strain) from the NIHR laboratory in Harare. Non-blood-fed, two-to-five-day-old female mosquitoes were used as follows: 10 mosquitoes per cone were exposed for 30 minutes in three plastic cones spread around the room at 0.5, 1.0, and 1.5m from the floor. After 30 minutes exposure, the mosquitoes were removed and transferred to clean paper cups. The numbers of mosquitoes knocked down were recorded just after exposure, and again at 60 minutes post-exposure. Final mortality was recorded after a 24-hour observation period. Control mosquitoes were exposed to non-sprayed surfaces for 30 minutes and followed the same procedure.

### Efficacy of LLINs Against Susceptible *An. Arabiensis*

According to WHO guidelines, an LLIN is expected to retain its biological activity for at least 20 standard washes under laboratory conditions and three years of recommended use under field conditions. The MOHCC, with ZAPIM support, distributed 3,209 LLINs (DuraNet® and Dawa Net®) through mass campaigns in Angwa Ward in September 2016. Continuous distribution of LLINs was then launched in January 2017 using nets manufactured in March 2015 and March 2016, respectively. VectorLink assessed the efficacy of these nets at Mupedzapasi and Mubairakuenda villages in July 2018, using WHO cone bioassays [13].

A total of sixteen standard WHO plastic cones were attached to each mosquito net (four at the bottom of each side, four on top, four on the middle, and four on the roof) in accordance with the WHO protocol [13]. Twelve LLINs were tested, six sampled from each of the two villages, representing 50:50 of the two brands. Five insecticide-susceptible, non-blood fed, two-to-five-day-old female *An. arabiensis* mosquitoes were introduced in each WHO cone and exposed for three minutes. The mosquitoes were then retrieved, placed in paper cups, and provided with cotton wool dabbed in 10% sugar solution. Mosquito knockdown was recorded at 30 and 60 minutes post-exposure to the treated nets. The final mortality rate was recorded after holding the mosquitoes for 24 hours.

# Results

The results are presented as they relate to the seven key objectives of the assessment, using data and information collected from the various methods described above.

## Malaria Trends in Angwa Ward, 2012-2017

### Malaria Incidence

Data collected during the desk review showed that Mbire District has had a history of fluctuating malaria incidence over the past several years. Figure 3 below shows the annual malaria incidence per 1,000 people in Mbire since 2012, which suggests cyclically fluctuating incidence over the six-year period through 2017. The malaria incidence in Angwa Ward (based on Angwa Health Facility data) from 2013 to 2017 is also variable and not quite aligned with the district level incidence.

Figure 3: Mbire District and Angwa Ward malaria incidence, 2012-2017

Note: Data for Angwa Ward in 2012 was incomplete and therefore excluded from the chart.

To gain a broader perspective on malaria in Mbire District over the past six years it is worth comparing its annual incidence rates with other high incidence districts in Zimbabwe. Mbire recorded the highest incidence in the whole country in 2014 and the second highest in 2015. In 2016, it recorded the sixth highest incidence, increasing to third highest in 2017. The decline in malaria incidence recorded in Angwa Ward since 2016 could be due to the deployment of both IRS and LLINs. Traditionally Angwa Ward is an IRS ward; however, in 2016 a decision was made to include LLIN distribution to cover sleeping places inside houses and outside sleeping places at home and in the fields.

While there are no actual incidence figures available that are disaggregated for each of the 17 wards that currently make up Mbire District, there is malaria data from all 13 clinics that are distributed throughout the district. The incidence per 1,000 persons over five years from 2013 to 2017 from each of the 13 clinics is shown in Figure 4 below. Health facility data shows Angwa Ward among the five most affected wards in the district.

Figure 4: Five-year incidence rates in Mbire District by health facility, 2013-2017

The seasonal distributions of malaria cases in Angwa Ward for the years 2013-2017 are presented in Figure 5 below. From 2013-2015, an increase in malaria cases started in February, peaked in April, then tailed off in June. However, in 2016 and 2017 the peak extended to May and June, respectively. This overall pattern is consistent with malaria transmission driven by seasonal rainfall in Zimbabwe.

Figure 5: Seasonal trends in malaria cases in Angwa Ward, 2013-2017

### Contribution of Children under 5 Years of Age to the Malaria Burden in Angwa Ward

Figure 6 below shows that from 2013 to 2017, the percentage of malaria cases in children under five years of age in Angwa was highly consistent at 15-16%, despite the variability in total cases in the ward over that time period.

Figure 6: Under-five malaria burden in Angwa Ward as a percentage of total cases, 2013-2017

## Socioeconomic and Geographic Context in Angwa Ward

### LQAS Household Survey

#### Response Rates and Data Collection

The LQAS household survey collected data on 40 indicators, including those associated with LLINs, IRS, IPTp, malaria case management, basic knowledge of malaria, and lifestyle behaviors such as outdoor activities that may increase the risk of malaria transmission. The response rate for the household survey was approximately 98% for three of the four respondent groups that participated: household heads, mothers of children under five years of age and other household members. However, the response rate was only 47% for the fourth group, mothers of children under five months of age, due to difficulty in finding a sufficient number of eligible mothers in the sample villages.

#### Background of Respondents

All four sets of respondents were asked questions about their backgrounds, including age, level of education, ability to read, religion, and number and gender of children in the household. The responses are shown in Table 2 below.

Table 2: Background Details of Household Survey Respondents in Angwa Ward, May 2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Questions | Criteria | HH Heads | Mothers of Children 0-5m | Mothers of Children 0-59m | Other HH Members | Summary for All the Four Groups |
|  | | N=93 | N=45 | N=93 | N=93 | N=324 |
| Mean age of respondents | Years | 50.4 | 26.5 | 30.4 | 38.3 | 36.4 |
| Attended school or pre-school | Yes | 79 (85%) | 41 (91.1%) | 90 (96.8) | 76 (81.7%) | 286(88.65%) |
| No | 14 (15%) | 4 (8.9%) | 3 (3.2%) | 17 (18.3%) | 38(11.35%) |
| Highest level of school attended (applicable to those who attended school or pre-school) n=286 | Pre-school | 2 (2.5%) | 0 | 1 (1.1%) | 0 | 3(1%) |
| Primary | 59 (74.7%) | 28 (68.3% | 57 (63.3%) | 47 (61.8%) | 191(66.8%) |
| Secondary | 17 (21.5%) | 10 (24.4%) | 32 (35.6%) | 29 (38.2%) | 88(30.8%) |
| Higher | 1 (1.3) | 3 (7.3%) | 0 | 0 | 4(1.4%) |
| Reading ability (applicable to those who attended school or pre-school) n=286 | Cannot read at all | 9 (11.4) | 11 (26.8%) | 15 (16.7%) | 15 (19.7%) | 50(17.5%) |
| Able to read only parts of the sentence | 11 (13.9) | 7 (17.1%) | 11 (12.2%) | 10 (13.2%) | 39(13.6%) |
| Able to read the whole sentence | 58 (73.4%) | 23 (56.1) | 64 (71.1%) | 50 (65.8%) | 195(68.2%) |
| Blind/visually impaired | 1 (1.3) | 0 | 0 | 1 (1.3%) | 2(0.7%) |
|  |  |  |  |  |  |
| Religion n=324 | Roman Catholic | 7 (7.5%) | 3 (6.7%) | 2 (2.2%) | 1 (1.1%) | 13(4%) |
| Protestant | 4 (4.3%) | 1 (2.2%) | 4 (4.3%) | 3 (3.2%) | 12(3.7%) |
| Pentecostal | 8 (8.6%) | 12 (26.7%) | 28 (30.1%) | 22 (23.7%) | 70(21.6%) |
| Apostolic Masowe | 22 (23.7%) | 15 (33.3%) | 27 (29%) | 23 (24.7%) | 87(26.9%) |
| Apostolic Marange | 2 (2.2%) | 2 (4.4%) | 1 (1.1%) | 3 (3.2%) | 8(2.5%) |
| Apostolic Mwazha | 0 (0%) | 0 | 0 | 0 | 0 |
| Apostolic Mugodhi | 0 (0%) | 0 | 0 | 0 | 0 |
| Other Christian | 6 (6.5%) | 3 (6.7%) | 8 (8.6%) | 9 (9.7%) | 26(8%) |
| Islam | 0 (0%) | 0 | 0 | 0 | 0 |
| Traditional | 24 (25.8) | 1 (2.2%) | 1 (1.1%) | 9 (9.7%) | 35(10.8%) |
| Other religion | 5 (5.4%) | 6 (13.3%) | 15 (16.1%) | 9 (9.7%) | 35(10.8%) |
| No religion | 15 (16.1) | 2 (4.4%) | 7 (7.5%) | 14 (15.1%) | 38(11.7%) |
| No. of HH members under age 5 | Mean | 0.7 | N/A | N/A | 1.3 |  |
| No. of HH members aged 5 years and above | Mean | 4.8 | N/A | N/A | 4.9 |  |
| Gender of children | Male | N/A | 22 (48.9%) | 53 (57%) | N/A |  |
| Female | N/A | 23 (51.1%) | 40 (43%) | N/A |  |
| Mean age of children | Months | N/A | 2.8 | 27.7 | N/A |  |

A total of 324 respondents (85%) were interviewed from a target sample of 380. The mean age of the heads of the households was 50.4 years; the mothers with children 0-5 months, 26.5 years; the mothers with children 0-59 months, 30.4 years; and the other household members, 38.3 years.

Most of the respondents (89%) had attended school. Of those who attended at least pre-school, 67% attained primary level education while 31% attained secondary level education. Reading ability was assessed using a sentence constructed for primary school level, and 68% were able to read a whole sentence, while 14% were able to read only parts of the sentence. Fifteen percent were not able to read at all.

Twenty-nine percent of the respondents belonged to the combined apostolic sect group that includes Johane Masowe, Marange, Mwazha, and Mugodhi. The second largest affiliation was Pentecostal. Respondents from other Christian denominations included Catholics and Protestants, while 12% had no religious affiliation (see Figure 7).

Figure 7. Religious affiliation of household survey respondents (N=324) in Angwa Ward, May 2018.

Among all respondents surveyed (n=324), 68% reported that a member of their household owned a mobile phone. Thirty-five percent indicated that they had a member who owns a bicycle, while 33% had an animal drawn cart, and 18% had a wheelbarrow. Eighty-nine percent reported that the household owned any kind of livestock, and 82% reported ever having to protect their livestock from wild animals. Eighty-three percent reported that the household had land that can be used for agriculture.

#### Household Characteristics

The questionnaire for heads of households had several questions about the general construction of the household dwelling. Just over half (52%) of the dwelling’s floors were earth/sand, 22% were made from dung, 22% were cement, 5% were made of wood planks, and 1.5% were other materials (see Table 3).

Table 3: Main Construction Materials of Dwellings Assessed in the Household Survey, Angwa Ward, May 2018

|  |  |  |
| --- | --- | --- |
| Questions | Criteria | N (%) |
| Main material of the roof (N=141) | Thatch | 90 (64%) |
| Wood planks | 1 (1%) |
| Metal/Tin | 20 (14%) |
| Wood | 14 (10%) |
| Tiles | 0 |
| Cement | 3 (2%) |
| Roofing shingles | 3 (2%) |
| Asbestos | 9 (6%) |
| Other | 1 (1%) |
| Main material of the exterior walls (N=117) | Cane / Trunks | 2 (2%) |
| Mud (Pole and dagga) | 26 (22%) |
| Cement | 12 (10%) |
| Stone with lime/ cement | 0 |
| Bricks | 76 (65%) |
| Cement blocks | 0 |
| Wood planks/ shingles | 1 (1%) |
| Windows of the house fly screened (N=93) | Yes  No | 4 (4%)  89 (96%) |
| House has any visible openings where mosquitoes could enter, e.g., uncovered windows, doors, openings in the roof, eaves, or walls (N=93) | Yes  No | 89 (96%)  4 (4%) |

A total of 141 dwellings were assessed concerning their roofing material. Most dwellings had thatch roofs (64%) and a sizeable number (15%) had tin as roofing material. Wood roofs were 10% and asbestos roof material dwellings were 6%. None of the dwellings had roofs made of tiles. Of the 117 dwellings assessed for the exterior wall materials, 65% were brick, 22% were mud (pole and dagga), and 10% were cement. Of particular note, the vast majority of the households (96%) indicated that their houses had visible openings where mosquitoes could enter.

The main source of fuel among the households was firewood. Meanwhile, 45% of respondents had a working radio set and 10% had a working television set.

## Angwa Ward Health Care System

Most of the information on the current health care situation in Angwa came from the three participants in the key informant interviews, with some further information gathered during the desk review.

### Malaria Program Funding

According to District Medical Officer, the main sources of malaria funding and support are the Global Fund, through MOHCC, and PMI, through ZAPIM. Regarding the adequacy of funds, the DMO reported that funding is not adequate, as evidenced by the commodity stock-outs (RDTs and ACTs) that the country periodically experiences. He also noted that funding is sometimes not available on time, leading to delays in carrying out malaria activities. Apart from Global Fund and PMI funding, he cited the World Bank results-based financing (RBF) initiative as another source of malaria funds. Under this initiative, health facilities are funded based on outputs verified through a monthly assessment score sheet that looks at various indicators, including malaria. However, he stated that these funds are often disbursed late.

### Malaria Program Management

According to the DMO, the district should ideally hold weekly District Health Executive (DHE) meetings to discuss malaria issues, including review of malaria epidemic preparedness and response thresholds and assessment of the availability of commodities for all health facilities in Mbire District. One of the challenges for malaria program coordination in Mbire is that DHE members are stationed at different locations that are geographically far apart (Chitsungo, Mushumbi, and Mahuhwe). For example, it is approximately 300 kilometers from Chitsungo to Mushumbi. As a result, in-person meetings are usually held twice a month. The District Health Information Officer (DHIO) provides monthly feedback on malaria data to health facilities, mainly through the WhatsApp platform.

### Health Workforce

According to the Nurse-in-Charge, Angwa Ward has a single health facility staffed by three nurses, two of whom were trained in malaria case management in 2016 and 2018 respectively, and one EHT, who was trained in malaria case management in 2015. The nurse, who is not trained in malaria case management, was recruited in 2018. There is also a nurse aide who tests for and treats malaria but who has not been officially trained in malaria case management. She received on-the-job training from the nurses. The ward has 21 VHWs covering a total of 51 villages. Of these, 16 have been formally trained and offer malaria testing and treatment in the community. Other key community malaria program implementers include 10 School Health Coordinators, who are teachers responsible for school health programs but are not trained in malaria community case management and do not test for and treat malaria. Currently, their role in malaria is limited to providing health education on malaria prevention and referral of sick children to the health facility.

