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Regional Malaria Elimination Initiative Belize

Baseline Measurement (2019-20)

October 2020

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Acronyms

BHIS - Belize Health Information System electronic medical record database
BMGF - Bill & Melinda Gates Foundation
CAPI - Computer-assisted personal interview
CHAI - Clinton Health Access Initiative
Col-vol - Volunteer collaborator (*Colaborador voluntario*)
COMISCA - Council of Ministers of Central America and the Dominican Republic
CSF - Carlos Slim Foundation
DTI-R - Detection, Diagnosis, Treatment, Investigation, and Response
ICD - International Classification of Diseases
IDB - Inter-American Development Bank
IHME - Institute for Health Metrics and Evaluation
IRS - Indoor residual spraying
ITN - Long-lasting insecticide-treated nets
LQAS - Lot Quality Assurance Sampling
MRR - Medical record review
PAHO - Pan American Health Organization
RBA - Results-based aid
RDT - Rapid diagnostic test
RMEI - Regional Malaria Elimination Initiative
TBF - Thick blood film

Executive summary

Introduction

The Regional Malaria Elimination Initiative (RMEI) is a regional public-private partnership administered by the Inter-American Development Bank (IDB) seeking to accelerate progress toward malaria elimination in Mesoamerica, the Dominican Republic, and Colombia. The Initiative focuses its resources on integrating evidence-based interventions aimed at reducing to zero the number of malaria cases in participating countries. The Institute for Health Metrics and Evaluation (IHME) is the independent external evaluator for the Initiative.

RMEI baseline measurement

The RMEI baseline measurement was designed to measure the status of key indicators to capture performance along the trajectory of the "Detection, Diagnosis, Treatment, Investigation, and Response (DTI-R)" management strategy. These include the supply of inputs for diagnosis and treatment, the proportion of suspected cases tested for malaria, the timeliness of detection and treatment of confirmed cases, the frequency and quality of reporting of cases and laboratory production, and the coverage of vector control interventions carried out in households at risk of infection.

IHME designed survey instruments based on the Initiative indicator manual and findings from the fact-finding visit to distinct points of the health system in Belize, with input from the Ministry of Health. The measurement included a health facility survey consisting of interview, observation, and records review components and a Lot Quality Assurance Sampled (LQAS) household survey in the catchment area of selected health facilities. The health facility survey sample was selected among eligible primary care facilities in malaria focus areas of Belize. Hospitals and their associated vector control offices were sampled together as one unit based on the understanding from the fact-finding mission around inter-facility pipelines for patient care (e.g., referrals), malaria diagnosis (e.g., thick blood film slides sent away for diagnosis by facilities without a laboratory), and notification and surveillance. However, during data collection IHME and the field team recognized the need to treat vector control offices independent of the hospitals since processes were much more separated from each other than initially anticipated. Therefore, data from vector control units and hospitals are often displayed as separate units throughout this report.

Data collection completed for the Belize baseline measurement is summarized in Table E1. The information sought as a part of the measurement varied by facility type.

Table E1: Belize data collection summary

Point of data collection	Number completed	Measurement completed
Primary care facilities and polyclinics	23	Suspected case medical record review
		Supplies and equipment
Hospitals	7	Suspected case medical record review
		Supplies and equipment
Suspected malaria cases reviewed	*858*	
Confirmed malaria cases reviewed	*7*	
Vector control offices	7	Confirmed case medical record review: diagnosis and treatment
		Aggregate case and lab production reporting
		Lab certification and quality control

Point of data collection	Number completed	Measurement completed
Communities	16	Fever and confirmed malaria cases
		Vector control coverage
Households interviewed	*411*	

Summary of results

Malaria prevention

In order to protect the populations most at risk of malaria infection, the public health system in Belize conducts vector control interventions such as the distribution of long-lasting insecticide-treated mosquito nets (ITNs) and the application of insecticide to interior walls of dwellings through indoor residual spraying (IRS). These activities may be carried out as part of an intervention plan based on the risk of transmission in a given zone, or in response to a recent malaria case or outbreak. Coverage of vector control interventions was measured in the LQAS survey. The interview respondent in each household was asked whether the interior walls of the home were sprayed with insecticide to protect against mosquitoes during the year prior to the day of the survey. Respondents were also asked how many treated and untreated mosquito nets their household owned. In the case they owned nets, interviewers recorded a detailed roster of which household member slept under each net the previous night. Individuals were considered to be protected when IRS had been applied to their home in the last year or when they slept under an ITN the night before the survey. Household members who did not sleep in the home the night before the survey and visitors to the household the night before the survey were excluded from the calculation. Table E2 shows intervention coverage according to the expectation in each community.

Table E2: Individuals protected by vector control measures (IRS or ITN), LQAS survey

Vector control reported	Communities	Used treated net	House sprayed
Spray	12	1.2%	31%
Both	3	0.4%	16.4%
None	1	0%	16.3%

Detection of malaria cases

In order to detect and treat malaria, facilities must have certain basic supplies and equipment on hand. During the health facility observation, survey personnel sought to observe each of these basic inputs according to the facility type. Equipment was checked to see if it was functioning. Stock of laboratory reagents was reviewed for the three months prior to the date of the survey to check for stockouts. Table E3 shows the results for each category of supplies for eligible facilities.

Table E3: Stock of inputs for malaria service provision, health facility observation

	N	n	%	95% CI
Sampling and biosafety equipment	17	9	52.9	(29 - 75)
Sample submission forms	7	4	57.1	(22 - 87)
Rapid diagnostic tests (RDTs) for onsite testing	20	0	0	(-)
Microscopy equipment	6	5	83.3	(34 - 98)
Equipment for staining and testing	6	6	100	(-)
Reagents for staining	6	5	83.3	(34 - 98)
Units with all required equipment and medications	**31**	**5**	**16.1**	**(7 - 34)**

The measurement sought to estimate the proportion of suspected malaria cases receiving a test from two different sources: the community survey and the medical record review in health facilities that provide primary care services. During the household interview, respondents were asked if each member of the

household had experienced a fever in the two weeks prior to the survey. Each individual reporting a fever was asked about the presence of concurrent respiratory, urinary, and skin symptoms that suggest the fever was caused by a condition other than malaria infection. Respondents reporting these symptoms were not considered to meet the case definition for suspected malaria and were excluded from the indicator calculation. Respondents meeting the case definition were asked if they received a blood test from any medical provider during the illness. Those reporting a blood draw were considered to have received a malaria test.

The medical record review provides a comparable indicator of passive case detection as measured in health facilities. A sample of attentions for patients presenting with fever or other eligible diagnoses was drawn from registries from the calendar year 2018. Survey personnel sought to observe all records available in the facility for each selected attention, such as medical charts, attention sheets, and laboratory records, and extracted information related to the illness episode. Cases that did not meet the suspected case definition for malaria because they had one of a list of exclusion diagnoses presumed to cause the fever were excluded from the calculation. Cases meeting the suspected case definition for malaria were checked for any evidence that a malaria test, whether rapid diagnostic test (RDT) or thick blood film (TBF), was ordered or carried out.

The results of both case detection indicators are shown in Table E4.

Table E4: Suspected malaria cases with test, LQAS survey and medical record review

	N	n	%	95% CI
Fevers with any blood sample (LQAS survey)	53	10	18.9	(8 - 40)
Suspected case with malaria test (medical record review)	836	22	2.6	(2 - 4)

Diagnosis of malaria cases

The RMEI baseline measurement also included a review of confirmed cases of malaria based on the case notification and investigation forms available at vector control offices. The review captured all seven cases of malaria diagnosed in Belize during 2018. The indicator for timely diagnosis of malaria compares the date of initiation of fever or other symptoms with the date of diagnosis as shown in Table E5. Cases with diagnosis two days or less after symptom initiation are considered to have timely diagnosis. Cases with fever/symptom initiation date or diagnosis date not registered are not considered to have timely treatment initiation.