### Health Center Committee

According to the Nurse-in-Charge, Angwa Clinic has a nine-member Health Center Committee (HCC), including the Nurse-in-Charge, the EHT and the Councilor, who is ex-officio. The other members are representatives from schools, traditional leaders, VHWs, church leaders, and an Agricultural Extension Officer. The role of Angwa Ward’s HCC is to link health services with the community. The HCC coordinates health facility development projects and provides oversight on the use of RBF funds. The HCC also works with clinic staff in developing annual plans, and meets quarterly to review progress on implementation of the plans.

### Supportive Supervision

#### Health Facility Worker Supportive Supervision

Table 4 details annual visits by district supervisors to provide supportive supervision of facility health workers.

Table 4: Supportive Supervision for Angwa Facility Health Workers by District Supervisors

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Total Number of Supportive Supervision Visits Received | Expected Number of Malaria Supportive Supervision Visits | Number of Supportive Supervision Visits that Covered Malaria (%) |
| 2016 | 16 | 12 | 3 (19%) |
| 2017 | 14 | 12 | 1 (7%) |
| 2018 (up to May) | 7 | 12 | 3 (43%) |
| **Total** | **37** | **36** | **7 (19%)** |

Source: Angwa Clinic Health facility visitors’/supportive supervision book.

Of the 37 supportive supervision visits received by Angwa Clinic from 2016-2018, only seven (19%) covered malaria. The seven visits covering malaria mainly focused on case management, M&E, and, to a lesser degree, on SBCC and vector control. This frequency of supportive supervision that includes malaria is far below the bimonthly and quarterly visits expected during peak malaria transmission season and off-peak transmission season, respectively.

### Community Case Management: Training, Supportive Supervision, and Contribution to Malaria Testing and Treatment

Asked about VHW supportive supervision and challenges, the Angwa Clinic Nurse-in-Charge reported that nurses are supposed to meet the VHWs at the health facility on a monthly basis. This is an opportunity to resupply the VHWs with malaria commodities and discuss any challenges that they may be facing. The main challenges are usually shortages of commodities. As a result, the nurses prioritize giving commodities to VHWs in higher malaria burden villages and furthest from the clinic. Another challenge is that, when there is only one nurse on duty, there is limited time to meet the VHWs. The nurses do not visit VHWs at their homes for supportive supervision because they do not have transportation. The EHTs periodically visit the VHWs because they do have transportation options. However, these visits are often hindered by shortage of fuel. The other challenge is a lack of coordination between the nurses and EHTs regarding VHW supervision, since they do not meet to plan topics to be covered during VHW visits or share feedback with each other after the visits. Therefore, the EHTs concentrate on aspects more familiar to their work, related to preventive interventions, such as vector control. This lack of mobility on the part of nurses and lack of coordination with mobile EHTs limits opportunities for effectively supervising VHWs in malaria case management. As shown in Figure 8 below, since 2016 there has been an increase in the proportion of malaria cases diagnosed and treated by VHWs compared to those treated at the health facility (HF).

Figure 8: Proportion of malaria cases diagnosed and treated by VHWs in Angwa 2016-2018

#### Malaria Case Management at the Health Facility

According to all three key informant interviewees, suspected malaria cases are tested using an RDT kit. Patients with suspected malaria, despite being malaria RDT negative, and patients suspected of malaria treatment failure are referred to the nearest hospital for microscopy. According to the guidelines, when there is a case of severe malaria the facility nurse gives pre-referral treatment and then communicates with the Mbire District Hospital for ambulance service. However, communication with the district hospital is often a challenge because there is no telephone network coverage at the hospital. There are also frequent delays because the ambulance has to come from Mahuhwe Clinic about 80 km away and the roads are bad, especially during the rainy season. The ambulance also services other clinics within the catchment area, further contributing to delays. Therefore, the time it takes for the ambulance to arrive at Angwa Clinic varies greatly.

#### Health Information System

The DMO, Nurse-in-Charge, and EHT reported being familiar with the MOHCC data reporting system of sending weekly malaria data to the district via cell phone messages every Monday as part of the rapid disease notification system (RDNS). In addition, Angwa facility staff work to consolidate malaria information on a monthly basis onto the T5 Return Form. The facility-level consolidated T5 Return Form is then sent to the district on a monthly basis for entry into the DHIS2 database by the DHIO. However, meetings to discuss malaria data at the health facility level are irregular because of other commitments, such as participation in workshops, vacation, and study leave. The last meeting was held two months before the assessment. The health facility also faces challenges in getting VHW data on a weekly basis because some of the VHWs are not supported for cell phone airtime, some are in areas with a limited cell phone network, and some do not have cell phones. Therefore, as in the majority of wards in Zimbabwe, the VHW data is collected on a monthly basis. This delay in data reporting undermines timely curative and public health management of malaria because, as shown in Figure 8 above, VHWs now make a significant contribution to malaria diagnosis and treatment in Angwa.

Updated malaria threshold limit values for 2018 were available and plotted at the clinic in the EHT’s office. However the alert line was missing on the graph. An updated spot map was also displayed on the wall.

## Current Coverage, Quality, Access, and Use of Malaria Prevention Interventions in Angwa Ward

### IPTp Coverage

#### Angwa Clinic Data

During the desk review, IPTp coverage for the different doses were calculated based on data extracted from the ANC registers for 422 women who booked their first ANC visit between January 2014 and July 2017. The calculations were done manually by counting and tallying the number of women who received each dose of IPTp, as documented. Figure 9 below presents a summary of these findings, showing that IPTp coverages have been gradually increasing since 2014. These coverages have been adjusted for cotrimoxazole prophylaxis. The difference in percentages of mothers receiving one dose and a second dose is minimal, although the difference increases for three and four doses. The desk review showed that IPTp coverages in Angwa are far higher than the national coverages of 37%, 32%, and 5% for IPTp 2, 3, and 4, respectively, obtained through national community based surveys.

Figure 9. Facility-based IPTp coverage of women who attended their first ANC visit between January 2014 and July 2017 in Angwa Ward

#### LQAS Household Survey

The LQAS household survey also included a question about IPTp for mothers of children aged 0-5 months. Coverages for those who reported taking various doses of intermittent preventive treatment for malaria with sulphadoxine-pyrimethamine are shown below in Table 5.

Table 5: Coverage Estimates for Mothers Who Took IPTp during their Previous Pregnancy, Angwa Ward, May 2018

|  |  |
| --- | --- |
| Indicators | Coverage |
| Proportion of mothers of children 0-5 months who report having taken at least one dose of IPTp during their last pregnancy | 91% |
| Proportion of mothers of children 0-5 months who report having taken at least two doses of IPTp during their last pregnancy | 82% |
| Proportion of mothers of children 0-5 months who report having taken at least three doses of IPTp during their last pregnancy | 64% |

As the table shows, 91% of pregnant women had received at least one dose of IPTp during their last pregnancy, dropping to 82% for two doses and 64% for at least three doses.

### Indoor Residual Spraying

#### Desk Review

Using health facility and provincial data, the desk review showed that IRS coverage of targeted structures, in terms of rooms sprayed and population protected, was relatively high over the six-year period assessed. This ranged from 83-95% of rooms sprayed, with an average of 87% for the six-year period, and from 83%-99% of the population protected, with an average of 89%. The highest coverage was achieved in 2017, with coverage of rooms sprayed and population protected at 95% and 99%, respectively. It should be stressed that this spray coverage represents the coverage based on the targeted rooms, which do not necessarily represent the full universe of sprayable rooms.

Data on IRS sourced from the health facility in Angwa during the desk review are shown in Table 6 below. For three consecutive years, 2015-2017, the spraying coverage was above 90% of the targeted rooms. The targeted rooms represent the number of habitable rooms with a roof and solid walls that can be sprayed in a defined geographical area. This figure is derived from the previous IRS campaign data, which include sprayed, locked, and refused rooms. According to data obtained from the province, the provincial officials assumed the same population levels over the years, although this should have been reviewed on an annual basis.

Table 6: IRS Coverage for Angwa Ward, 2012-2017

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year | Dates of Spraying | Insecticide | Targeted Rooms | No. of Rooms Sprayed | IRS Coverage | Targeted Population | Population Protected | % Pop. Protected |
| 2012 | 30/10/12 | DDT | 3941 | 3016 | 86% | 6110 |  |  |
| 2013 | 10/10/13 | DDT | 3582 | 2981 | 83% | 6110 | 5298 | 87% |
| 2014 | 02/11/14 | DDT | 3388 | 2878 | 85% | 6110 | 5091 | 83% |
| 2015 | 01/11/15 | OPS | 3588 | 3249 | 91% | 6110 | 5736 | 94% |
| 2016 | 16/11/16 | OPS | 3486 | 3124 | 90% | 6110 | 5178 | 85% |
| 2017 | 02/10/17 | DDT | 4185 | 3984 | 95% | 5178 | 5131 | 99% |

Source: Facility and provincial data.

#### LQAS Household Survey

Data on IRS coverage was also provided by the LQAS household survey and is shown in Table 7 below.

Table 7: Indicators of IRS and LLIN Coverages from LQAS Household Survey, Angwa Ward, May 2018

|  |  |
| --- | --- |
| Indicators | Coverage |
| Proportion of rooms sprayed in the past IRS campaign (Household heads) | 91% |
| Proportion of rooms sprayed in the past IRS campaign (Mothers of children 0-5 months) | 93% |
| Proportion of rooms sprayed in the past IRS campaign (Mothers of children 0-59 months) | 89% |
| Proportion of rooms sprayed in the past IRS campaign (Other household members) | 93% |
| Proportion of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign (Household heads) | 94% |
| Proportion of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign (Mothers of children 0-5 months) | 91% |
| Proportion of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign (Mothers of children 0-59 months) | 95% |
| Proportion of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign (Other household members) | 95% |

Note: The above indicators were calculated as follows:

* The proportion of rooms sprayed in the past IRS campaign: Denominator- Number of household rooms; Numerator- Number of rooms sprayed in the past IRS campaign.
* Proportion of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign: Denominator-Number of households surveyed; Numerator: Number of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign.

### LLIN Distribution, Ownership and Usage

#### Desk Review

Table 8 shows data on LLIN mass distribution from 2012 to 2017 collected from the health facility in Angwa Ward and from other provincial data. Data for 2012 and 2014 could not be found at the health facility.

Table 8: LLIN Mass and Continuous Distribution Data, Angwa Ward, 2012-2017

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Distributed Y/N | Brands Distributed | Number of Sleeping Spaces | Number of LLINs Distributed | Distribution  Channels | % Coverage |
| 2013 | Y | Interceptor/ Dawa | 3181 | 1861 | Mass distribution | 59% |
| 2015 | Y | Interceptor/ Dawa | N/A | 138 | Targeted mass distribution via schools: Grades 3&6 | N/A |
| 2016 | Y | Duranet/ Dawa | 3170 | 3170 | Mass distribution | 100% |
| 2017\* | Y | Duranet/ Dawa | 1579 | 1548 | Continuous distribution via ANC, EPI and community channels | N/A |

\* Initiated nets for outdoor sleeping spaces.

Two LLIN mass distribution campaigns were conducted over the last five years. The administrative coverage rose from 59% in 2013 to 100% in 2016. LLIN coverage (administrative) is defined as the percentage of LLINs distributed out of the targeted beneficiaries’ number of sleeping spaces during a mass campaign. The NMCP goal is to distribute an LLIN for every sleeping space in the targeted area. The main brands distributed were Interceptor, DuraNet, and Dawa.

#### LLIN Data from LQAS Household Survey

Respondents were asked about the number of LLINs they owned, for both indoor and outdoor use, as well as how those nets were used. Among the 324 respondents, 294 (91%) reported that their households possessed LLINs. Reported ownership was highest among the head of household respondents at 95%, with mothers of children and other household members all at 89%. The assessment further undertook to establish the number of nets per household respondent. On average, there were 2.5 nets per surveyed household. Of the 742 nets seen during the assessment, 637 (86%) were found to be in use. Of the 637 nets found to be in use, 142 (22%) were used outside or at the field. See Table 9 below.

Table 9: Household LLIN Ownership by Survey Respondent Type, Angwa Ward, May 2018

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Category | Number of HHs Surveyed | Number of HHs with at Least One LLIN | Percentage of HHs with at Least One LLIN | % of HHs with One LLIN | % of HHs with More than One LLIN |
| Head of household | 93 | 88 | 95% | 10 (11%) | 78 (89%) |
| Mothers 0-5 months | 45 | 40 | 89% | 11 (28%) | 29 (72%) |
| Mothers 0-59 months | 93 | 83 | 89% | 20 (24%) | 36 (76%) |
| Other HH member | 93 | 83 | 89% | 17 (20%) | 66 (80%) |
| **Total** | **324** | **294** | **91%** | **58 (20%)** | **236 (80%)** |

The above results indicate that, of the 324 households surveyed, 294 (91%) had at least one LLIN. Of the 294 households with LLINs, 58 (20%) had only one, while 236 (80%) reported that they had more than one LLIN per household.

A total of 485 indoor rooms with 499 indoor sleeping places were observed during the household survey, giving an average of approximately one sleeping place per room. Of the 499 indoor sleeping places observed, 287 (58%) were observed with an LLIN the night before the survey, and for the 175 outdoor sleeping places, 67 (38%) were reported to have LLINs.

LLIN usage was also assessed, specifically for children (see Table 10). The results for children under age five were inconsistent among the respondent groups, with mothers reporting a much higher rate than heads of households and other household members.

Table 10: Indicators for the use of LLINs from the LQAS household survey, Angwa Ward, May 2018

|  |  |
| --- | --- |
| Indicators | Coverage |
| Proportion of children under 5 years who slept under an LLIN the night preceding the assessment (Household heads) | 28% |
| Proportion of children 0-5 months who slept under an LLIN the night preceding the assessment (Mothers of children 0-5 months) | 69% |
| Proportion of children under 5 years who slept under an LLIN the night preceding the assessment (Mothers of children 0-59 months) | 71% |
| Proportion of children under 5 years who slept under an LLIN the night preceding the assessment (Other household members) | 34% |
| Proportion of household members above 5 years old who slept under an LLIN the night preceding the assessment (Household heads) | 53% |
| Proportion of household members above 5 years old who slept under an LLIN the night preceding the assessment (Other household members) | 53% |

### Entomological Survey Findings

The assessment team surveyed structural characteristics related to protection against mosquitoes in 31 households in each of the two villages selected for entomological monitoring (Mubairakuenda and Mupedzapasi). The findings are summarized in Table 11 below.

Table 11: Household Structures Observed during Vector Bionomics Survey in Angwa Ward, May 2018

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Mubairakuenda | | | Mupedzapasi | | TOTAL | |
|  |  | **Total** | **%** | **Total** | | **%** |  | **%** |
| Type of house | Modern | 27 | 87% | 29 | | 94% | 56 | 90.3 |
| Traditional | 4 | 13% | 2 | | 6% | 6 | 9.7 |
| Wall material | Cement | 8 | 26% | 0 | | 0% | 8 | 12.9 |
| Farm brick | 18 | 58% | 28 | | 90% | 46 | 74.2 |
| Pole and mud | 4 | 13% | 3 | | 10% | 7 | 11.3 |
| Other | 1 | 3% | 0 | | 0% | 1 | 1.6 |
| Roof material | Asbestos | 11 | 35% | 7 | | 23% | 18 | 29.0 |
| Iron sheets | 12 | 39% | 4 | | 13% | 16 | 25.8 |
| Thatch | 8 | 26% | 20 | | 65% | 28 | 45.2 |
| Status of structure | Completed | 29 | 94% | 31 | | 100% | 60 | 96.8 |
| Under construction | 2 | 6% | 0 | | 0% | 2 | 3.2 |
| Purpose/use of structure | Sleeping | 28 | 90% | 28 | | 90% | 56 | 90.3 |
| Sleeping & living | 3 | 10% | 3 | | 10% | 6 | 9.7 |
| Shape | Rectangular | 30 | 97% | 28 | | 90% | 58 | 93.5 |
| Round | 1 | 3% | 3 | | 10% | 4 | 6.5 |
| Eaves present | Yes | 12 | 39% | 17 | | 55% | 29 | 46.8 |
| No | 19 | 61% | 14 | | 45% | 33 | 53.2 |
| Doors present | Yes | 31 | 100% | 31 | | 100% | 62 | 100.0 |
| No | 0 | 0% | 0 | | 0% | 0 | 0.0 |
| Door closely fit | Yes | 10 | 32% | 27 | | 87% | 37 | 59.7 |
| No | 21 | 68% | 4 | | 13% | 25 | 40.3 |
| Ceiling present | Yes | 0 | 0% | 0 | | 0% | 0 | 0.0 |
| No | 31 | 100% | 31 | | 100% | 62 | 100.0 |
| Windows screened | Yes | 1 | 3% | 2 | | 6% | 3 | 4.8 |
| No | 30 | 97% | 29 | | 94% | 59 | 95.2 |

All houses surveyed had solid walls. The walls were constructed from materials such as concrete, brick, timber, or rammed earth. Although all houses in the two villages surveyed had doors, not all of them fitted closely to the door frame, thereby leaving potential entry ports for mosquitoes. Some had lintels of either wood or concrete, but most did not have lintels. Most houses had windows, although they were mainly mere openings in walls without fitted glass.

Only three houses had screened windows: one in Mubairakuenda and two in Mupedzapasi. Three different types of material were observed on the three houses that had screened windows: sack cloth, wire mesh, and cloth.

Eave openings were found in 39% of the houses in Mubairakuenda, compared to 55% in Mupedzapasi. Among houses that had eave openings, 75% were made of brick under asbestos or zinc sheets (modern type) at Mubairakuenda, while 88% were modern type at Mupedzapasi. The average size of the eave openings was 10.5 cm (range: 5-20 cm) in Mubairakuenda and 9.76 cm (range: 6-17 cm) in Mupedzapasi. Finally, none of the houses in Mubairakuenda and Mupedzapasi had ceilings. This was not unexpected, as ceilings are not a standard feature in rural houses in Zimbabwe.

### Accessibility of Malaria Case Management

#### LQAS Household Survey

The household survey questions related to accessibility of care for fever/malaria explored access to care from the village health worker, the time it takes to walk to the nearest health facility, and any specific reasons for not receiving care at the facility. The responses are shown in Table 12 below.

Table 12: Frequency of Responses for Access to Malaria Care in Angwa Ward, May 2018

| Questions | Criteria | HH Heads | Mothers of Children  0-5m | Mothers of Children  0-59m | Other HH Members | TOTAL |
| --- | --- | --- | --- | --- | --- | --- |
|  | | N=93 | N=45 | N=93 | N=93 |  |
| When you or your family member is sick with a fever, where do you go for treatment? (Multiple responses possible) | VHW | 71 | 25 | 61 | 63 |  |
| Health facility | 42 | 17 | 47 | 42 |  |
| Traditional healer | 1 | 0 | 0 | 0 |  |
| None | 0 | 2 | 3 | 3 |  |
| Other | 3 | 1 | 0 | 0 |  |
| When you or your family member is sick with a fever and try to access care from the VHW, how often are you able to receive care? | Always | 47 (50.5%) | 21 (46.7%) | 52 (55.9%) | 47 (50.5%) | 167(51.5%) |
| Sometimes | 41 (44.1%) | 20 (44.4%) | 30 (32.3%) | 37 (39.8%) | 128(39.5%) |
| Never | 5 (5.4%) | 4 (8.9%) | 11 (11.8%) | 9 (9.7%) | 29(9%) |
| Total | 93(100%) | 45(100%) | 93(100%) | 93(100%) | 324(100%) |
| What is the reason(s) that you are not able to get care from the VHW? (Multiple responses possible)1 | VHW not present in village | 10 | 8 | 10 | 9 |  |
| VHW busy with other activities | 2 | 0 | 4 | 1 |  |
| Unable to travel to VHW | 1 | 0 | 0 | 0 |  |
| VHW does not have medicines | 0 | 0 | 0 | 0 |  |
| What is the nearest health facility? | Angwa Clinic | 88 (94.6%) | 43 (95.6%) | 85 (91.4%) | 84 (90.3%) | 300(92.6%) |
| Other | 5 (5.4%) | 2 (4.4%) | 8 (8.6%) | 9 (9.7%) | 24(7.4%) |
| Total | 93(100%) | 45(100%) | 93(100%) | 93(100%) | 324(100%) |
| How long does it take to walk to the nearest health facility? (in hours) | < 30 min | 10 (10.8%) | 6 (13.3%) | 8 (8.6%) | 9 (9.7%) | 33(10.2%) |
| 30-60 min | 8 (8.6%) | 5 (11.1%) | 12 (12.9%) | 9 (9.7%) | 34(10.5%) |
| 1-2 hours | 14 (15.1%) | 5 (11.1%) | 19 (20.4% | 14 (15.0%) | 52(16%) |
| >2 hours | 58 (62.3) | 25 (55.6%) | 50 (53.8%) | 57 (61.3%) | 190(58.6%) |
| Don’t Know | 3 (3.2%) | 4 (8.9%) | 4 (4.3%) | 4 (4.3%) | 15(4.6%) |
| **Total** | **93(100%)** | **45(100%)** | **93(100%)** | **93(100%)** | **324(100%)** |
| From which health facility do you normally access care? | Angwa clinic | 88 (94.6%) | 43 (95.6%) | 82 (88.2%) | 85 (91.4%) | 298(92%) |
| Other | 5 (5.4%) | 2 (4.4%) | 11 (11.8%) | 8 (8.6%) | 26(8%) |
| Total | 93(100%) | 45(100%) | 93(100%) | 93(100%) | 324(100%) |
| When you or your family member is sick with a fever and try to access care from the health facility, how often are you able to receive care? | Always | 72 (77.4%) | 35 (77.8%) | 77 (82.8%) | 71 (76.4%) | 255(78.7%) |
| Sometimes | 19 (20.4%) | 10 (22.2%) | 15 (16.1%) | 19 (20.4%) | 63((19.4%) |
| Never | 2 (2.2%) | 0 | 1 (1.1%) | 3 (3.2%) | 6(1.9%) |
| Total | 93(100%) | 45(100%) | 93(100%) | 93(100%) | 324(100%) |
| What is the reason(s) that you are not able to get care from the health facility? (Multiple responses possible)1 | Distance too far | 9 | 2 | 3 | 2 |  |
| Travel costs too high | 0 | 0 | 0 | 0 |  |
| No reliable transport | 0 | 0 | 0 | 0 |  |
| HF charges too high | 0 | 0 | 0 | 0 |  |
| Clinic staff not available | 0 | 0 | 0 | 0 |  |
| Clinic hours too restrictive | 0 | 0 | 0 | 0 |  |

1These questions are a follow-up to respondents who answered “sometimes” or “never” in the previous question. Note: Not every respondent answered the follow-up question.

Observations of note from Table 13 include the fact that 59% of all respondents from the four groups reported the nearest health facility as being over two hours walking distance away. Additionally, while 68% usually go to the village health worker when they or one of their family members has a fever, 40% reported receiving care from the VHW only sometimes, while 9% reported never managing to receive care from the VHW. Unfortunately, many of respondents who reported receiving care from the VHW only sometimes or never did not answer the follow-up question and it was not possible to ascertain why they received treatment only sometimes or never.

The results for indicators related to accessibility to malaria treatment services are shown in Table 13 below.

Table 13: Coverage of Indicators for Accessibility to Malaria Case Management Services in Angwa Ward, May 2018

|  |  |
| --- | --- |
| Indicators | Coverage |
| Proportion of household heads who report existence of VHWs in their village (N=93) | 70% |
| Proportion of mothers of children 0-5 months who report existence of VHWs in their village (N=45) | 69% |
| Proportion of mothers of children 0-59 months who report existence of VHWs in their village (N=93) | 69% |
| Proportion of other household members who report existence of VHWs in their village (N=93) | 69% |
| Proportion of household heads who report seeking care from a VHW when family member is sick with a fever (N=93) | 95% |
| Proportion of mothers of children 0-5 month who report seeking care from a VHW when a child and herself are sick with a fever (N=45) | 91% |
| Proportion of mothers of children 0-59 months who report seeking care from a VHW when a child and herself are sick with a fever (N=93) | 87% |
| Proportion of other household members who report seeking care from a VHW when family member is sick with a fever (N=93) | 91% |

Despite the fact that only 69% of respondents across the household interviewed groups reported the existence of VHWs in their villages, on average 91% reported access to a VHW. Ninety-three percent also reported seeking care from Angwa Clinic.

## Knowledge, Attitudes, Practices, and Perceptions of Malaria and Malaria Risk

### LQAS Household Survey

Participants in the household survey were comprehensively assessed on their general knowledge about malaria, including causes, symptoms, and danger signs. Table 14 below shows the results, broken down according to the four interview groups.

Table 14: Knowledge, Attitudes, Practices, and Perceptions of Malaria among Survey Respondents, Angwa Ward, May 2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | HH Head | Other HH Member | Mothers of Children  0-5 Months | Mothers of Children  0-59 Months | Total | |
|  | **N=93** | **N=93** | **N=45** | **N=93** | **324** |
| Know at least two signs and symptoms of malaria | 55 (59%) | 60 (65%) | 24 (53%) | 51 (55%) | 190 (59%) | |
| Know at least two danger signs of malaria in children | 20 (22%) | 27 (29%) | 7 (15%) | 11 (12%) | 65 (20%) | |
| Report mosquito bites as a cause of malaria | 82 (88%) | 84 (90%) | 43 (96%) | 86 (93%) | 295 (91%) | |
| Recognize fever as a sign of malaria in adults | 8 (9%) | 7 (7%) | 1 (3%) | 9 (10%) | 25 (8%) | |
| Heard or read any messages about malaria in the past 6 months | 51 (55%) | 32 (34%) | 18 (40%) | 40 (43%) | 141 (44%) | |
| Mention at least one message about malaria | 10 (11%) | 7 (7%) | 7 (16%) | 7 (8%) | 31 (10%) | |
| Cite at least one specific source of malaria messages | 33 (36%) | 21 (23%) | 17 (38%) | 28 (30%) | 99 (31%) | |

Almost all respondents expressed familiarity with malaria as a disease, plus some of its symptoms. However, their level of knowledge varied somewhat depending on the particular content area. Across the four respondent groups, 88-96% of participants cited mosquito bites as the cause of malaria and reported using mosquito nets as a way of preventing malaria, while 53-65% knew at least two signs and symptoms of malaria. However, only 12-29% knew at least two danger signs of malaria in children, of which one was fever. Surprisingly, only 3-10% recognized fever as a sign of malaria in adults. Unfortunately, no respondent was able to correctly identify at least two ways to avoid getting malaria.

Exposure to malaria information varied across the four survey respondent groups. Only 34-55% of respondents had heard or read any message about malaria in the previous six months, a proportion that dropped to 23-38% when assessing those able to cite the specific source of the message. Retention of malaria messages and information was also very low, with only 7-16% of interview participants able to cite at least one message about malaria from the previous six months.

### Focus Group Discussions

Analysis of the FGD responses revealed a high frequency of participants mentioning a need for more malaria education, a sentiment that aligns with the above LQAS survey findings suggesting that knowledge on key facets of the disease was generally lacking. Perception of risk of malaria was clearly present across the whole population as the presence of mosquitoes, including outdoor biting mosquitoes, was associated with risk for contracting malaria. During the FGDs, people indicated that they still feel highly exposed to mosquito bites despite all the interventions that have been carried out. There were strong claims that not all of the dwellings are reached by the spraying teams during the spraying season. The FGD participants frequently mentioned the danger posed by wildlife as a reason for delaying travel to the clinic, even in cases where malaria was suspected. Participants also reported that the presence of wildlife could negatively affect IRS operations. Some participants explained that they would not use LLINs if they did not sense the presence of mosquitoes.

The overall perception of the state of service delivery for malaria prevention and control in Angwa was that substantial improvements could be made. IRS was perceived not to offer optimum protection since there were claims that not all sprayable structures are covered by the spraying teams and the timing and chemicals used for spraying contributed to limited protection, as the chemicals were perceived to wear off too quickly and not last for the entire time between spraying seasons.

Seeking treatment was clearly perceived as important. However, professed challenges to accessing clinical services included distance to the clinic, fear of wild animals, and shortage of commodities in some instances. Religious beliefs were not perceived as a major deterrent to treatment seeking among the majority of the population, despite the presence of religious sects that are traditionally associated with shunning of modern medicine.