Table E5: Diagnosis within two days, Confirmed case review

	N	n	%	95% CI
Indicator result: Cases diagnosed within 48 hours of onset*	5	1	20	(1 - 83)
1-2 days from onset to diagnosis	5	1	20	(1 - 83)
Over 7 days from onset to diagnosis	5	3	60	(12 - 94)
Only onset date registered	5	1	20	(1 - 83)

*Two cases excluded due to suspected inscription/data entry error (<-7 day or >30 day window)

Treatment of malaria cases

The review of confirmed malaria cases also captured all available information about malaria treatment administered to patients from case investigation forms or treatment logs. The indicator for timely treatment of malaria compares the date of diagnosis with the date of treatment initiation (Table E6). Cases for which the first dose of the appropriate treatment was given one day or less after diagnosis are considered to have timely treatment initiation. Cases with diagnosis date or treatment initiation date not registered are not considered to have timely treatment initiation.

Table E6: Treatment within one day, Confirmed case review

	N	n	%	95% CI
Correct treatment administered for species	7	7	100	(-)
First dose treatment within 24 hours of diagnosis	7	4	57.1	(15 - 91)
Correct treatment administered within 24 hours of diagnosis	7	4	57.1	(15 - 91)

The indicator for complete, supervised treatment of malaria identifies the cases with evidence that all doses of the appropriate treatment scheme were administered to the patient, and that at least one dose was supervised by any health care provider (Table E7). Cases with type of medication administered or number of treatment administrations not registered are not considered to have complete treatment.

Table E7: Complete and supervised treatment, Confirmed case review

	N	n	%	95% CI
Adequate treatment and number of doses administered	7	4	57.1	(15 - 91)
Evidence of at least one supervised dose	7	5	71.4	(22 - 96)
Indicator Result: Complete treatment with supervision	7	2	28.6	(4 - 78)

Malaria reporting and surveillance

The RMEI health facility survey included a review of malaria case and laboratory production reports and laboratory quality control reports from the year 2018 to measure adherence of each facility to reporting and quality control standards as defined through the Initiative. Field personnel conducted an audit of all malaria case reports from 2018 stored at primary and secondary level facilities in the sample. They then sought to observe all 12 monthly reports for the year 2018. Next, surveyors sought to find the reports corresponding to a randomly selected month, and captured detailed information from this report, such as the number of malaria cases reported (or whether zero cases were reported) and the date sent or received as listed on the report (or as listed in a logbook of official correspondence sent and received in facilities that use such a book). An analogous process was completed for laboratory production reports and reports of the indirect quality control (slide cross-checking) exercise in facilities with microscopic diagnostic capacity. A report of the 2018 annual direct quality control (slide panel) exercise with feedback from the reference laboratory was also sought in each facility with malaria microscopy, and a report of external microscopy certification from the Pan American Health Organization was sought in the national reference laboratory.

The results for reports from the year 2018 complete with quality standards are shown in Table E8.

Table E8: Reporting for malaria surveillance and diagnosis quality control, health facility observation

	N	n	%	95% CI
Malaria case reporting to standard	6	0	0	(-)
Laboratory production reporting to standard	6	1	16.7	(2 - 66)
External quality control: 2018 National Lab Evaluation form observed	1	1	100	(-)
Facilities passing direct quality control (DQC) component	6	1	16.7	(2 - 66)
Facilities passing indirect quality control (IDQC) component	6	2	33.3	(8 - 75)

Key findings

The results of the Belize baseline measurement suggest several opportunities for RMEI to strengthen practices on the trajectory to malaria elimination. First, even when activities like treatment of malaria

patients or laboratory quality control are conducted to standard, a sufficient record of the activity carried out is not always maintained at the relevant health facility, which complicates measurement of performance and timeliness. Enhancing record keeping will thus lead to improved results that better reflect high-quality work carried out on the ground. Electronic systems have the capacity to improve information availability, but in order to be effective, adoption of these systems must account for the strengths and weaknesses of existing paper-based systems.

The measurement found evidence of local and regional variation in practices for malaria detection and notification. While different strategies may be necessary in zones with different levels of receptivity or malaria importation risk, it is important to ensure a shared understanding of goals and adherence to standard at the local level when such standards have been established. Furthermore, this understanding of the strategy and the role of each contributor must extend beyond the malaria and vector control programs and diagnosis networks to include primary health care providers who play an increasingly important role in detection and management of cases as Belize draws closer to malaria elimination.

Chapter 1: Introduction

1.1 Overview

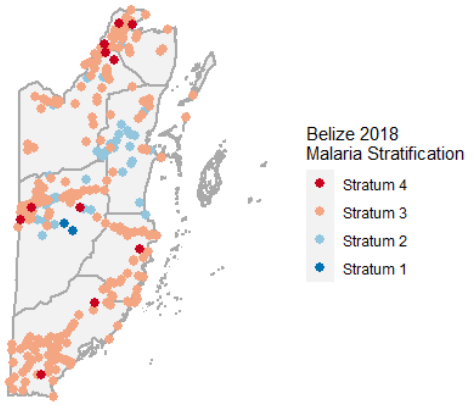
The Regional Malaria Elimination Initiative (RMEI) is a regional public-private partnership administered by the Inter-American Development Bank (IDB) seeking to accelerate progress toward malaria elimination in Mesoamerica, the Dominican Republic, and Colombia. One of its defining features is the application of a results-based aid (RBA) model that relies on performance measurement and enhanced transparency and accountability. The Initiative focuses its resources on integrating evidence-based interventions aimed at reducing to zero the number of malaria cases in participating countries. RMEI is funded by the Bill & Melinda Gates Foundation (BMGF), the Global Fund to Fight AIDS, Tuberculosis, and Malaria, the Carlos Slim Foundation (CSF) and each of the participating country governments. The Initiative is implemented in close coordination with the Pan American Health Organization (PAHO), the Council of Ministers of Central America and the Dominican Republic (COMISCA), the Project Mesoamerica, Clinton Health Access Initiative (CHAI), and other regional partners. The Institute for Health Metrics and Evaluation (IHME) is the independent external evaluator.

Interventions aim to build on the malaria control and elimination activities ongoing for several decades in Belize. RMEI's approach seeks to eliminate malaria in humans, the main reservoir of the parasite, through surveillance and "Detection, Diagnosis, Treatment, Investigation, and Response (DTI-R)" interventions. A hallmark intervention of the Initiative, as many countries in the region enter the elimination phase of their malaria programs, was to carry out micro-stratification of geographic areas vulnerable and receptive to malaria transmission. In Belize, active, residual, and inactive foci were defined, and each locality was assigned to a stratum 1 through 4, as seen in Table 1.1. This exercise was completed prior to the baseline measurement and served as a basis for defining the study area and selecting the sample. Localities may be redefined with updated stratum classification in subsequent points on the Initiative as their level of importation risk and number of autochthonous cases evolves. The malaria program in Belize carries out household-level vector control interventions such as indoor residual spraying (IRS) and distribution of long-lasting insecticide-treated nets (ITNs) which are to be expanded and monitored as a part of the Initiative. Other interventions focus on providing training, disseminating standards for clinical care, improving record-keeping with medical providers country-wide, and improving surveillance capacity by reviewing existing practices, expanding use of digital information systems, and standardizing reporting for case detection.