## Type, quantity, and timing of outdoor activities in Angwa

### LQAS Household Survey

A set of lifestyle questions in the LQAS household survey was designed to investigate behavior that might increase the risk of catching malaria. These questions included evening and night-time outdoor activities that the respondents might undertake between 6 pm and 6 am, including streambank cultivation and/or protecting crops from wildlife. The section also included questions about using any personal protection against mosquitoes. Full details of survey coverage estimates for the lifestyle indicators are shown in Annex 1.

Between 37% and 55% of respondents in the four groups surveyed reported spending some time outdoors the night before the survey, for whatever reason. Of these, 20-36% did so without any form of malaria protection (see Figure 10 below).

Figure 10. Proportion of respondents who spent time outdoors between 6 pm and 6 am without any form of protection against malaria, Angwa Ward, May 2018.

Only 4-10% of those who spent time outdoors the night before the survey reported doing so under an LLIN, while only one respondent applied repellent. However, about half of the respondents reported at least wearing long trousers and long sleeved tops as a way to prevent being bitten by mosquitoes. Among respondents reporting evening and night-time outdoor activity, 6-8 pm was the most commonly reported two-hour period, with 82% reporting outdoor activity during that time period. However substantial portions of respondents reported activity during other time periods throughout the night, as shown in Figure 11 below.

Figure 11. Proportion of respondents reporting outdoor activities by two-hour increment between 6 pm and 6 am the previous night, Angwa Ward, May 2018.

A total of 249 respondents (77%) from the household survey indicated that they participate in streambank cultivation. Just over three-quarters of the respondents (76%) indicated that this activity is mainly practiced between January and June. Sixty-seven percent also reported having some temporary or second dwelling on the streambank (see Figure 12).

Figure 12. Percentage of respondents who participate in streambank cultivation, Angwa Ward, May 2018.

The respondents were also asked to indicate the time of the night spent guarding crops from wild animals at the streambank. Although guarding crops was most common from 6-8 pm across the respondent groups, it was also prevalent throughout the night, with 60-90% of the respondents across the four interview groups indicating that they spent some time outdoors between 6 pm and 6 am guarding crops from wild animals. The majority of respondents (65-71%) indicated that they are subjected to mosquito bites when outside.

### Focus group discussions related to nighttime outdoor activities

Information on lifestyles, especially night-time outdoor activities, was also gathered from the 10 focus group discussions conducted to assess community attitudes, knowledge, beliefs, and practices regarding malaria. Most people in Angwa Ward depend on farming, gardening, and some sort of trading for a living. Men are involved in building, while women do the household chores, including cooking, but there are other jobs that are done by both males and females together. According to FGD participants, cooking outdoors was associated with getting bitten by mosquitoes. Other activities felt to be associated with an increased chance of being bitten included relaxing outside their homes in the evening, with some people socializing until dawn, and all-night prayer meetings and traditional dances. Some of the community members practice nocturnal hunting, even though this is not allowed by the National Parks. Finally, the participants in the FGDs indicated that they regularly have financial problems and thus are not able to buy medication if they are sick; if there are very sick people in the community, they use ox drawn carts to ferry them to the clinic.

### Key informant interviews

Participants in the three key informant interviews mentioned that contributory factors to continued malaria transmission in Angwa Ward might include streambank cultivation, guarding of fields and crops at night, sleeping outdoors due to the hot weather, and the presence of many water bodies that are associated with mosquito breeding, especially as the area is prone to flooding. Another issue raised concerned living in structures that are not suitable for net hanging, and some villagers using the mosquito nets for fishing. Finally, the Vadoma people in the area live in structures that are not sprayable and they are also involved in hunting and gathering.

## Malaria vector bionomics in Angwa Ward

### Mosquito species collected

A total of 1,299 adult *Anopheles* mosquitoes were collected from the two villages sampled (Mubairakuenda and Mupedzapasi), and then analyzed at Africa University laboratory. Two hundred and fifty-two *Anopheles* were collected from Mubairakuenda, and 1,047 from Mupedzapasi. The majority of the mosquitoes were *An. gambiae* s.l., (58% at Mubairakuenda and 65% at Mupedzapasi). *An. funestus* s.l. were also collected at the two villages, but the number was much lower than for *An. gambiae*. See Table 15 below.

Table 15: Overview of the *Anopheles* species collected at Mubairakuenda and Mupedzapasi Villages*,* Angwa Ward, May 2018*.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Anopheles collected** | **Mubairakuenda** | **Mupedzapasi** | **TOTAL** |
| **Number collected (%)** | **Number collected (%)** |  |
| An. gambiae s.l. | 147 (58.3%) | 680 (64.9%) | 827 |
| An. funestus s.l. | 44 (17.5%) | 29 (2.8%) | 73 |
| Other Anopheles species | 61 (24.2%) | 338 (32.3%) | 399 |
| Total collected | 252 | 1,047 | 1,299 |

In total, 11 *Anopheles* species were identified among mosquitoes from Mubairakuenda, compared to 12 species for Mupedzapasi. Three sibling species of the *An. gambiae* s.l. were identified by molecular methods: *An. arabiensis, An. gambiae* s.s., and *An. quadriannulatus*, with the latter predominant at both villages. *An. arabiensis* and *An. gambiae* s.s. are primary malaria vectors, whereas *An. quadriannulatus* is not known as a vector. The predominance of *An. quadriannulatus* is probably an indication of the limited exposure of this species to vector control interventions such as IRS and LLINs since the species principally feeds on animals and rests outdoors. Five species of the *An. funestus* s.l. complex were collected at Mupedzapasi: *An. funestus* s.s., *An. leesoni, An. parensis, An. Rivulorum,* and *An. rivulorum*-like. *An. leesoni* was the predominant species followed by *An. parensis.* The same sibling species were found at Mubairakuenda except for *An. rivulorum*-like. There was greater species diversity at Mupedzapasi compared with Mubairakuenda (Table 16). While *An. funestus s.s.* and *An. leesoni* are known malaria vectors, the other sibling species are only secondary vectors. Four other species--*An. pretoriensis, An. maculipalpis, An. Rufipes,* and *An. Squamosus*--were identified. A substantial number of specimens did not amplify and remain unknowns (18 from Mubairakuenda and 48 from Mupedzapasi). Although *An. pretoriensis* was predominant among the other species, it is not known as a malaria vector. The other three species under this category are considered possible secondary malaria vectors.

Table 16: *Anopheles* species identified by molecular methods, Angwa Ward, May 2018

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Anopheles* groups** | **Species** | **Mubairakuenda** | | | **Mupedzapasi** | | **TOTAL** | |
| **No. of mosquitoes** | **(%)** | | **No. of mosquitoes** | **(%)** |  | **%** |
| *An. gambiae* s.l. | *An. arabiensis\** | 4 | | 2.7 | 4 | 0.6 | 8 | 1.0 |
| *An. gambiae* s.s.\* | 1 | | 0.7 | 2 | 0.3 | 3 | 0.4 |
| *An. quadriannulatus* | 142 | | 96.6 | 674 | 99.1 | 816 | 98.7 |
| Sub-total | | 147 | | 100.0 | 680 | 100.0 | 827 | 100 |
| *An. funestus* s.l. | *An. funestus* s.s.\* | 3 | | 6.8 | 1 | 3.4 | 4 | 5.5 |
|  | *An. leesoni\** | 21 | | 47.7 | 11 | 37.9 | 32 | 43.8 |
|  | *An. parensis\*\** | 8 | | 18.2 | 8 | 27.6 | 16 | 21.9 |
|  | *An. rivulorum\*\** | 12 | | 27.3 | 3 | 10.3 | 15 | 20.5 |
|  | *An. rivulorum*-like\*\* | 0 | | 0.0 | 6 | 20.7 | 6 | 8.2 |
| Sub-total | | 44 | | 100.0 | 29 | 100.0 | 73 | 100 |
| Other *Anopheles* species | *An. pretoriensis* | 20 | | 32.8 | 205 | 60.7 | 225 | 56.4 |
| *An. maculipalpis\*\** | 7 | | 11.5 | 20 | 5.9 | 27 | 6.8 |
| *An. rufipes\*\** | 1 | | 1.6 | 4 | 1.2 | 5 | 1.3 |
| *An. squamosus\*\** | 15 | | 24.6 | 61 | 18.0 | 76 | 19.0 |
| Unknown | 18 | | 29.5 | 48 | 14.2 | 66 | 16.5 |
| Sub-total | | 61 | | 100.0 | 338 | 100.0 | 399 | 100 |
| **Total** |  | **252** | | **100.0** | **1,047** | **100.0** | **1299** | **100** |

\* primary malaria vectors; \*\* potential secondary malaria vectors

#### Molecular Analysis, Blood Meal Identification, and P. Falciparum Infection Rates

From the collected 1,299 mosquitoes, 26 were freshly engorged with blood and were tested by ELISA to determine the source of the blood meal. Of these, *An. quadriannulatus* constituted the majority (42%), followed by *An. squamosus* (27%). *An. arabiensis,* the primary malaria vector, constituted only 4% (see Table 17).

Table 17: Blood fed *anopheline* mosquitoes tested, Angwa Ward, May 2018

|  |  |  |  |
| --- | --- | --- | --- |
| **Anopheles species** | **Mubairakuenda** | **Mupedzapasi** | **Total Anopheles tested** |
| **No. tested (%)** | **No. tested (%)** |  |
| *An. arabiensis* | 1 (8%) | 0 (0%) | 1 (4%) |
| *An. quadriannulatus* | 6 (46%) | 5 (39%) | 11 (42%) |
| *An. leesoni* | 3 (23%) | 0 | 3 (12%) |
| *An. rivulorum* | 1 (8%) | 0 | 1 (4%) |
| *An. squamosus* | 0 (0%) | 7 (55%) | 7 (27%) |
| *Unknown Anopheles* | 2 (15%) | 1 (8%) | 3 (12%) |
| **Total tested** | **13** | **13** | **26** |

Overall, the ELISA tests identified three mammalian hosts: goat, dog, and human. For nearly half (12/26) of the blood-engorged mosquitoes, the host could not be identified based on the protocol used. Only two out of the 26 had recently fed on humans (Table 18).

Table 18: Blood meal source for *Anophelin*e species determined by ELISA, Angwa Ward, May 2018

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Collection Site** | **Source of blood meal** | **Method of collection** | **PCR Species ID** | **Total number** |
| Mubairakuenda | Dog | Pit trap | *An. leesoni* | 1 |
| Goat | CDC\* Out | *An. quadriannulatus* | 1 |
| PSC\* | *An. leesoni* | 1 |
| Human | HLC\* In | Unknown due to no amplification | 1 |
| PSC | Unknown | 1 |
| Unknown | CDC In | *An. rivulorum* | 1 |
| HLC Out | *An. quadriannulatus* | 1 |
| w trap | *An. leesoni* | 1 |
| *An. quadriannulatus* | 2 |
| PSC | *An. arabiensis* | 1 |
| *An. quadriannulatus* | 2 |
| Mupedzapasi | Dog | CDC In | *An. quadriannulatus* | 1 |
| PPA\* | *An. squamosus* | 4 |
| PSC | *An. quadriannulatus* | 3 |
| Goat | Pit trap | *An. squamosus* | 1 |
| Unknown | Pit trap | *An. quadriannulatus* | 1 |
| *An. squamosus* | 1 |
| Unknown | 1 |
| PPA | *An. squamosus* | 1 |

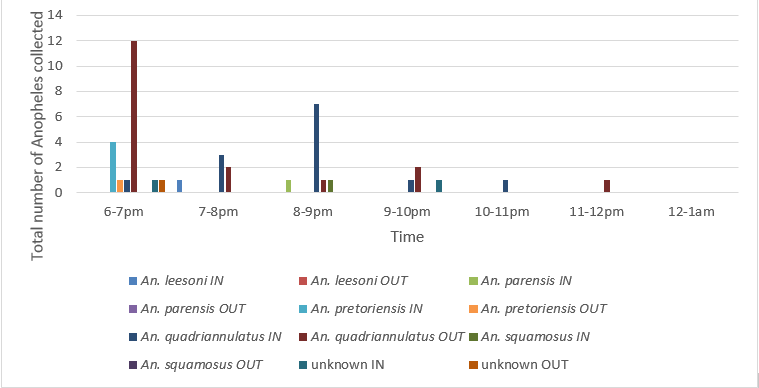
\*Where: CDC – Centers for Disease Control and Prevention light trap set either indoors (In) or outdoors (Out); PSC – pyrethrum spray catches; HLC – human landing collection; PPA – Prokopack Aspirator

A total of 1,299 specimens were analyzed for parasite infection using the ELISA method: 252 from Mubairakuenda and 1,047 from Mupedzapasi. Only two specimens from Mubairakuenda were positive for *P. falciparum*; these were one *An. leesoni* collected from the pit and one unidentified specimen collected outdoors by CDC light trap. None of the human-fed mosquitoes were positive for *P. falciparum.* None of the mosquitoes from Mupedzapasi were sporozoite positive. Note that tests for sporozoite infection were done on all adult mosquitoes regardless of their physiological status.

### Mosquito biting and resting habits

Observations of mosquito biting behavior in Mubairakuenda and Mupedzapasi villages showed a predominance of outdoor biting by *An. gambiae* s.l., entirely between 6 pm and 12 pm. There was effectively no biting after midnight, probably due to the low temperatures (<15°C) observed from midnight until dawn. *An. pretoriensis* also featured between 6 pm and 9 pm indoors, but this species is not considered a malaria vector. Figure 13 below shows the hourly biting rates from Mubairakuenda and Mupedzapasi villages. Five identified species and a few unknown species were collected, including *An. leesoni, An. parensis, An. quadriannulatus, An. pretoriensis,* and *An. squamosus*. At Mupedzapasi, three species--*An. maculipalpis, An. quadriannulatus,* and *An. Squamosus*--and some unknown species were collected (Figure 13); biting at this village also started at sunset (6 pm) but stopped by 10 pm.

Figure 13. Number of *Anopheles* collected attempting to feed on humans during the night at Mubairakuenda (n = 42)



Most of the mosquitoes collected during the night were *An. quadriannulatus*. Biting behavior started at sunset (6-7 pm) both indoors and outdoors and ended by midnight, with no further biting activity between midnight and sunrise at 6am. *An. quadriannulatus* is normally associated with zoophilic and exophilic behavior, but here there was distinct biting activity indoors. This behavior could be opportunistic given that none of the *An. quadriannulatus* analyzed had fed on humans. Only two of the blood-fed mosquitoes had fed on humans (2/26), and these are of an unknown species. Since most of the biting occurs during the early part of the night as well as being outdoors, this suggests a behavioral adaptation to counter the vector control strategies in place indoors in these communities.

Figure 14. Number of *Anopheles* collected attempting to feed on humans during the night at Mupedzapasi (n = 23)



Mosquitoes were predominantly collected from pits at both villages, with no mosquitoes collected from exit window traps and clay pots. Close to 72% (543/757) of the *Anopheles* were collected from pits at the two villages. At Mupedzapasi, 80.6% (407/505) were from pits, compared to 53.9% (136/252) at Mubairakuenda. *An. quadriannulatus* was the dominant species at both villages, constituting 59% and 80% at Mupedzapasi and Mubairakuenda, respectively (Figure 15a and b). This non-vector species overshadowed the vector *An. arabiensis* within the *An. gambiae* s.l. at the two villages. *An. leesoni* dominated the sibling species of the *An. funestus* s.l. at both villages. Other species included *An. squamosus* (a potential vector), and *An. pretoriensis* at Mubairakuenda. Four other species at Mupedzapasi were *An. squamosus, An. maculipalpis, An. Rufipes,* and *An. pretoriensis.*

Figure 15a. Species collected resting outdoors at Mubairakuenda (n = 136)

Figure 15b. Species collected resting outdoors at Mupedzapasi (n = 407)

### Characterization of water bodies and larval habitats

A total of 53 water pools were characterized at various localities around Mubairakuenda and Mupedzapasi villages. Most pools were associated with the Angwa River and its tributaries, such as the Manyemu River. The majority of breeding habitats were natural (83%), while the remainder were human-made (17%). Most of the 53 breeding habitats were found on the riverbed (87%) as backwater pools, with 2% being dams and excavations, while 9% were classified as ‘other.’ All 53 pools studied had *Anopheles* larvae in them, while only 32% of the pools had *culicine* larvae cohabiting with *Anopheles*. *Anopheles* pupae were recorded in 36% of the breeding habitats as compared with *culicine* pupae detected in only 6% of the habitats.

Water pH is an important factor when planning larval control, as extreme acidity or alkalinity can influence the efficacy of bio-larvicides. Twenty-one of the 53 pools had the pH measured, with pH ranging from 6.99 to 10.23, giving a median of 7.56 and an average of 8.09. This indicates that the mosquito breeding habitats were invariably alkaline rather than acidic. These pH ranges fall within the ranges associated with vector breeding sites elsewhere except for the pH 10.23 measurement, which was an outlier. The expected pH for unpolluted rivers is 6.8-7.8, with a pH greater than 8.5 considered highly alkaline. The source of alkalinity can be due either to hard-water minerals or the release of basic agricultural effluent. The one pool found to have a pH of 10.23 was situated at Mupedzapasi, and had 2nd and 3rd stage larvae as the predominant instars.

Of the 53 pools assessed, 72% were temporary, 15% were semi-permanent, and 8% were permanent; while the rest could not be classified. Most breeding habitats (92%) had clear water, a few were muddy (6%) and there was one (2%) that could not be classified. Water bodies were classified as clear if the entomologist could see the bottom of the water. This classification, though rather subjective, is useful in field entomology in the absence of sophisticated equipment. Almost all the pools (98%) were exposed to the sun for most of the day, most (85%) did not have aquatic vegetation, 77% did not have floating debris, and 81% had algae. Temperature affects larval and pupal development and survivorship and is influenced by the presence of vegetation and/or algae, soil properties, and turbidity. Turbidity is a measure of water cleanliness. Malaria vectors breed in clean water. Sunlit breeding sites are associated with higher temperatures conducive for larval development. Aquatic vegetation reduces exposure to sun but some *Anopheles* species, such as *An. funestus*, naturally prefer such conditions.

Average larval density, expressed as the number of larvae per dip, was 12.9, (range: 0.1–55.3). The frequency of *Anopheles* larval instars and pupae is shown in Figure 16 below. Second and third *Anopheles* larval instars were the most common (28%) followed by all larval instars (26%), and first and second instars (19%). Fourth larval instar and pupae were the least common (2%). This suggests that the breeding sites were relatively freshly formed during the assessment.

Figure 16. Occurrence of larval and pupal stages in mosquito breeding sites in Angwa Ward, May 2018.

Only 11 pools (21%) had other aquatic organisms cohabiting with mosquito larvae (see Figure 17 below). These other organisms were, however, not identified to the species level. Some aquatic organisms prey on mosquito larvae and have been considered for biological control of mosquitoes.

Figure 17. The occurrence of *Anopheles* larval instars in relation to the presence of other aquatic organisms.

Overall, *Anopheles* mosquitoes were breeding more in water without other aquatic organisms.

### Residual efficacy of DDT used for IRS in Angwa Ward

The residual efficacy of DDT used for IRS was assessed in five randomly selected houses in each village. Residual activity of DDT nine months after the October 2017 routine spraying was estimated by WHO cone bioassay tests conducted in July 2018. Residual efficacy was high in Mubairakuenda village, with a mean 24-hour mosquito mortality of 88% (64.3- 96.5%), but low at Mupedzapasi, where mean mosquito mortality was only 40% (16.7-56.7%). Tables 19 and 20 show the results from the cone bioassay tests done on DDT-sprayed walls at the two villages.

Table 19: Summary of Cone Bioassay Test Results at Mupedzapasi Village (9 month post spray)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Place of the cone on the surface assayed** | **Measured parameters** | **House 1 (Mud)** | **House 2 (Mud)** | **House 3 (Mud)** | **House 4 (Cement)** | **House 5**  **(Cement)** | **Control** |
| Top (1.5m) | 30 min knockdown (%) | 70 | 0 | 10 | 0 | 0 | 0 |
| 60 min knockdown (%) | 60 | 0 | 50 | 0 | 30 | 0 |
| **24h % mortality** | **60** | **10** | **60** | **16.7** | **70** | **0** |
| Middle (1m) | 30 min knockdown (%) | 60 | 0 | 0 | 0 | 0 | 0 |
| 60 min knockdown (%) | 60 | 10 | 10 | 0 | 0 | 0 |
| **24h % mortality** | **60** | **10** | **0** | **10** | **40** | **0** |
| Bottom (0.5m) | 30 min knockdown (%) | 70 | 10 | 10 | 0 | 0 | 0 |
| 60 min knockdown (%) | 50 | 10 | 70 | 0 | 40 | 0 |
| **24h % mortality** | **40** | **30** | **60** | **60** | **60** | **0** |
| Total | 30 min knockdown (%) | 66.7 | 3.33 | 6.67 | 0 | 0 | 0 |
| 60 min knockdown (%) | 56.7 | 6.67 | 43.3 | 0 | 23.3 | 0 |
| **24h % mortality** | **53.3** | **16.7** | **40** | **30.7** | **56.7** | **0** |
| **Average 24h % mortality on different types of walls** | | **36.7** | | **43.7** | |  | |

There were slight differences in efficacy on the two wall surface types tested, with greater mosquito mortality observed on mud (94.9%) compared to cement (83.6%) walls at Mubairakuenda. In contrast, mosquito mortality was greater on cement (43.7%) compared to mud (36.7%) walls at Mupedzapasi. Mosquito mortality also varied with the position of the cone on the wall, with the middle (1m) tending to have less mortality compared with the bottom (0.5m) and the top (1.5m) from the floor. In the controls at the two villages, no mosquitoes were knocked down at 30 and 60 minutes post-exposure, and no mortalities were recorded after the 24-hour observation period. None of the walls in the randomly selected dwellings had been re-plastered. This data indicates that the residual efficacy of DDT can exceed nine months, as previously reported in other studies, although this can vary depending on the quality of spraying.

### Efficacy of LLINs against susceptible *An. arabiensis*

Six LLINs were randomly sampled from each village, consisting of three DawaNet® and three DuraNet® nets that ZAPIM and the MOHCC provided to communities in Angwa through mass distribution in 2016. The nets were taken for bioassay tests at NIHR in Harare using two-to-five-day-old females of a susceptible strain of *An. arabiensis.* Tables 20 and 21 below show the average percentages of mosquito knockdown after 30 minutes (KD30) and 60 minutes (KD60), and the mortality recorded 24 hours post-exposure to the LLINs per site.

Table 20: Efficacy results of bioassay tests using susceptible *An. arabiensis* (KGB strain) exposed to LLINs from Mubairakuenda

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **LLINs** | **Cone Position** | **No. of mosquitoes exposed** | **Knockdown after exposure** | | | | **Mortality after 24hrs** | |
| **30mins** | | **60mins** | |
| **No.** | **%** | **No.** | **%** | **No.** | **%** |
| **Dawa Net®**  **(n=3)** | Bottom | 60 | 55 | 92 | 60 | 100 | 57 | 95 |
| Middle | 60 | 45 | 75 | 60 | 100 | 57 | 95 |
| Top | 60 | 50 | 83 | 60 | 100 | 53 | 88 |
| Roof | 60 | 58 | 97 | 60 | 100 | 55 | 92 |
|  | **Total** | **240** | **208** | **87** | **240** | **100** | **222** | **90** |
| **DuraNet®**  **(n=3)** | Roof | 60 | 54 | 90 | 56 | 93 | 60 | 100 |
| Top | 60 | 53 | 88 | 59 | 98 | 60 | 100 |
| Middle | 60 | 60 | 100 | 60 | 100 | 60 | 100 |
| Bottom | 60 | 59 | 98 | 60 | 100 | 60 | 100 |
| Total | 240 | 226 | 94 | 235 | 98 | 240 | 100 |

Table 21: Efficacy results of *An. arabiensis* exposed to LLIN from Mupedzapasi

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **LLINs** | **Cone Position** | **No. of mosquitoes exposed** | **Knockdown after exposure** | | | | **Mortality after 24hrs** | |
| **30mins** | | **60mins** | |
| **No.** | **%** | **No.** | **%** | **No.** | **%** |
| **DawaNet®**  **(n=4)** | Bottom | 80 | 70 | 88 | 76 | 95 | 78 | 98 |
| Middle | 80 | 79 | 99 | 79 | 99 | 80 | 100 |
| Top | 80 | 77 | 96 | 80 | 100 | 80 | 100 |
| Roof | 80 | 74 | 93 | 80 | 100 | 80 | 100 |
|  | **Total** | **320** | **300** | **94** | **315** | **98** | **318** | **99** |
| **DuraNet®**  **(n=1)** | Roof | 20 | 20 | 100 | 19 | 95 | 20 | 100 |
| Top | 20 | 20 | 100 | 20 | 100 | 20 | 100 |
| Middle | 20 | 20 | 100 | 20 | 100 | 20 | 100 |
| Bottom | 20 | 20 | 100 | 20 | 100 | 20 | 100 |
| **Total** | **80** | **80** | **100** | **79** | **99** | **20** | **100** |

Overall across both villages, 90% and 97% of exposed mosquitoes were knocked down after 30 minutes with DawaNet® and DuraNet®, respectively, while 100% and 98% were knocked down after 60 minutes. These results indicate that the nets available in Angwa Ward were efficacious against susceptible colony-bred mosquitoes after one year of use following distribution to the communities.

#### Insecticide susceptibility using WHO tube bioassay tests

*Anopheles gambiae s.l.* from Angwa Ward were susceptible to pirimiphos-methyl (100% mortality), deltamethrin (100%), and DDT (100%) at Mupedzapasi, but resistant to permethrin at Mupedzapasi (87.5% mortality) and Mubairakuenda (80.6% mortality) (see Table 22).

Table 22: Susceptibility status (mortality rates) of *An. gambiae s.l.* from Mupedzapasi and Mubairakuenda in Angwa Ward exposed to the WHO-discriminating concentrations of DDT, deltamethrin, permethrin and pirimiphos-methyl

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Site** | **Pirimiphos-methyl (0.25%)** | | **Deltamethrin (0.05%)** | | **Permethrin (0.75%)** | | **DDT (4%)** | |
| **No. exposed** | **Mortality (%)** | **No. exposed** | **Mortality (%)** | **No. exposed** | **Mortality (%)** | **No. exposed** | **Mortality (%)** |
| Mupedzapasi | 100 | 100 | 49 | 100 | 16 | 87.5 | 49 | 100 |
| Mubairakuenda | Not done | Not done | Not done | Not done | 26 | 80.6 | Not done | Not done |

WHO standards [14] were used for interpretation, with 98-100% mortality indicating susceptibility; 90-97% mortality indicating possible resistance, with resistance genes to be confirmed; and <90% mortality indicating resistance.

#### Insecticide susceptibility using CDC bottle bioassay for permethrin

Follow-up resistance tests on *An. gambiae s.l.* from four localities in Angwa done using the CDC bottle bioassay with an intensity concentration of 2X further confirmed permethrin resistance (Table 23). The resistance tests were defined or categorized by collection site. Manyemu River, though within the Mubairakuenda location, constituted an ecologically distinct setting with more pronounced streambank cultivation than along the Angwa River where larval sampling was done for Mubairakuenda. Permethrin resistance was found at Mubairakuenda (57% mortality), Manyemu (84% mortality), and Mupedzapasi Lower (79%).P Possible resistance was found at Mupedzapasi Upper (98% mortality).

Table 23: Susceptibility status (mortality rates) of *An. gambiae s.l.* from localities in Angwa Ward exposed to the CDC 2X discriminating concentration of permethrin, May 2018.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Site** | **No. exposed** |  | |  | |
|  | **Mosquito mortality (%) after 30 minutes** | **Resistance status\*** | |
| Mubairakuenda | 58 | 56.9% | |  | R |
| Manyemu | 38 | 84.2% | |  | R |
| Mupedzapasi Upper | 46 | 97.8% | |  | PR |
| Mupedzapasi Lower | 19 | 78.9% | |  | R |

\* R=resistant; PR=possible resistance; S=susceptible

#### Mosquito species and resistance

A total of 116 specimens from three sites, including susceptible (n = 40) and resistant (n = 76) insects from the CDC bottle bioassay resistance test using permethrin 2X diagnostic concentration, were further assessed using the polymerase chain reaction (PCR).

As shown in Table 24 below, 92% of the Anopheles identified from Manyemu were *An. Arabiensis*, while 54% from Mubairakuenda were *An. arabiensis* and 33% were *An. quadriannulatus*. Among *An. arabiensis*, 57% were resistant to permethrin (2X), while 43% were susceptible. Of the 38 specimens from Mupedzapasi, 58% were *An. arabiensis*, of which most, 90%, were susceptible to permethrin (2X), with 9% resistant. Of the 116 mosquitoes tested for resistance, 39 were from Manyemu River, 39 from Mubairakuenda, and 38 from Mupedzapasi. For the 39 mosquitoes from Manyemu River, 20 were resistant and 19 were susceptible to permethrin 2X. All 19 of the susceptible mosquitoes were identified as the vector *An. arabiensis*, while 17/20 (85%) of the resistant specimens were identified as *An. Arabiensis*. The remaining three resistant specimens were identified as *An. pretoriensis* (n=1)*, An. rivulorum* (n=1), and *An. squamosus* (n=1)*.* As a result, the resistance tests with permethrin (2X) were performed on mainly the major vector species, *An. arabiensis*.