Table 1.1: Belize malaria stratification: Definition and distribution of strata

Stratum	Number of localities	Definition
1	2	Non-receptive
2	44	Receptive, no autochthonous cases, no risk of importation
3	235	Receptive, risk of importation, no autochthonous cases
4	11	Receptive, presence of autochthonous cases in last 3 years

Figure 1.1: Belize malaria stratification: national



Map prepared by IHME with data provided by the RMEI operations team

In Belize, malaria burden has dropped significantly in recent years. In 2018, the reference year for the baseline measurement, Belize had seven confirmed cases of malaria according to national public health surveillance data provided by the Ministry of Health. Belize has historically depended on a vertically integrated malaria program that operates in close coordination with programs for other vector-transmitted diseases. Belize has an established network of community health volunteers called “volunteer collaborators” (*colaborador voluntario* or “col-vol”) who collaborate in case detection in communities with active malaria transmission and with limited access to health services. In the malaria elimination phase, Belize is transitioning malaria detection and case management to be more closely horizontally integrated within the public primary care system, increasingly relying on passive detection of cases at health facilities and eventually shifting responsibility to primary care providers to administer treatment and follow-up care.

1.2 Components of the RMEI baseline measurement

The objective of the RMEI baseline measurement is to compile a detailed picture of malaria health services in each participating country, including information about readiness to eliminate malaria through the support of the Initiative. The measurement is designed around a set of indicators that participating countries and implementation partners negotiate as a part of RMEI DTI-R management strategy. These include the supply of inputs for diagnosis and treatment, the proportion of suspected cases tested for malaria, the timeliness of detection and treatment of confirmed cases, the frequency and quality of reporting of cases and laboratory production, and the coverage of vector control interventions carried out in households at risk of infection. Indicators for Belize are listed in full in Appendices A and B. Subsequent measurement rounds will assess whether countries are reaching the indicator targets set through the Initiative and evaluate the results of specific interventions.

The baseline measurement includes a health facility survey (interview and observation), a review of medical records for suspected and confirmed cases of malaria, and a household survey conducted in communities served by health facilities in the sample. This report summarizes the data and findings of the RMEI baseline measurement conducted by IHME.

The health facility survey involves the following components:

- an interview with the administrator of the facility about the services provided there (general facility characteristics, infrastructure, and human resource composition, supply logistics, infection control, and provision of services related to malaria diagnosis and treatment),
- an observation of supplies, equipment, and pharmaceutical stock present in the facility,
- an observation of laboratory supplies and equipment, laboratory production and case notification reports in facilities with malaria diagnostic capacity,
- a review of medical records of suspected malaria cases (case definition detailed in Chapter 6),

- a review of paper case notification and case investigation forms for confirmed malaria cases at vector control offices.

The facility survey, observation, and record review is designed to collect information on facility preparedness for detecting and treating malaria cases, as well as the quantity and quality of malaria care services provided in the baseline time period. Importantly, health facility data collection captures changes produced by interventions at the level of the health services access point, which may foretell changes in population health outcomes.

The household survey is designed to collect information on malaria detection, prevention practices, and knowledge in malaria focus areas of Belize from a randomly selected group of households in each surveyed community. Respondents are asked questions about their background, dwelling conditions, knowledge and use of behaviors to prevent malaria, illness and care-seeking history, and other questions that will be helpful to policy makers and administrators in controlling and seeking to eliminate malaria. Community data collection permits the observation of health status, knowledge of malaria, access to health care, and uptake of interventions and practices that prevent malaria infection.

1.3 Fact-finding and data collection scope

In order to refine the survey instruments and prepare for sample selection and data collection, IHME and IDB conducted a joint multi-day fact-finding visit in three regions of Belize in May 2019. During the exploratory visit, the team visited a range of health facilities around the country. The goal of the visit was to learn:

- the local practices for detection and treatment of malaria
- the structure of the health system for malaria care
- the procedures for case notification and channels for data reporting
- the nature of community and prevention activities
- the sources of subnational variation in systems or service provision.

The trip also helped to define sampling methodology and framed expectations about measurement challenges for each indicator, insufficient data availability, and potential gaps in systems and procedures that must be addressed in order to meet Initiative targets and to reach malaria elimination.

The set of indicators defined and negotiated for the baseline measurement necessitates data collection at several distinct points of the health system. The findings from the fact-finding visit determined the points of service visited to measure the indicators, the sources of information reviewed at each unit, and the sample size dedicated to each type of unit. In Belize, the sample includes primary care facilities, polyclinics, hospitals, and district and regional vector control headquarters. Households within the catchment area of primary care facilities selected to the sample were interviewed for the community survey. Table 1.2 shows the information collected at each point.

Table 1.2: Points of data collection for baseline measurement

Type of health unit	Measurement completed
Primary care facilities and polyclinics	Suspected case medical record review
	Supplies and equipment
Hospitals	Suspected case medical record review
	Supplies and equipment
Vector control offices	Confirmed case medical record review: diagnosis and treatment
	Aggregate case and lab production reporting
	Lab certification and quality control
Households	Fever and confirmed malaria cases
	Vector control coverage

Another point of care that has historically contributed to systems of malaria detection and treatment in Belize is the volunteer collaborator (col-vol). These volunteer community health workers provide fever screening and malaria testing via thick blood film (TBF or “gota gruesa”) preparation, out of their own homes or around their communities. Col-vol posts were considered for inclusion in the measurement sample, because col-vols prepare TBF slides, keep registers of patients tested, and sometimes store and administer treatment for confirmed malaria cases. However, because col-vols do not manage their own supply stocks, keep records of patient care, nor have primary responsibility for case investigation and follow-up, the col-vol post is not eligible for inclusion in the RMEI indicators. All the necessary records to be reviewed for a patient with malaria detected by a col-vol, or with treatment supervised by a col-vol, will be filed at a vector control office rather than at the col-vol’s home and thus are captured as a part of the confirmed case review. Further, col-vol posts are costly to reach because they are intended to serve communities without an easily accessible health facility, and col-vols may not keep regular hours since they are volunteers and not health system employees. Confirmed cases of malaria detected by a col-vol were included in the review of medical records, as paperwork for cases detected at any service point is always filed at the vector control offices, where review took place, in Belize.

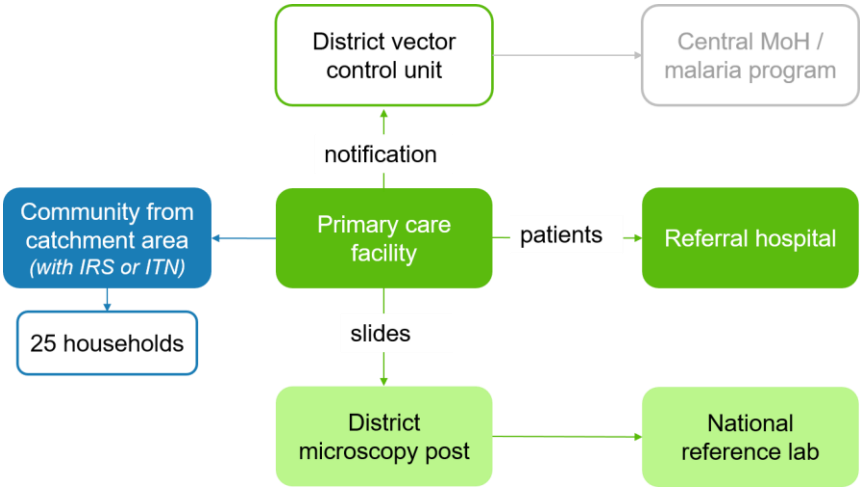
Chapter 2: Survey Methodology

2.1 Sample selection and description

The RMEI baseline measurement aims to measure performance of the health system in zones that play an important role in malaria prevention, detection, and treatment. Since malaria activities are more intensive in endemic and vulnerable areas, the sample is targeted toward presenting representative estimates for the focus areas identified for interventions through the Initiative. Since the Initiative aims to eliminate malaria, its success depends on reducing the burden in countries with ongoing malaria transmission and preventing reintroduction in receptive and vulnerable areas. We expect to return to some of these zones in future measurement rounds to monitor changes in practice. In Belize, the sample is made up of facilities and communities in malaria strata 2, 3 and 4 (see strata definitions in Table 1.1). We focused on the zones with risk for malaria transmission in order to maximize our sample size from these zones.

The set of indicators defined and negotiated for the baseline measurement necessitates data collection at several distinct points of the health system. To draw the sample, we selected a primary care facility at random as the primary sampling unit, and then selected the other health services linked with it in malaria service provision, such as hospitals and vector control units responsible for notification and reporting, as depicted in Figure 2.1. The communities we selected for the household survey are within the catchment areas of the selected primary care facilities.

Figure 2.1: RMEI-Belize baseline health system structure



2.1.1 Health facility sample selection

In Belize, malaria stratification was completed at the locality level. Primary care facilities in localities classified as malaria strata 2, 3 and 4 were eligible to enter the sampling frame, with priority to facilities serving communities with vector control measures (ITN distribution or IRS) implemented. Because of the very small number of localities in strata 1, no health facilities are excluded from the sampling frame.

The initial sampling frame for the health facility survey is the list of facilities that provide primary care services for malaria. Each health facility eligible to be selected for the sample was assigned to a malaria stratum 1 through 4 based on the localities it serves. We assigned each vector control administrative unit to the maximum stratum found in its service area (offices serving any localities in stratum 4 are therefore assigned to stratum 4). The five facilities without microscopy capacity that serve communities in scenario 4 are selected with certainty, and the six facilities with microscopy capacity are selected with certainty. The remainder of the sample is selected at random among ambulatory facilities without microscopy serving scenarios 2 and 3. Facilities with vector control activities carried out in the catchment area during

2018 had first priority for selection. Because the district vector control offices and national malaria reference laboratory are located at community or regional hospitals, they enter the sample based on the criteria described above. More detail on sample selection procedures and sample size considerations is in Appendix C.

This sample selection strategy minimizes the need for sample stratification while maximizing the opportunity to track care and surveillance activities from the point of service to the central level, and thus to identify gaps in malaria service provision and surveillance. Additionally, the selection strategy allows for a random sample of facilities to be included in the measurement for supplies and equipment, testing of suspected cases, and reporting sent from the local level, but remains cost-effective by concentrating household measurement in the zones with history of autochthonous transmission.

2.1.2 Substitutions within the sample

The remaining facilities were selected and added, in random order, to an alternate sample to be used in the case a selected facility could not be interviewed due to security or logistic concerns. When replacement was required, we replaced with a facility of the same level, with the same diagnostic capacity, and within the same district when possible. If substitutes were not available in the same district, we replaced with a randomly selected facility from the same malaria stratum. In the Belize baseline, one primary care facility was replaced during data collection because the facility was found to not provide regular services to the community, but instead referred all patients to a nearby hospital already in the sample. As this unit was planned for the community survey, the community survey was carried out in a locality associated with the replacement facility rather than the original facility. The final sample totals 30 facilities and 16 communities.

2.1.3 Community and household sample selection

One community was selected for the Lot Quality Assurance Sampling (LQAS) household survey from the catchment area of each of the first 16 primary care facilities selected to the facility sample in malaria strata 3 and 4. Within the selected catchment area, IHME selected a community that had received ITN or IRS interventions since the start of 2018 at random among all communities with vector control interventions, based on information about vector control interventions and referral networks received from the Ministry of Health. If no communities received vector control interventions or intervention status was unknown, a community was selected at random among all communities in the catchment area. A random starting point and direction and a calculated skip interval based on community population was provided in the sample for use in field random selection of households.

Twenty-five households in each surveyed community were selected systematically for the interview using field random sampling techniques. The random sampling unit was the dwelling, and all households living in a selected dwelling were eligible for the survey. The interview was responded by the head of household or another adult member of the household knowledgeable about household characteristics. Absent and refused households were replaced with a randomly selected alternate household. Revisits to selected households are not part of the LQAS survey protocol; any selected household that could not be completed the day of the survey was replaced with an alternate. The visit results among selected and replacement households are shown in Table 2.1.

Table 2.1: Result in households selected for survey, unweighted proportions

	N	n	%	95% CI
Status of selected and replacement households				
Complete	427	411	96.3	(94 - 98)
Refused	427	8	1.9	(1 - 4)
Partially complete	427	3	0.7	(0 - 2)
Members absent	427	2	0.5	(0 - 2)
Unoccupied dwelling	427	2	0.5	(0 - 2)
Postponed	427	1	0.2	(0 - 2)

2.1.4 Confirmed case medical record review sample selection

For confirmed cases of malaria, the sample was designed to include review of all seven confirmed cases from 2018. Field staff collected information from all documents available at the vector control offices, including case notification and investigation forms, lab records, and treatment follow-up forms. Table 2.2 shows the number of cases expected in each district (based on counts of cases by district in malaria surveillance data provided to IHME), and the number of case reviews completed during data collection.

Table 2.2: Confirmed case collection

District	Confirmed cases according to surveillance data	Confirmed cases captured during collection
Belize*	1	2
Cayo*	3	2
Stann Creek	3	3
Total	7	7

*One case was diagnosed in Belize district, where medical records were reviewed. This case was categorized as Cayo district in the surveillance data because the patient residence and likely location of infection was in Cayo.

2.1.5 Suspected case medical record review sample selection

For suspected cases of malaria (fever and other complaints and diagnoses meeting the case definition), a random sample of eligible attentions from 2018 was selected for medical record review (MRR). The total budgeted quota of record reviews was divided equally among the primary care facilities and hospitals selected to the sample. Eligible attentions were identified in-facility using attention registries or Belize Health Information System (BHIS) diagnosis databases. The sample was selected for full review using a systematic manual sampling technique as detailed in Appendix C. Field staff collected information from all documents available at the health facility, including daily attention registries, electronic or paper medical records or attention forms, and lab records. Table 2.3 shows the total number of suspected cases reviewed (851), the number of cases selected based on diagnosis or principal complaint but found to be ineligible based on final diagnosis (7), and the cases selected and requested at facilities for which no paperwork could be located for review (39). Sampling for suspected cases of malaria was completed at many health facilities using the diagnosis database of the BHIS electronic medical record system. For 39 cases, the visit noted in the database or registry could not be successfully located or the medical record was found to be empty. In some facilities in Belize, all eligible cases from the entire year 2018 were selected for review, because there were relatively few attentions with eligible diagnoses recorded. Additionally, suspected cases could not be reviewed in 13 of the planned 30 facilities. There were varying causes for inability to sample suspected cases: some facilities did not have access to logbooks or the electronic information system which prevented random sampling, some facilities did not have any eligible suspected cases to select, and some facilities only provided maternal and infant healthcare, meaning no fever attention was provided at the facility. The deficit in collected suspected cases was compensated for by raising the quota of cases for collection at other facilities in the sample. Suspected case sampling issues meant that no suspected cases were collected from facilities in stratum 2.

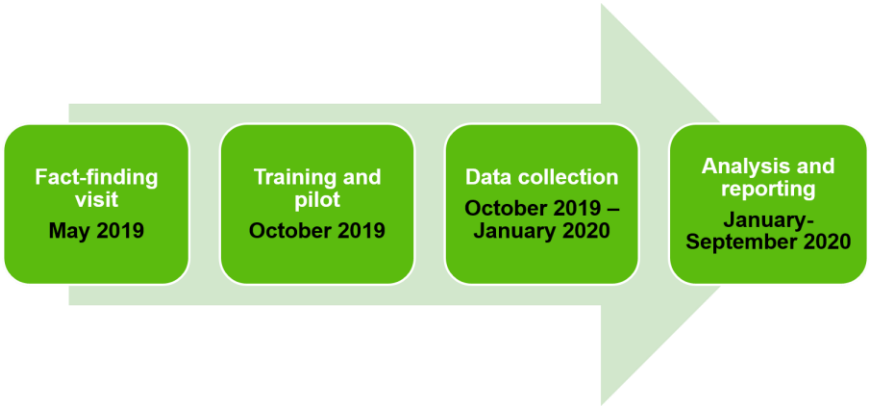
Table 2.3: Suspected case collection

	#
Total suspected cases selected for review	897
Suspected cases selected but could not be located for review	39
All suspected cases screened for eligibility	858
Ineligible suspected cases discarded	7
Eligible suspected cases collected	851

2.2 Survey implementation

In Belize, baseline data was collected between October 2019 and January 2020. The timeline of baseline measurement activities is shown in Figure 2.2.