Table 24: Relative frequency of mosquito species and resistance to Permethrin (2X) using the CDC bottle bioassay test

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Site** | **Outcome** | **Anopheles species identified by PCR after resistance tests** | | | | | | **NA** | **Total** |
| ***An. arabiensis*** | ***An. quadriannulatus*** | ***An. pretoriensis*** | ***An. maculipalpis*** | ***An. rivulorum*** | ***An. squamosus*** |
| Manyemu  (n=39) | Resistant (n=20) | 17 (85%) | 0 | 0 | 1 (5%) | 1 (5%) | 1 (5%) | 0 | 20 (51.3%) |
| Susceptible  (n=19) | 19 (100%) | 0 | 0 | 0 | 0 | 0 | 0 | 19 (48.7%) |
| Mubairakuenda  (n=39) | Resistant  (n=17) | 12 (70.6%) | 4 (23.5%) | 1 (5.9%) | 0 | 0 | 0 | 0 | 17 (43.6%) |
| Susceptible  (n=22) | 9 (40.9%) | 9 (40.9%) | 0 | 0 | 0 | 2 (9.1%) | 2 (9.1%) | 22 (56.4%) |
| Mupedzapasi  (n=38) | Resistant  (n=3) | 2 (66.7%) | 1 (33.3%) | 0 | 0 | 0 | 0 | 0 | 3 (7.9%) |
| Susceptible  (n=35) | 20 (57.1%) | 12 (34.3%) | 0 | 0 | 0 | 0 | 3 (8.6%) | 35 (92.1%) |
| All sites  (n=116) | Resistant  (n=40) | 31 (77.5%) | 5 (12.5%) | 1 (2.5%) | 1 (2.5%) | 1 (2.5%) | 1 (2.5%) | 0 | 40 |
| Susceptible  (n=76) | 48 (63.2%) | 21 (27.6%) | 0 | 0 | 0 | 2 (2.6%) | 5 (6.6%) | 76 |
| **Total tested (%)** | | 79 (68.1%) | 26 (22.4%) | 1 (0.9%) | 1 (0.9%) | 1 (0.9%) | 1 (0.9%) | 2 (1.7%) | 116 |

For the 39 specimens tested at Mubairakuenda, 17 (43.6%) were resistant, and 22 were susceptible to permethrin (x2). Of the 17 resistant mosquitoes, 12 (70.6%) were identified as the malaria vector *An. arabiensis*, while the remainder were *An. quadriannulatus* (4/17) and *An. pretoriensis* (1/17). Of the 22 susceptible mosquitoes, 9 were the malaria vector *An. arabiensis*, 9 were *An. Quadriannulatus*, and 1 was *An. pretoriensis*. These results show that about half of the susceptible mosquitoes were malaria vector *An. arabiensis*, with about half being the non-vector *An. quadriannulatus.* Three of the 22 susceptible mosquitoes could not be identified.

For the 38 mosquitoes tested for resistance at Mupedzapasi, only 3 were resistant, and 35 were susceptible to permethrin (2X). Two out of three of the resistant mosquitoes were identified as the vector *An. arabiensis*, while one was identified as *An. quadriannulatu.* Of the 35 susceptible mosquitoes, 20 were identified as the vector *An. arabiensis*, 12 were *An. quadriannulatus*, and 3 could not be identified to the species level.

#### Synergist bioassay for permethrin

The mortality rate of *An. gambiae s.l.* increased following a pre-exposure to synergist piperonyl butoxide (PBO) for mosquitoes from Angwa River collected from Mubairakuenda and Mupedzapasi (Table 25). No mosquitoes from Manyemu were tested for this synergist because the breeding sites were dry on the occasion of the follow-up larval collection.

Table 25: CDC bioassay results for *An. gambiae s.l.* from Angwa Ward, with and without pre-exposure to synergist PBO at the 30-minute diagnostic time

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | | | | **Susceptible reference colony** |
| **Mubairakuenda** | | **Mupedzapasi** | |
|  | **Permethrin 2X** | **Permethrin 2X + PBO** | **Permethrin 2X** | **Permethrin 2X + PBO** | **Permethrin 2X** |
| Total tested | 17 | 20 | 19 | 11 | 17 |
| Mortality (%) | 94.1% (16/17) | 95% (19/20) | 78.9% (15/19) | 90.9% (10/11) | 100% (17/17) |
|  |  |  |  |  |  |

#### Occurrence of knockdown resistance alleles in Anopheles at Angwa

*Anopheles* specimens collected at the two villages were also tested for the knockdown resistance (*kdr*) alleles (East and West). Of the 252specimens collected from Mubairakuenda, no homozygous resistant genotype (RR) alleles were detected, but there were heterozygous genotype (RS) and homozygous sensitive genotype (SS) alleles for both the *kdr* east and west (see Table 26). The presence of the RS allele indicates a possible onset of *kdr*-type resistance to pyrethroids that needs to be monitored.

Table 26: Occurrence of *kdr* (east and west) alleles at Mubairakuenda

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Species** | **Kdr East\*** | | | | **Kdr West\*** | | | |
| **RR** | **RS** | **SS** | **N/A** | **RR** | **RS** | **SS** | **N/A** |
| *An. arabiensis* | 0 | 3 | 0 | 1 | 0 | 1 | 2 | 1 |
| *An. funestus s.s.* | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| *An. gambiae s.s.* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| *An. leesoni* | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 21 |
| *An. maculipalplis* | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 7 |
| *An. parensis* | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 8 |
| *An. pretoriensis* | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 20 |
| *An. quadriannulatus* | 0 | 32 | 110 | 0 | 0 | 13 | 129 | 0 |
| *An. rivulorum* | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 12 |
| *An. rufipes* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| *An. squamosus* | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 15 |
| Unknown | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 18 |

\*RR=homozygote resistant; RS=heterozygote resistant/susceptible; SS=homozygous susceptible; N/A=not amplifiable

At Mupedzapasi, a single *An. quadriannulatus* was found to possess the resistant RR (east) allele (Table 27), while a significant number of RS *kdr* west alleles were also observed (n = 1,055). A single non-*An. quadriannulatus* RS allele was also observed. However, the majority of species were the homozygous sensitive allele (SS) for both east and west. As with Mubairakuenda, the situation with *kdr* type resistance needs to be further monitored. The *kdr* West and East in *An. gambiae* and other mosquitoes refers to a single point mutation changing leucine to phenylalanine (location 1014F) originally reported in West Africa and leucine to serine (location 1014S) originally reported in Kenya. These mutations confer different levels of resistance. The underlying resistance mechanism of both *kdr* mutations is responsible for cross-resistance to DDT and pyrethroids.



| **Species** | **Kdr East** | | | | **Kdr West** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **RR** | **RS** | **SS** | **N/A** | **RR** | **RS** | **SS** | **N/A** |
| *An. arabiensis* | 0 | 1 | 3 | 0 | 0 | 0 | 4 | 0 |
| *An. funestus s.s.* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| *An. gambiae s.s.* | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 |
| *An. leesoni* | 0 | 0 | 2 | 9 | 0 | 0 | 2 | 9 |
| *An. maculipalplis* | 0 | 0 | 3 | 17 | 0 | 0 | 2 | 18 |
| *An. parensis* | 0 | 0 | 2 | 6 | 0 | 0 | 2 | 6 |
| *An. pretoriensis* | 0 | 0 | 10 | 195 | 0 | 0 | 10 | 195 |
| *An. quadriannulatus* | 1 | 102 | 571 | 0 | 0 | 98 | 576 | 0 |
| *An. rivulorum* | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| *An. rivulorum-like* | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 6 |
| *An. rufipes* | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 |
| *An. squamosus* | 0 | 0 | 1 | 60 | 0 | 0 | 1 | 60 |
| Unknown | 0 | 0 | 1 | 47 | 0 | 0 | 1 | 47 |

# Discussion

Despite reportedly high coverage of standard malaria control interventions, Angwa Ward, Mbire District, Zimbabwe, continues to experience relatively high malaria transmission. This wide-ranging assessment employed both quantitative and qualitative methods to determine the drivers of this continuing transmission. The assessment team also endeavoured to make recommendations as to how programmatic decision-makers can address this situation. It is hoped that this assessment will provide insights that can be applied in other areas of Zimbabwe facing similar issues.

A desk review of the malaria incidence data over the past five years confirmed that Mbire District has had among the highest annual incidence rates of any district in Zimbabwe. Analysis of data collected by the 13 health facilities in Mbire showed that Angwa Ward was among the most affected wards in the district from 2014 to 2016. Malaria incidence in Angwa Ward did decrease disproportionately compared to the other wards in Mbire District in 2017. However, this was consistent in direction with the overall trend in the District, and the level of transmission in Angwa Ward remained substantial. This epidemiological context of high and relatively sustained transmission suggests that current malaria prevention interventions are either not sufficiently implemented in terms of scale or coverage and/or, due to the currently prevailing vector bionomics (e.g., outdoor biting) and sociocultural and economic activities (e.g., evening and nighttime outdoor activities), the current interventions are not adequately protecting the community despite successful scale-up. Overall, children under age five have constituted 16% of all malaria cases in Angwa from 2013 to 2017. In a malaria endemic area like Mbire District, the expectation is for the disease burden to be higher in children under five years of age due to lower immunity. According population projections, children under five represent about 16% of the total population (ZIMSTAT). Therefore, children under five are at equal risk of contracting malaria compared to the rest of the population. This observation suggests that they are other factors increasing the risk to contract malaria in older children and adults relative to the children which outweighs the lower immunity in children under five years of age. One such factor is increased exposure to night-time mosquito bites in older children and adults.

To better understand the relative contributions of the drivers of continued transmission in Angwa Ward, this assessment first attempted to determine the recent coverage levels, and, in some instances, the quality of the interventions currently supported by the NMCP and malaria partners. These interventions include IRS, LLIN distribution, IPTp, increased access to quality malaria case management, and SBCC. In general, the coverage of these interventions was found to be reasonably extensive, though quality and coverage gaps still exist and further progress can be made.

The desk review of historical IRS records suggested that nearly universal coverage levels had been attained, ranging from 83-95% coverage of targeted rooms during the 2012--2017 period. Although slight variations were noted, IRS coverage estimates from the household-level survey implemented during this assessment were consistent with those collected during this record review. Assuming the rooms targeted during IRS campaigns represent the full universe of sprayable rooms in the area and an effective insecticide was used according to best IRS spray practices, coverage levels of this magnitude would be expected to provide indoor protection for the vast majority of the Angwa population. Determining the comprehensiveness of the spray selection was beyond the scope of this assessment. However, it should be noted that experiences with satellite mapping in other Zimbabwean districts has suggested that IRS targets set without such an approach, as has been the case in Angwa Ward, can underestimate the full universe of sprayable rooms. This results in a subsequent overestimate of the level of IRS coverage. With regard to insecticide selection and effectiveness, available entomological data suggest vector susceptibility to the insecticides (DDT and organophosphates) that have been used in Angwa Ward in recent years. The assumption, therefore, is that quality implementation of IRS using these insecticides would provide adequate protection. Unfortunately, this study was unable to fully assess IRS spray quality. The available findings suggest potential concerns about the residual efficacy of DDT in Mupedzapasi, where the residual efficacy of DDT was much lower nine months post-spray compared to findings at Mubairakuenda. This is probably due to poor quality of the initial spray in Mupedzapasi. Taken together, the assessment findings suggest that, although improvements can be made, IRS has been implemented consistently and with reasonable effectiveness in Angwa Ward.

LLINs are a recent addition to the vector management approach in Angwa Ward. Implementation began in 2016 as a response to the presence of non-sprayable structures, the outdoor sleeping practices of the population, and continued transmission despite the scale-up of IRS. The desk review revealed overall LLIN coverage of 58% among households already covered by IRS. In the household survey, respondents indicated that 91% of households had at least one LLIN and that 58% of indoor sleeping spaces and 38% of outdoor spaces were covered by an LLIN the night preceding the survey. The percentage of children under age five sleeping under an LLIN the previous night varied substantially depending on the survey respondent category, with a range of 34% to 71%. Among those five years and older, 53% reportedly slept under an LLIN the preceding night. Although these figures indicate that universal LLIN access and use has not been attained, it is important to remember that this was not necessarily the intended purpose of LLIN distribution. Rather, LLIN distribution was intended as a supplement to IRS, the primary vector control intervention, to cover outdoor sleeping places and non-sprayable habitable rooms. In this sense, it has been beneficial, as 91-95% of households report owning an LLIN or having received IRS during the previous campaign (see Table 8). With regard to residual bio-efficacy, the DawaNet® and DuraNet® LLINs available in Angwa Ward were efficacious against susceptible colony-bred mosquitoes one year after distribution to the communities. It is important to note that the frequency of use of an LLIN can affect the efficacy of an LLIN, and that the length of time since the LLIN was distributed does not necessarily correlate with the period of use since the LLIN may not be opened immediately upon receipt.

Insecticide resistance testing of field-collected mosquitoes conducted during this assessment showed a mixed picture for pyrethroids, creating some concerns regarding the bio-efficacy of distributed LLINs. *An. gambaie* s.l. from three localities in the Ward were resistant to permethrin, an insecticide that is present in the Olyset® LLIN--which was not distributed in the area. Further work should be done to assess this and explore the potential use of synergist-containing LLINs or alternate non-pyrethroid LLINs. However, it should be remembered that these nets will still provide a barrier effect, even in the setting of mixed pyrethroid resistance. Resistance tests on alpha-cypermethrin could not be done since mosquitoes could not be collected after July, when mosquito breeding sites along the rivers dried up.

According to a review of Angwa Ward Clinic ANC registers, IPTp coverage has increased steadily since 2014. In 2017, 97% of ANC attendees received at least one dose, 94% received at least two doses, and 78% received three or more doses, which approaches the national IPTp3 coverage target of 85%. The corresponding figures from the survey of mothers of children 0-59 months of age were 91%, 82%, and 64% for IPTp1, IPTp2, and IPTp3, respectively. Although these community-level figures were lower (as may be expected from a community-based survey of IPTp coverage), they still suggest substantial progress has been made in the scale-up of IPTp coverage in Angwa Ward.