Figure 2.2: RMEI-Belize baseline timeline



2.2.1 Data collection instruments

Questionnaires were initially developed in English. To best reflect the issues most relevant to the region under study and the local language, we revised the questionnaires following input from key stakeholders and at the conclusion of the pilot studies (described below). Study areas included a substantial proportion of indigenous populations, many of them also English speakers. In order to allow the participation of non-English speakers in the survey, the data collection team included Spanish-speaking interviewers and was prepared to contract local interpreters proficient in Creole, Yucatec, Mopán, Kekchí, and Garifuna as required.

All surveys were conducted using a computer-assisted personal interview (CAPI), programmed using SurveyCTO and installed onto tablets. CAPI supports skip patterns, inter-question answer consistency, and data entry ranges. CAPI reduces survey time by prompting only relevant questions, maintains a logical answering pattern across different questions, decreases data entry errors, and permits rapid data verification remotely. Field team leaders monitored the implementation of the survey and reported feedback. Data collection using CAPI allowed data to be transferred instantaneously once a survey was completed via a secure link to IHME. IHME monitored collected data on a continuous basis and provided feedback. Suggestions, surveyor feedback, and any approved modifications were incorporated into the survey instruments and readily transmitted to the field.

2.2.2 Survey content

The health facility survey includes several modules. An interview with the facility director records information about facility characteristics, services provided, and personnel employed by the facility. Observation modules are organized by room or category to facilitate visits to the rooms where care is provided to patients, the pharmacy, the laboratory, and other areas.

The MRR Module is a format for capturing the data recorded in a patient's medical chart, including from the clinical provider's notes or from malaria testing, notification, or case investigation forms that may be stored with or apart from the record. The MRR is not an interview, but a data collection method where the surveyor reviews the record and transfers the relevant information into the digital form. The questionnaire is filled out once per medical record selected to the sample of suspected malaria cases or to the sample of confirmed malaria cases. The Quotas Module is used to capture information about the manual sample selection process in each facility.

The households selected to the LQAS survey sample are visited and interviewed using a Household Questionnaire. The Household Questionnaire includes a listing of basic demographic information for household members, and collects information on housing characteristics such as type of water source, sanitation facilities, quality of flooring, ownership of durable goods, and ownership and use of mosquito nets. The household questionnaire records knowledge and practices for malaria prevention, as well as history of recent illness for all members of the household. The LQAS survey also includes a summary module filled once per community that includes GPS coordinates of the community (GPS waypoints are not collected at the household level to protect respondent confidentiality) and totals of households visited and surveyed.

2.2.3 Training and supervision of data collectors

IHME led training sessions and pilot surveys in health facilities and households in Belize between October 1 and October 7, 2019. The local agency contracted for data collection in Belize, UNIMER, hired two doctors, one nurse, four community personnel and two field supervisors who we trained to conduct surveys in households and health facilities and to review medical records. The training included content of each survey, proper conduct of the survey, in-depth review of the instrument, and hands-on training on the CAPI software, as well as interview practice among participants. Surveyors participated in a two-day pilot where they applied the health facility questionnaire, conducted observation exercises, and practiced medical record sampling and review for suspected and confirmed cases of malaria, as well as household sample selection and interviews. Representatives from IHME, IDB, and the Belize Ministry of Health provided oversight during pilot exercises. IHME and UNIMER held debriefing and re-training sessions with surveyors post-pilot and provided continued training during the first week of data collection in communities and health facilities. UNIMER continued providing retraining throughout data collection to maintain homogeneity and quality standards of the data collection teams over time. During the data collection launch from October 8-11, 2019, an IHME staff member observed active household and health facility data collection and provided feedback to data collectors.

2.2.4 Data analysis and report writing

IHME conducted data analysis using STATA versions 14 and 15 and R versions 3 and 4. This report provides data summaries for the baseline measurement in health facilities and households in Belize. The estimates from the household surveys are weighted by the inverse probability of selection (see details in Appendix C) and account for clustering in variance calculations, except where explicitly noted otherwise. IHME calculated RMEI indicators in accordance with the Indicator Manual provided by IDB and previously negotiated with the Belize Ministry of Health.

2.2.5 Ethical considerations

The study received authorization from by the Belize Ministry of Health to conduct data collection in health facilities and by local authorities to collect data in communities. While data collection in general was approved by the Belize Ministry of Health for all interviewers, only three medical professionals were granted special usernames and access to the Belize Health Information System (BHIS) for medical record review. The study was approved, receiving non-human subjects research determination by the Institutional Review Board of the University of Washington given that no personally identifiable information was collected as a part of any of the survey modules. All respondents to the household survey, and the senior responsible staff member at participating health facilities, signed informed consent forms prior to data collection. Signed consent forms were collected and managed by UNIMER, the in-country data collection partner, and this information was not transmitted to IHME for privacy reasons.

Chapter 3: Malaria Knowledge, Attitudes, and Practices in Household Survey

This chapter provides a descriptive summary of basic demographic, socioeconomic, and environmental characteristics, as well as knowledge and behaviors for malaria prevention, of the households interviewed for the RMEI-Belize Baseline LQAS Survey in households. All estimates reported in this chapter are weighted by the inverse probability of selection (see details in Appendix C) and account for clustering in variance calculations, except where otherwise noted. For this reason, many proportions reported are not equal to the ratio of numerator to denominator.

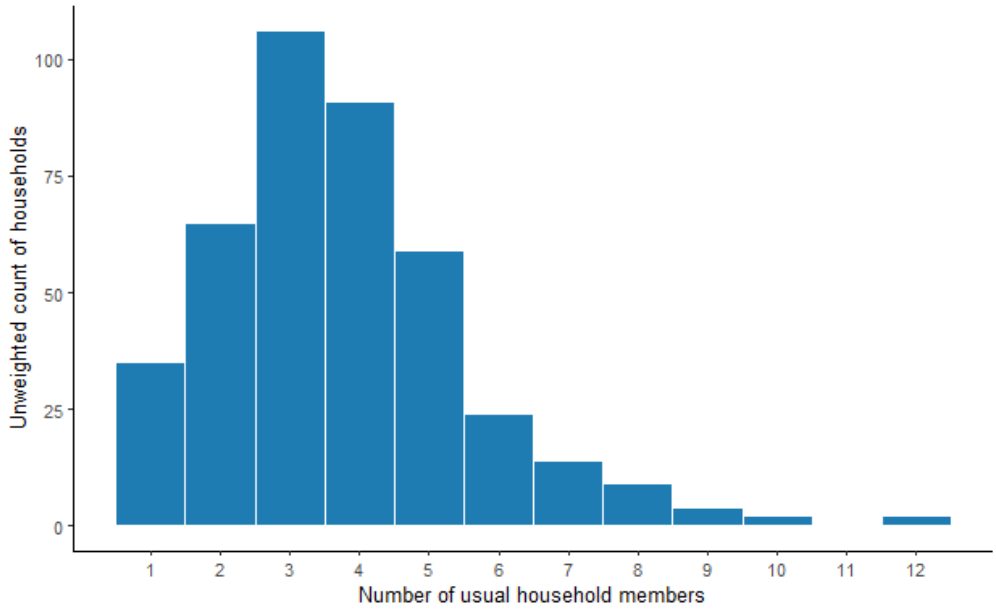
3.1 Characteristics of participating households

This section includes results for composition of surveyed households, physical characteristics of dwellings they inhabit, household assets, and proximity to health facilities.