Assessment findings suggest that access to quality malaria case management remains a challenge for the citizens of Angwa Ward. There is only a single clinic to serve the whole population, and not enough VHWs to cover all villages, with 21 VHWs reportedly covering 52 villages. Only 16 of these VHWs have been trained in malaria community case management. Nearly 60% of respondents reported living two or more hours walk from the nearest health facility, and distance was identified as the main reason why people were not able to get care from the health facility. Not surprisingly, 68% reported that they usually go to the VHW when they or one of their family members has a fever. However, 49% reported receiving care from the VHW only sometimes or never, citing absence of the VHW from the village as the primary barrier to receiving VHW care. At the health facility level, most staff members had been trained in, and were able to articulate the correct methods for, malaria case management. However, supportive supervision from higher levels to the facility was limited, as was supervision by health facility staff to VHWs. All three key informants agreed that health care funding was insufficient and often delayed. Stock outs of RDTs and ACTs were also a concern, though this was not mentioned by respondents in the household survey and was only a minor concern among FGD participants.

The assessment also revealed that the level of community knowledge related to malaria is less than desirable. The household survey revealed low numbers of respondents able to recognize the danger signs of malaria in adults and children, including fever, and a lack of knowledge on how to avoid malaria in their community. Even though over 90% of respondents knew that mosquito bites can cause malaria, far fewer (approximately 60%) knew at least two signs and symptoms of malaria. An even lower proportion (20%) knew at least two danger signs of malaria in children, while only 8% of respondents recognized fever as a sign in adults. The figures for respondents hearing recent messages about malaria in the past six months were also relatively low, ranging from 45% for hearing or reading any message to as low as 10% for being able to mention at least one message about malaria. When asked about where they had received any messages about malaria in the previous six months, all except one participant in the survey mentioned either the VHW (8%) or staff at the health facility (31%). No one mentioned receiving messages about malaria from radio, TV, newspapers, schools, posters/pamphlets, road shows, or community meetings.

On religious affiliations, 29.4% of the surveyed households were of the apostolic sects. Of these 2.5% belonged to the Marange Sect. The apostolic sects, particularly the Marange Sect, has been associated with religious objection to use of medicines including antimalarial treatment, and non-acceptance of IRS and LLINs in other areas like Manicaland where they are the predominant sect. The other apostolic sects are more tolerant and generally accept these interventions. The apostolic sects also hold their religious meetings outdoors at night on a weekly basis and for longer periods over religious festivals. These activities further increase the risk of malaria among members.

In aggregate, the assessment findings described thus far suggest that 1) substantial progress has been made in the scale-up of the three traditional prevention measures discussed (IRS, LLINs, and IPTp) and should continue to be improved in quality and coverage as much as possible, and 2) substantial improvements in access to quality malaria case management and malaria educational messaging are needed immediately.

Certainly, the incomplete scale-up of these traditional interventions contributes to the ongoing level of malaria transmission in Angwa Ward. However, other assessment findings indicate that complete, high-quality scale-up of these interventions would not likely be sufficient to eliminate malaria in this setting. The findings suggest that residual malaria transmission is occurring despite high coverage of IRS and LLINs with insecticides to which vectors are susceptible. The socioeconomic practices of this population, the vector bionomics, and the type and quality of housing suggest that outdoor biting and the limited protection available during outdoor activities are critical components of the malaria transmission picture in Angwa Ward.

This assessment confirmed that communities in Angwa Ward spend considerable amounts of time outdoors during malaria transmission periods, particularly for activities such as streambank cultivation, guarding of crops against marauding wildlife, outdoor cooking and relaxing, hunting, prayer meetings, and traditional dances. Overall, 37% and 55% of respondents in the four household survey groups reported spending some time outdoors between 6 pm and 6 am the night before the survey. Of these, 20% and 36% across the household survey groups did so without any form of malaria protection. The most commonly reported time for outdoor activities was 6-8 pm; however, high levels of outdoor activities persisted through the night, with just over half of respondents reporting outdoor activities between 4 am and 6 am. Only 4-10% of those who spent time outdoors the night before the survey reported spending time under a LLIN, and only one respondent reported repellent use. Sixty-seven percent of respondents reported they had some sort of temporary structure at the streambank in order to guard crops; however, these structures are generally not sprayable (see picture above).

The entomological monitoring results indicate that peak mosquito biting times (6-7 pm) align with the peak human outdoor activity timing just described. The risk of exposure is supported by the finding that 65-71% of individuals surveyed reported mosquito bites when outside and 60-90% of respondents reported experiencing mosquito bites while guarding their crops from wild animals between 6 pm and 6 am. The outdoor biting observed was largely associated with non-vector or secondary vector species. This finding may not reflect the true situation during the peak malaria season, but probably indicates the relay role played by secondary vectors during the dry season. Different findings pertaining to mosquito densities and composition would likely be obtained if the same study were done during summer, when mosquito breeding sites are created from rains as opposed to the backwater pools that were dominant during the winter when this study was done. Longitudinal vector surveillance will provide insights on temporal vector fluctuation.

House construction norms in Angwa Ward may also contribute to malaria transmission, despite the scale-up of traditional prevention interventions. The housing survey conducted during this assessment revealed that the majority of structures had thatched roofs, and 96% had openings that would allow mosquitoes to enter. Window screening was uncommon, and open windows, eaves, and doors are potential entry ports for mosquitoes. Despite these features, it is expected that LLINs and IRS may still provide substantial indoor protection for inhabitants of these homes. However, the freestanding structures, such as the one depicted above, are often used for sleeping near the fields when protecting crops. These structures are unsprayable. LLINs can be used for outdoor sleeping in some of these structures (and this was occasionally observed). However, rapid wear and tear of LLINs used for this purpose is a concern.

Given the high levels of evening and night-time outdoor activities without adequate protection, the alignment of biting times with these activities, and the focus of current interventions on indoor protection, it is not surprising that malaria transmission persists in Angwa Ward. To further reduce the level of malaria transmission, the NMCP and malaria partners will need to continue to improve the quality and coverage of existing interventions, while investigating and eventually implementing additional measures. Such measures could include larviciding (based on the findings described in this assessment, this could serve as an effective adjunct if administered properly); use of personal protection measures such as protective clothing and repellents; spatial repellents and attractants such as repellent eaves and attractive toxic sugar baits; additional distribution of LLINs for outdoor sleeping; and housing modification. Currently, the appropriate type and mix of additional measures is unclear and further assessment of these interventions is indicated.

# Conclusions

From the assessment findings, the team concludes that malaria incidence in Angwa has declined substantially from 731/1000 population in 2015 to 94/1000 population in 2017. The age group above five years was the most affected, while children under-five contributed 16% of total cases. IRS, the major prevention strategy in the area, has been documented as well delivered, with coverage levels of 83%-95%. LLIN coverage was low, but this was intended as a supplemental vector control intervention, added within the last two years to help cover households with unsprayable and outdoor sleeping spaces. Coverage levels for IPTp were relatively high, with IPTp3 coverage of 78% and 64% reported depending on the data collection methodology.

Health services provision in Angwa were generally inadequate with one health centre and 21 VHWs covering 51 villages and 16 VHW having been trained to test and treat malaria. IRS, which is the major prevention strategy in the area, was optimally delivered with a coverage of 83 - 95%. LLIN coverage and utilization was low for both indoor and outdoor sleeping spaces. IPTp3 coverage has been significantly high (61% and 78%). The housing structures in the ward exposed the community to mosquitoes as majority had visible openings where mosquitoes could enter and the simplest structure having no roof.

Practices identified that increased the risk of exposure to mosquito bites outdoors during peak biting times included: all night prayer vigils, guarding fields at night, and staying/sleeping outdoors in the evening due to high temperatures. Community members (65% to 71%) were unprotected and vulnerable to mosquito bites while engaging in these commonly practiced outdoor activities. In addition, the typical housing structures in the community were characterized as having visible openings in multiple places where mosquitoes could enter (for example, open eaves, uncovered windows and openings and the simplest of structure having no roof).

The major malaria vector species in the ward were *A. gambie sl* and *A. funestus*, both feed and rest indoors as well as outdoors. The vectors showed a predominance of outdoor biting. The peak biting period was between 6pm to 12 midnight and no biting occurred after midnight. The vectors were susceptible to DDT and resistant to Pyrethroids.

Community’s malaria risk perception was generally high though general knowledge was low. Literacy rate was low. Being an apostolic sect member did not affect access to health services.

The drivers of malaria transmission in Angwa Ward were multifaceted. The main causes of continuous malaria transmission in Angwa were: high levels of outdoor activities during peak biting of mosquitoes (characterised by guarding of fields at night and stream bank cultivation; all night prayer vigils; and staying/sleeping outdoors in the evening due to high temperatures), in an environment where the mosquitoes exhibit outdoor biting. In addition to housing structures with multiple visible openings that allow mosquitoes to enter.

# Recommendations

Angwa requires a tailor-made combination of interventions that will take into account the community’s livelihood and lifestyle. The recommendations below are for Angwa Ward. Where applicable, they may be considered for replication in other areas experiencing similar entomological and socio-epidemiological settings**.**

There should be an effort to disseminate these findings, conclusions and recommendations to a wide array of audiences at central level in Zimbabwe as well as to provincial, district, ward and community-level audiences, with a special effort to include groups within Angwa Ward. Comments and feedback on the assessment should be requested and collected by members of the assessment team.

The assessment team should seek guidance from the NMCP in putting together a task force to consider and plan for implementation of the recommendations listed below. The assessment team should have a discussion about planning for specific resources needed to implement the recommendations – including time, funding, and persons/organizations.

**Recommendation I.**

Continued efforts should be made to improve the coverage and quality of the malaria prevention and control interventions already being implemented in Angwa Ward.

1. Vector control and entomological monitoring

NMCP to provide optimal coverage of malaria prevention and control commodities. The district health executive (DHE) and partners should:

* 1. Enhance coverage of spraying operations by adopting geo-mapping and electronic household listing to ensure accurate assessment of the full universe of sprayable structures.
  2. Enhance supervision of IRS to ensure high quality and coverage including in hard-to-reach areas of the ward. Use trained local people as part of the IRS teams. Village heads and VHWs could help in locating all homes and increasing coverage.
  3. Increase the scope and scale of LLIN distribution with more accurate monitoring of LLINs per sleeping space, including outdoor sleeping spaces. People should be trained on how to properly use the nets for every outdoor sleeping space.
  4. Develop a winter larval source management plan to reduce vector density.
  5. Conduct a more comprehensive mosquito survey covering the entire year. More work is needed to determine the seasonal fluctuations of the breeding habitats in Angwa to gain a better understanding of how mosquitoes belonging to the *An. gambiae* complex can cause major outbreaks in the rainy season, especially following flooding. Such work should also determine the relative abundance and distribution of the total mosquito species found over a longer observation period.

1. Malaria case management
   1. The number of clinics in Angwa Ward needs to be increased beyond the single one at present or set up health posts in the harder to reach areas.
   2. The DHE should increase the number of VHWs and ensure that there is a trained and well supported VHW per village throughout the ward.
   3. All Angwa Ward Clinic staff should be trained on malaria case management.
   4. Supportive supervision by DHE to Angwa Ward Clinic health facility staff and from health facility staff to VHWs should be prioritized and adequately funded.
   5. Stock management practices at the health facility and community-levels should be assessed and improved.
   6. DHE and clinic staff should maintain adequate stocks of treatment commodities for the health facility and VHWs throughout the year and preposition commodities in line with transmission patterns.
   7. DHE should put in place a reliable transportation system for referral of severe malaria cases to the nearest hospital.
   8. The Angwa community leaders should come up with a community transportation system (for example ox drawn carts) for patients to reach the clinic.
2. Social and behaviour change communication
   1. Immediately enhance community knowledge on malaria causes, symptoms, danger signs and required actions for better prevention and care seeking behaviours.
   2. Strengthen SBCC activities (taking into account the low literacy rate in the ward) through:
      1. Conducting community meetings
      2. Introducing and strengthening community action cycle to enable the community to come up with local solutions for sustainable malaria prevention interventions
      3. Using mass media messaging

These activities will improve and ensure sustainable behaviour change, increase uptake of malaria prevention and control interventions, and increase community ownership of malaria prevention and control strategies. In addition:

* 1. Target specific groups with SBCC messages (such as, churches) that are crafted to address and modify practices that currently increase church members’ risk to contracting malaria.

**Recommendation II.**

Efforts should be made to identify and implement additional prevention interventions designed to limit exposure during outdoor activities, including the conduct of operational research, as appropriate.

1. Explore the potential benefits of additional personal protection measures such as use of repellents and pilot supply models that are sustainable through community-generated funding, particularly in areas where outdoor biting is likely to be a substantial driver of transmission. (For example, consider a model that is implemented by the HCCs through the development fund as an income generating project.).
2. Health workers at ward level should consider raising awareness on beneficiary repurposing of old, unusable LLINs. HCCs should encourage use of house screening and other housing improvements to enhance indoor protection against mosquitoes. DHEs should work with other stakeholders to pilot interventions to support screening of houses at selected sites.
3. Explore ideas for increasing outdoor, spatial protection, for example within a defined area within a household compound or defined outdoor spaces during a church service. Spatial repellents and attractants such as repellent eaves and attractive toxic sugar baits are potential solutions to research and consider.
4. NMCP should work with partners and WHO to coordinate any possible introduction of personal protection tools (such as repellents) when outdoors. NMCP should consider including promotion of alternative personal, home and spatial protections within the current mix of vector control interventions (LLINs, IRS, larviciding and repellents).

**Recommendation III.**

Going forward monitor rainfall, temperature and humidity patterns in Angwa Ward and perform further analysis in the context of historical malaria trends. This monitoring will enable prediction of increases in malaria incidence in the area and enhance preparedness to respond to these increases. These factors should be interpreted in relation to vector dynamics over the monitoring period.