3.1.1 Household composition and household member characteristics

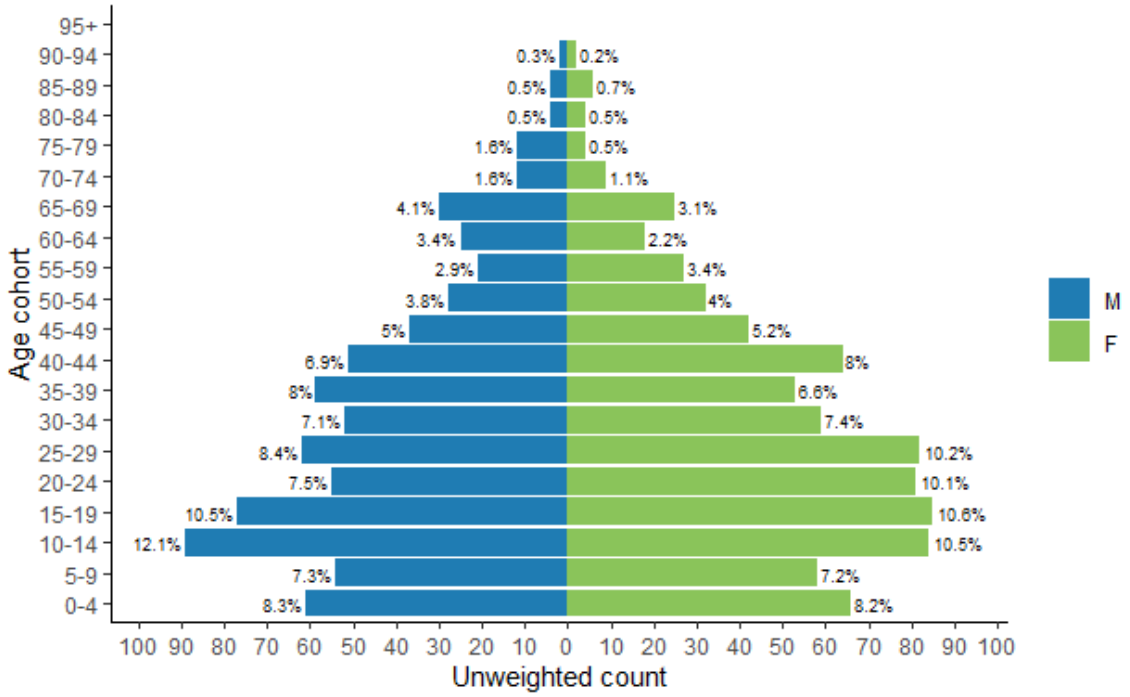
A total of 411 households in the Belize baseline survey completed the interview. The unweighted distribution of the number of members by household is shown in Figure 3.1. The survey sample for Belize has a median household size of 3 and an unweighted average household size of 3.7.

Figure 3.1: Household size, unweighted percent distribution



The unweighted distribution of the de facto household population in the surveyed households in Belize by five-year age groups and by sex is shown in Figure 3.2. Belize has a larger proportion of its population in the younger age groups than in the older age groups. Figure 3.2 indicates that in the baseline, 27% of the population in the baseline is under age 15 years, more than half (66%) of the population is in the economically productive age range (15-64), and the remaining 7% is age 65 and above.

Figure 3.2: Age and sex of household sample, unweighted percent distribution of usual members by 5-year age groups



The respondent was asked to indicate education level and languages spoken for all usual household members aged 15 or older. Respondents could indicate multiple languages spoken. The results are shown in Table 3.1 and Table 3.2, respectively. In Belize, 8.1% of household members had no formal schooling, and 45.7% completed only primary education. Eighty-four percent speak English and 77.4% speak Spanish.

Table 3.1: Education of household members age 15 and older

	N	n	%	95% CI
Education level of household members age 15 and older				
No schooling or pre-school only	1124	92	8.1	(6 - 12)
Primary	1124	540	45.7	(40 - 52)
Secondary	1124	334	30.9	(27 - 35)
University	1124	133	12.9	(10 - 17)
Specialty	1124	3	0.3	(0 - 1)
Masters	1124	3	0.3	(0 - 1)
Don't know	1124	16	1.5	(1 - 3)
Decline to respond	1124	3	0.3	(0 - 2)

Table 3.2: Languages spoken by household members age 15 and older

	N	n	%	95% CI
Languages spoken by household members age 15 and older				
English	1124	969	84	(77 - 89)
Spanish	1124	796	77.4	(57 - 90)
Mayan	1124	276	21.6	(9 - 44)
Creole	1124	256	20.6	(10 - 39)
Garifuna	1124	66	2.9	(0 - 16)

	N	n	%	95% CI
French	1124	3	0.2	(0 - 1)
German	1124	1	0.1	(0 - 1)
Other	1124	1	0.2	(0 - 1)

3.1.2 Dwelling characteristics

The quality of building materials used in houses is related to malaria protection for those living within. Dwellings that offer more protection have no slits or gaps where mosquitoes can enter, glassed or screened-in windows, and closed eaves. Field personnel observed building materials as a part of the survey. In Belize, as seen in Table 3.3, Table 3.4, and Table 3.5, most homes are built with walls of cement block, sheet metal (zinc/alucin) roofs, and cement brick or tile floors.

Table 3.3: Exterior wall material as observed

	N	n	%	95% CI
Main material of exterior walls of dwelling				
Cement block	411	269	69.3	(59 - 78)
Cane/palm/trunks	411	45	8	(4 - 14)
Polished wood	411	35	7.7	(4 - 14)
Plywood	411	26	6.5	(4 - 11)
Palm/bamboo	411	19	3.9	(1 - 10)
“Tejamanil”/wood shingle	411	10	2.5	(1 - 6)
Stone with lime/cement	411	2	0.5	(0 - 2)
Brick/covered adobe	411	1	0.3	(0 - 2)
Other	411	4	1.3	(1 - 3)

Table 3.4: Roofing material as observed

	N	n	%	95% CI
Main material of roof of dwelling				
Sheet metal (zinc/Alucin)	411	243	62	(53 - 70)
Thatch/palm leaf/cane	411	77	15.1	(7 - 30)
Concrete	411	57	14	(10 - 18)
Cement fiber/asbestos sheet	411	18	5.1	(3 - 10)
Wood planks	411	12	3.1	(1 - 6)
Clay tile	411	2	0.4	(0 - 2)
Cement tile	411	1	0.1	(0 - 1)
Other	411	1	0.3	(0 - 2)

Table 3.5: Flooring material as observed

	N	n	%	95% CI
Main material of floor of dwelling				
Cement brick or tile	411	179	46.6	(38 - 55)
Cement sheet/board	411	122	29.3	(21 - 38)
Earth/sand	411	41	8	(5 - 13)
Wood planks	411	27	5.4	(3 - 8)
Ceramic tiles	411	17	5.3	(2 - 12)
Granite/stone	411	12	2.9	(2 - 5)
Parquet or polished wood	411	10	1.9	(1 - 6)
Mud brick	411	1	0.3	(0 - 2)
Other	411	2	0.3	(0 - 2)

Many houses (44.7%) have open roof eaves. Most have no glass in windows (62.7%), screens in windows (50.7%), nor screens in doors (61.2%).

Table 3.6: Open or closed roof eave as observed

	N	n	%	95% CI
Open gap between wall and roof eave	411	190	44.7	(35 - 55)

Table 3.7: Glass in windows as observed

	N	n	%	95% CI
Do windows have glass panes?				
None	411	277	62.7	(48 - 75)
Yes, in all windows	411	97	28.6	(16 - 46)
Yes, but only in some windows	411	33	7.9	(4 - 14)
There are no windows in the house	411	4	0.9	(0 - 3)

Table 3.8: Screens in windows as observed

	N	n	%	95% CI
Do windows have screens?				
None	411	220	50.7	(41 - 60)
Yes, in all windows	411	115	31.9	(23 - 42)
Yes, but only in some windows	411	71	16.3	(11 - 24)
There are no windows in the house	411	5	1.1	(0 - 3)

Table 3.9: Screens in doors as observed

	N	n	%	95% CI
Do doors have screens?				
None	411	272	61.2	(46 - 74)
Yes, in all doors	411	80	24.3	(13 - 40)
Yes, but only in some doors	411	59	14.6	(10 - 21)

Aedes mosquitoes, which spread arboviruses like dengue, zika, and chikungunya, breed in small deposits of water like puddles, flowerpots, and old tires. *Anopheles* mosquitoes, which spread malaria, breed in water bodies like lagoons, rivers, and canals. After the interview, field personnel observed the surroundings of each surveyed dwelling for potential breeding areas. Table 3.10 shows that while 57.8% of homes had clean surroundings without standing water on the day of the survey, 12.2% had natural water bodies within or bordering the yard.

Table 3.10: Maintenance of dwelling surroundings as observed

	N	n	%	95% CI
Status of yard/surroundings of dwelling				
Clean, no trash or standing water	411	227	57.8	(48 - 67)
Trash, tires, or other refuse present, but no standing water	411	65	13.9	(8 - 22)
Yes, pond or other natural water body	411	54	12.2	(8 - 18)
Yes, water collected in trash, tires, or other small containers	411	47	11.2	(9 - 13)
Yes, puddles	411	38	8.5	(5 - 14)
Other	411	6	1.8	(1 - 5)

Table 3.11 shows the principal water source of the household as reported by the respondent; 39.7% of households have water piped to their house. The most common type of sanitation facility is a flush toilet (67.5% of households), as seen in Table 3.12.

Table 3.11: Principal water source

	N	n	%	95% CI
Main source of drinking water				
Piped into dwelling	411	167	39.7	(28 - 52)
Bottled water	411	113	30.1	(19 - 43)
Large jug of purified water	411	63	14.9	(10 - 21)
Rainwater	411	41	10.3	(7 - 15)
Piped to yard/plot	411	13	2.1	(1 - 5)
Protected dug well	411	5	1.3	(0 - 5)
Protected spring	411	2	0.5	(0 - 4)
Public tap/standpipe	411	3	0.4	(0 - 2)
Tube well or borehole	411	1	0.1	(0 - 1)
Unprotected spring	411	1	0.1	(0 - 1)
Other	411	2	0.5	(0 - 2)

Table 3.12: Type of sanitation facility used

	N	n	%	95% CI
Type of toilet used				
Flush toilet	411	265	67.5	(54 - 79)
Pit latrine	411	128	29.2	(19 - 42)
Dry latrine	411	8	1.5	(0 - 7)
Pour flush toilet	411	5	0.8	(0 - 2)
No facility/bush/field	411	4	0.7	(0 - 2)
Hanging latrine	411	1	0.3	(0 - 2)

Each respondent was asked which fuels they usually use for cooking (some households use more than one fuel type), and the results are shown in Table 3.13. Most households do their cooking in the house (Table 3.14).

Table 3.13: Cooking fuel source

	N	n	%	95% CI
Principal cooking fuel				
Gas tank	411	354	88.4	(82 - 93)
Wood	411	134	27.9	(16 - 43)
Electricity	411	14	3.5	(2 - 6)
No food cooked in household	411	4	0.7	(0 - 2)
Charcoal	411	1	0.2	(0 - 2)
Straw/shrubs/grass	411	0	0	(-)
Agricultural crop	411	0	0	(-)
Other	411	0	0	(-)

Table 3.14: Cooking location

	N	n	%	95% CI
Where cooking is done[1]				
In the house	407	352	88.1	(81 - 93)
In a separate building	407	49	10.4	(6 - 17)
Outdoors	407	5	1.3	(1 - 3)
Other	407	1	0.3	(0 - 2)

[1]Cooking location not captured for four households.

3.1.3 Household wealth

Ownership of farmland and livestock, along with possession of durable consumer goods, indicate a household's socioeconomic status. Respondents were asked how many of each listed item the household (or household members) possessed. Table 3.15 and Table 3.16 show the proportion of households with at least one of each item. Many households (94.3%) have electricity. Of the 150 households that own livestock, most own poultry (94.3% of households, as in Table 3.16). Table 3.17 shows the proportion of households with agricultural land.

Table 3.15: Household assets

	N	n	%	95% CI
Electricity	411	380	94.3	(87 - 98)
Radio	411	211	52.9	(47 - 58)
Sound system	411	173	42.6	(34 - 51)
Television	411	304	77.2	(67 - 85)
Home telephone	411	23	6.2	(3 - 12)
Mobile phone	411	369	91.5	(85 - 96)
Refrigerator	411	314	80.1	(69 - 88)
Washing machine	411	279	71.9	(59 - 82)
Computer	411	99	26.4	(19 - 35)
Electric fan	411	351	88.2	(78 - 94)
Air conditioner	411	23	7	(3 - 18)
Watch	409	273	67.8	(60 - 74)
Guitar	411	34	8.3	(5 - 14)
Bike	411	291	67	(55 - 77)
Motorcycle or scooter	411	127	32.1	(23 - 42)
Animal-drawn cart	411	9	2.3	(1 - 5)
Car	411	124	31.5	(23 - 41)
Truck	411	55	13.4	(6 - 26)
Motor boat	411	9	1.8	(1 - 4)
Bank account	395	162	43.1	(33 - 54)

Table 3.16: Livestock ownership

	N	n	%	95% CI
Does this household own any livestock?	411	150	33.3	(23 - 46)
Cattle	150	22	15.6	(7 - 30)
Horses, donkeys or mules	150	23	15.9	(6 - 36)
Goats or sheep	150	11	8.1	(2 - 24)
Chickens or other poultry	150	142	94.3	(90 - 97)
Pigs	150	58	33.8	(24 - 45)

Table 3.17: Ownership of agricultural land

	N	n	%	95% CI
Does any member of the household own, rent, or share agricultural land?				
No	411	291	73	(59 - 83)
Yes, own	411	83	18.8	(11 - 30)
Yes, rent	411	29	6.8	(4 - 11)
Yes, share	411	7	1.3	(1 - 3)
Don't know	411	1	0.1	(0 - 1)

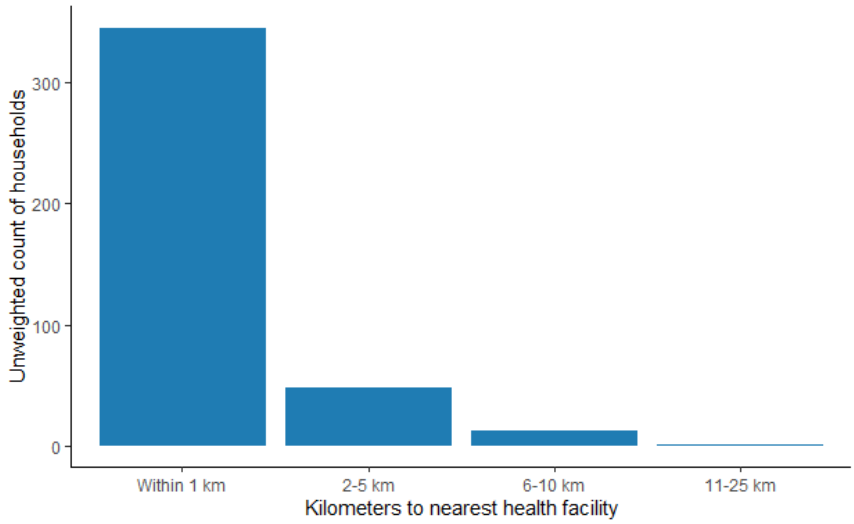
As a part of the interview, respondents estimated their monthly household income (including money earned by all members of the household and received from other sources such as public benefits or remittances). Though some households are hesitant to report their income, the estimates as reported are shown in Table 3.18.