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# Annex 1:

**Coverage of indicators for ownership of LLINs**

|  |  |
| --- | --- |
| **Indicators** | **Coverage** |
| Proportion of households owning at least one net (Household heads) | 95% |
| Proportion of households owning at least one net (Mothers of children 0-5 months) | 89% |
| Proportion of households owning at least one net (Mothers of children 0-59 months) | 88% |
| Proportion of households owning at least one net (Other household members) | 90% |
| Proportion of households owning at least one LLIN (Household heads) | 94% |
| Proportion of households owning at least one LLIN (Mothers of children 0-5 months) | 69% |
| Proportion of households owning at least one LLIN (Mothers of children 0-59 months) | 71% |
| Proportion of households owning at least one LLIN (Other household members) | 87% |
| Proportion of households owning more than one LLIN (Household heads) | 72% |
| Proportion of households owning more than one LLIN (Mothers of children 0-5 months) | 53% |
| Proportion of households owning more than one LLIN (Mothers of children 0-59 months) | 52% |
| Proportion of households owning more than one LLIN (Other household members) | 64% |
| Proportion of households owning at least one LLIN per indoor sleeping space (Household heads) | 45% |
| Proportion of households owning at least one LLIN per indoor sleeping space (Other household members) | 33% |
| Proportion of households owning at least one LLIN per outdoor sleeping space (Household heads) | 50% |
| Proportion of households owning at least one LLIN per outdoor sleeping space (Other household members) | 69% |

**Coverage of Indicators in Use of LLINs**

| **Indicators** | **Coverage** |
| --- | --- |
| Proportion of children 0-5 months who slept under an LLIN the night preceding the assessment (Mothers of children 0-5 months) | 69% |
| Proportion of children under 5 years who slept under an LLIN the night preceding the assessment (Household heads) | 28% |
| Proportion of children under 5 years who slept under an LLIN the night preceding the assessment (Mothers of children 0-59 months) | 71% |
| Proportion of children under 5 years who slept under an LLIN the night preceding the assessment (Other household members) | 34% |
| Proportion of household members above 5 years old who slept under an LLIN the night preceding the assessment (Household heads) | 53% |
| Proportion of household members above 5 years old who slept under an LLIN the night preceding the assessment (Other household members) | 53% |
| Proportion of mothers of children 0-5 months who slept under an LLIN the night preceding the assessment (Mother of children 0-5 months) | 69% |

**Indicator Coverage for Indoor Residual Spraying**

|  |  |
| --- | --- |
| **Indicators** | **Coverage** |
| Proportion of rooms sprayed in the past IRS campaign (Household heads) | 91% |
| Proportion of rooms sprayed in the past IRS campaign (Mothers of children 0-5 months) | 93% |
| Proportion of rooms sprayed in the past IRS campaign (Mothers of children 0-59 months) | 89% |
| Proportion of rooms sprayed in the past IRS campaign (Other household members) | 93% |
| Proportion of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign (Household heads) | 94% |
| Proportion of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign (Mothers of children 0-5 months) | 91% |
| Proportion of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign (Mothers of children 0-59 months) | 95% |
| Proportion of households with at least one LLIN per sleeping space and/or IRS in the past IRS campaign (Other household members) | 95% |

**Indicator Coverage for use of LLINs and/or IRS**

|  |  |
| --- | --- |
| **Indicators** | **Coverage** |
| Proportion of household members **under** 5 years old who, the night preceding the survey, slept under a LLIN, or in a dwelling in which the interior walls have been sprayed against mosquitoes in the last IRS campaign (Mothers of children 0-59 months) | 95% |
| Proportion of household members **above** 5-year-old who, the night preceding the survey, slept under a LLIN, or in a dwelling in which the interior walls have been sprayed against mosquitoes in the last IRS campaign (Household heads) | 88% |
| Proportion of household members **abov**e 5-year-old who, the night preceding the survey, slept under a LLIN, or in a dwelling in which the interior walls have been sprayed against mosquitoes in the last IRS campaign (Other household members) | 94% |

**Coverage estimates for mothers who took IPTp during their previous pregnancy**

|  |  |
| --- | --- |
| **Indicators** | **Coverage** |
| Proportion of mothers of children 0-5 months who took at least one dose of IPTp during their last pregnancy | 91% |
| Proportion of mothers of children 0-5 months who took at least two doses of IPTp during their last pregnancy | 82% |
| Proportion of mothers of children 0-5 months who took at least three doses of IPTp during their last pregnancy | 64% |

**Coverage of indicators for accessibility to malaria case management services**

|  |  |
| --- | --- |
| **Indicators** | **Coverage** |
| Proportion of household heads who report existence of VHWs in their village | 70% |
| Proportion of mothers of children 0-5 months who report existence of VHWs in their village | 69% |
| Proportion of mothers of children 0-59 months who report existence of VHWs in their village | 69% |
| Proportion of household members who report existence of VHWs in their village | 69% |
| Proportion of household heads who report accessibility of malaria community case management services at village level from a VHW | 95% |
| Proportion of mothers of children 0-5 month who report accessibility of malaria community case management services at village level from a VHW | 91% |
| Proportion of mothers of children 0-59 months who report accessibility of malaria community case management services at village level from a VHW | 87% |
| Proportion of household members who report accessibility of malaria community case management services at village level from a VHW | 91% |
| Proportion of household heads who report accessibility to the Angwa clinic services | 96% |
| Proportion of mothers of children 0-5 months who report accessibility to the Angwa clinic services | 96% |
| Proportion of mothers of children 0-59 months who report accessibility to the Angwa clinic services | 90% |
| Proportion of household members who report accessibility to the Angwa clinic services | 93% |

**Coverage estimates for indicators on general knowledge about malaria**

| **Indicators** | **Coverage** |
| --- | --- |
| Proportion of household heads who know at least two signs and symptoms of malaria | 59% |
| Proportion of mothers of children 0-5 months who know at least two signs and symptoms of malaria | 53% |
| Proportion of mothers of children 0-59 months who know at least two signs and symptoms of malaria | 55% |
| Proportion of household members who know at least two signs and symptoms of malaria | 65% |
| Proportion of household heads who reported mosquito bites as a cause of malaria | 88% |
| Proportion of mothers of children 0-5 months who reported mosquito bites as a cause of malaria | 96% |
| Proportion of mothers of children 0-59 months who reported mosquito bites as a cause of malaria | 93% |
| Proportion of household members who reported mosquito bites as a cause of malaria | 90% |
| Proportion of household heads who reported the use of mosquito nets as a way of preventing malaria in their community | 87% |
| Proportion of mothers of children 0-5 months who reported the use of mosquito nets as a way of preventing malaria in their community | 96% |
| Proportion of mothers of children 0-59 months who reported the use of mosquito nets as a way of preventing malaria in their community | 90% |
| Proportion of household members who reported the use of mosquito nets as a way of preventing malaria in their community | 86% |
| Proportion of household heads who know at least two danger signs of malaria in children | 22% |
| Proportion of mothers of children 0-5 months who know at least two danger signs of malaria in children | 29% |
| Proportion of mothers of children 0-59 months who know at least two danger signs of malaria in children | 15% |
| Proportion of household members who know at least two danger signs of malaria in children | 12% |
| Proportion of household heads who know at least two danger signs of malaria in adults | 9% |
| Proportion of mothers of children 0-5 months who know at least two danger signs of malaria in adults | 7% |
| Proportion of mothers of children 0-59 months who know at least two danger signs of malaria in adults | 3% |
| Proportion of household members who know at least two danger signs of malaria in adults | 10% |
| Proportion of household heads who recognize fever as a sign of malaria in children | 22% |
| Proportion of mothers of children 0-5 months who recognize fever as a sign of malaria in children | 29% |
| Proportion of mothers of children 0-59 months who recognize fever as a sign of malaria in children | 15% |
| Proportion of household members who recognize fever as a sign of malaria in children | 12% |
| Proportion of household heads who recognize fever as a sign of malaria in adults | 9% |
| Proportion of mothers of children 0-5 months who recognize fever as a sign of malaria in adults | 7% |
| Proportion of mothers of children 0-59 months who recognize fever as a sign of malaria in adults | 3% |
| Proportion of household members who recognize fever as a sign of malaria in adults | 10% |

**Access to malaria information**

|  |  |
| --- | --- |
| **Indicators** | **Coverage** |
| Proportion of household heads who have ever heard or read any messages about malaria in the past 6 months | 55% |
| Proportion of mothers of children 0-5 months who have ever heard or read any messages about malaria in the past 6 months | 40% |
| Proportion of mothers of children 0-59 months who have ever heard or read any messages about malaria in the past 6 months | 43% |
| Proportion of household members who have ever heard or read any messages about malaria in the past 6 months | 34% |
| Proportion of household heads who have ever heard or read any messages about malaria in the past 6 months and cite at least one specific source of malaria messages | 36% |
| Proportion of mothers of children 0-5 months who have ever heard or read any messages about malaria in the past 6 months and cite at least one specific source of malaria messages | 38% |
| Proportion of mothers of children 0-59 months who have ever heard or read any messages about malaria in the past 6 months and cite at least one specific source of malaria messages | 30% |
| Proportion of household members who have ever heard or read any messages about malaria in the past 6 months and cite at least one specific source of malaria messages | 23% |
| Proportion of household heads who have ever heard or read any messages about malaria in the past 6 months and mention at least one message about malaria | 11% |
| Proportion of mothers of children 0-5 months who have ever heard or read any messages about malaria in the past 6 months and mention at least one message about malaria | 16% |
| Proportion of mothers of children 0-59 months who have ever heard or read any messages about malaria in the past 6 months and mention at least one message about malaria | 8% |
| Proportion of mothers of household members who have ever heard or read any messages about malaria in the past 6 months and mention at least one message about malaria | 7% |

**Personal protection against malaria**

| **Indicators** | **Coverage** |
| --- | --- |
| Proportion of household heads who last night (between 6pm and 6am) applied mosquito repellent (e.g. spray, lotion, soap, plants) as a way of malaria protection | 0% |
| Proportion of mothers of children 0-5 months who last night (between 6pm and 6am) applied mosquito repellent (e.g. spray, lotion, soap, plants) as a way of malaria protection | 0% |
| Proportion of children 0-59 months who last night (between 6pm and 6am) applied mosquito repellent (e.g. spray, lotion, soap, plants) as a way of malaria protection | 0% |
| Proportion of household members who last night (between 6pm and 6am) applied mosquito repellent (e.g. spray, lotion, soap, plants) as a way of malaria protection | 1% |
| Proportion of household heads who last night (between 6pm and 6am) wore long sleeves/trousers/skirts as a way of malaria protection | 46% |
| Proportion of mothers of children 0-5 months who last night (between 6pm and 6am) wore long sleeves/trousers/skirts as a way of malaria protection | 42% |
| Proportion of mothers of children 0-59 months who last night (between 6pm and 6am) wore long sleeves/trousers/skirts as a way of malaria protection | 45% |
| Proportion of household members who last night (between 6pm and 6am) wore long sleeves/trousers/skirts as a way of malaria protection | 53% |
| Proportion of household heads who would be willing to pay for alternative malaria prevention measures (mosquito repellents and mosquito coils) | 17% |
| Proportion of mothers of children 0-5 months who would be willing to pay for alternative malaria prevention measures (mosquito repellents and mosquito coils) | 18% |
| Proportion of mothers of children 0-59 months who would be willing to pay for alternative malaria prevention measures (mosquito repellents and mosquito coils) | 23% |
| Proportion of household members who would be willing to pay for alternative malaria prevention measures (mosquito repellents and mosquito coils) | 36% |
| Proportion of household heads who feel protected from getting malaria | 25% |
| Proportion of mothers of children 0-5 months who feel protected from getting malaria | 31% |
| Proportion of mothers of children 0-59 months who feel protected from getting malaria | 37% |
| Proportion of household members who feel protected from getting malaria | 33% |

**Indoor coverage with LLINs and IRS**

| **Indicators** | **Coverage** |
| --- | --- |
| Proportion of household heads who last night (between 6pm and 6am) spent some time indoors in a structure/ house/dwelling sprayed under the 2017 IRS campaign | 72% |
| Proportion of mothers of children 0-5 months who last night (between 6pm and 6am) spent some time indoors in a structure/ house/dwelling sprayed under the 2017 IRS campaign | 76% |
| Proportion of mothers of children 0-59 months who last night (between 6pm and 6am) spent some time indoors in a structure/ house/dwelling sprayed under the 2017 IRS campaign | 78% |
| Proportion of household members who last night (between 6pm and 6am) spent some time indoors in a structure/ house/dwelling sprayed under the 2017 IRS campaign | 72% |
| Proportion of household heads who last night (between 6pm and 6am) spent time indoors/slept under a LLIN | 53% |
| Proportion of mothers of children 0-5 months who last night (between 6pm and 6am) spent time indoors/slept under a LLIN | 69% |
| Proportion of mothers of children 0-59 months who last night (between 6pm and 6am) spent time indoors/slept under a LLIN | 72% |
| Proportion of household members who last night (between 6pm and 6am) spent time indoors/slept under a LLIN | 63% |
| Proportion of household heads who last night (between 6pm and 6am) spent some time indoors in a sprayed house and slept under an LLIN | 68% |
| Proportion of mothers of children 0-5 months who last night (between 6pm and 6am) spent some time indoors in a sprayed house and slept under an LLIN | 73% |
| Proportion of mothers of children 0-59 months who last night (between 6pm and 6am) spent some time indoors in a sprayed house and slept under an LLIN | 81% |
| Proportion of household members who last night (between 6pm and 6am) spent some time indoors in a sprayed house and slept under an LLIN | 75% |

**Coverage estimates for night-time outdoor activities**

| **Indicators** | **Coverage** |
| --- | --- |
| Proportion of household heads who last night (between 6pm and 6am) spent some time outdoors without any form of malaria protection | 36% |
| Proportion of mothers of children 0-5 months who last night (between 6pm and 6am) spent some time outdoors without any form of malaria protection | 24% |
| Proportion of mothers of children 0-59 months who last night (between 6pm and 6am) spent some time outdoors without any form of malaria protection | 20% |
| Proportion of household members who last night (between 6pm and 6am) spent some time outdoors without any form of malaria protection | 26% |
| Proportion of household heads who last night (between 6pm and 6am) spent some time outdoors under a LLIN | 8% |
| Proportion of mothers of children 0-5 months who last night (between 6pm and 6am) spent some time outdoors under a LLIN | 4% |
| Proportion of mothers of children 0-59 months who last night (between 6pm and 6am) spent some time outdoors under a LLIN | 9% |
| Proportion of household members who last night (between 6pm and 6am) spent some time outdoors under a LLIN | 10% |
| Proportion of household heads who last night (between 6pm and 6am) went outdoors for whatever reason | 55% |
| Proportion of mothers of children 0-5 months who last night (between 6pm and 6am) went outdoors for whatever reason | 40% |
| Proportion of mothers of children 0-59 months who last night (between 6pm and 6am) went outdoors for whatever reason | 37% |
| Proportion of household members who last night (between 6pm and 6am) went outdoors for whatever reason | 44% |