Table 3.18: Monthly household income, all sources

	N	n	%	95% CI
Monthly household income				
Less than 300 Belize dollars	411	34	8.3	(6 - 12)
301 - 600 Belize dollars	411	46	11.4	(8 - 17)
601 - 900 Belize dollars	411	55	13.2	(9 - 18)
901 - 1200 Belize dollars	411	45	9.2	(6 - 14)
1201 - 1500 Belize dollars	411	26	6.8	(5 - 9)
1501 - 1800 Belize dollars	411	27	6.6	(3 - 13)
1801 - 2100 Belize dollars	411	19	5.5	(3 - 11)
2101 - 2400 Belize dollars	411	13	3.8	(2 - 7)
More than 2400 Belize dollars	411	11	3.3	(2 - 6)
Don't know	411	62	14.4	(10 - 20)
Decline to respond	411	73	17.5	(10 - 28)

The interview also asked respondents the distance (km) to the health facility nearest their home. Long distances and travel times to health establishments can discourage households in remote locations from seeking medical care. Figure 3.3 shows the unweighted distribution of distances reported in the survey. The survey sample for Belize has an unweighted average distance of 1 kilometer to the nearest health facility.

Figure 3.3: Distance to nearest health facility, unweighted household count



3.2 Malaria knowledge

Respondents were asked a series of questions to assess their knowledge about malaria causes and prevention strategies. This section summarizes the results.

3.2.1 Disease knowledge

As Table 3.19 shows, most respondents had heard of malaria before (86.5%). Respondents were asked the cause of malaria (Table 3.20) and the mode of transmission of malaria (Table 3.21) and interviewers could register more than one response. Most respondents are aware of the role of mosquitoes in malaria transmission.

Table 3.19: Malaria awareness

	N	n	%	95% CI
Heard of illness called malaria[1]	408	353	86.5	(81 - 91)

[1]Three respondents answered 'do not know' to whether they had heard of malaria.

Table 3.20: Knowledge of cause of malaria

	N	n	%	95% CI
In your opinion, what causes malaria?				
Mosquito bites	353	321	91.3	(88 - 94)
Dirty surroundings	353	20	6	(4 - 10)
Stagnant water	353	15	4.5	(2 - 9)
Anopheles mosquito bite	353	11	3.1	(1 - 7)
Weedy surroundings	353	5	1.3	(1 - 3)
Cold or changing weather	353	3	0.9	(0 - 3)
Contaminated air	353	2	0.9	(0 - 4)
Working in the forest or the fields	353	3	0.7	(0 - 3)
Eating dirty food/drinking dirty water	353	4	0.6	(0 - 2)
Other	353	2	0.4	(0 - 2)
Don't know	353	13	3.6	(2 - 6)

Table 3.21: Knowledge of malaria transmission

	N	n	%	95% CI
How is malaria transmitted?				
By mosquitoes	353	323	92.7	(89 - 95)
Stagnant water	353	15	4.2	(2 - 9)
Eating dirty food/drinking dirty water	353	4	0.8	(0 - 2)
Poor personal hygiene	353	3	0.7	(0 - 3)
Passes from one person to another	353	2	0.4	(0 - 2)
Contaminated air	353	2	0.4	(0 - 2)
Other	353	3	0.6	(0 - 2)
Don't know	353	18	4.4	(3 - 7)

Respondents were also asked the main sign or symptom of malaria and more than one response could be registered (Table 3.22). Many respondents recognize fever as a key symptom. Throughout the question series about malaria knowledge, however, there were some respondents who indicated they did not know how to respond to the questions, as displayed in the tables. Table 3.23 shows the combinations of symptoms that are most common during a malaria illness, which were not commonly reported together by respondents.

Table 3.22: Knowledge of malaria symptoms

	N	n	%	95% CI
Main sign or symptom of malaria known				
Fever	353	318	90.9	(87 - 94)
Body ache or joint pain	353	162	46.2	(34 - 58)
Headache	353	150	44.1	(37 - 52)
Chills	353	127	36.1	(30 - 43)
Nausea and vomiting	353	90	25.5	(18 - 34)
Diarrhea	353	49	14.9	(10 - 22)
Dizziness	353	24	6.9	(4 - 12)
Body weakness	353	22	6.5	(5 - 9)
Loss of appetite	353	18	4.7	(3 - 8)
Cough	353	14	3.9	(2 - 7)
Pale eyes or skin	353	12	3.5	(2 - 8)
Sweating	353	4	1.2	(0 - 4)
Other	353	1	0.1	(0 - 1)
Don't know	353	28	7	(4 - 11)

Table 3.23: Multiple common symptoms of malaria known

	N	n	%	95% CI
Fever and chills	353	125	35.4	(31 - 41)
Fever and sweating	353	4	1.1	(0 - 3)
Fever, chills, and sweating	353	1	0.3	(0 - 2)

Respondents were asked how many people in their own community they knew who had had malaria during the last year. Most did not report to know anyone who had malaria in the last year (Table 3.24).

Table 3.24: Knowledge of community transmission

	N	n	%	95% CI
In your community, during the last year, how many people do you know who had a case of malaria?				
None	353	281	79.1	(76 - 82)
One person	353	37	11.4	(9 - 15)
2-4 people	353	15	4.4	(2 - 8)
5-10 people	353	2	0.6	(0 - 3)
Don't know	353	18	4.5	(3 - 8)

3.2.2 Knowledge of malaria messages

Malaria programs and public health systems carry out education campaigns to help people who live in areas with malaria transmission know how to protect themselves from the disease, and what to do if they become sick. Respondents were asked to list the messages they had heard about malaria in the last year, and interviewers sorted their answers among the available responses in the survey. In all, 47.1% had heard messages about malaria during the last year. Of those who had heard messages, the specific information heard is detailed in Table 3.25.

Next, respondents were asked to indicate whether or not they had heard malaria messages from each source in a list of media. The sources and the proportion of those who had heard messages through each, among respondents who had heard any messages about malaria in the past year, are in Table 3.26.

Table 3.25: Malaria messages heard in last year

	N	n	%	95% CI
Messages seen or heard in last year				
If have fever go to health facility	152	79	57.8	(45 - 70)
Eliminate breeding sites/clean up trash	152	62	39.2	(33 - 46)
Malaria kills	152	13	8.9	(5 - 16)
Sleep under an insecticide-treated mosquito net	152	13	8.4	(4 - 17)
Always test before treating malaria	152	13	7.3	(3 - 18)
Nets are used to protect from mosquitoes	152	7	4.5	(2 - 9)
Sleep under a net every night to protect yourself against malaria	152	5	3.2	(1 - 8)
Anopheles mosquitoes transmit malaria by biting people at night	152	3	2.5	(1 - 7)
Treat malaria with ACTs	152	3	2.2	(1 - 6)
Treatment for severe malaria is available free of charge	152	4	2.2	(1 - 6)
Wash nets only when they are dirty	152	1	1.3	(0 - 7)
Be sure to tuck the borders of the net under the mattress	152	3	1.1	(0 - 5)
Other	152	12	8.1	(5 - 13)
Don't know	152	9	4	(2 - 10)
Decline to respond	152	1	0.6	(0 - 4)

Table 3.26: Source of malaria messages

Source of messages, among those who heard them	N	n	%	95% CI
On the radio	152	62	42.4	(30 - 56)
On TV[1]	151	66	46.8	(29 - 65)
On a poster or billboard	151	32	21.9	(15 - 31)
From a community health worker	152	18	11.3	(6 - 20)
From personnel at a health facility	152	53	32.6	(20 - 48)
At a community event	151	12	8.9	(4 - 18)
At school	150	16	9.2	(4 - 22)
On the internet or social media	152	36	23.1	(15 - 34)
Somewhere else	151	6	4.5	(2 - 11)

[1]Discrepant denominators due to excluded 'do not know' responses.

3.2.3 Knowledge of community resources

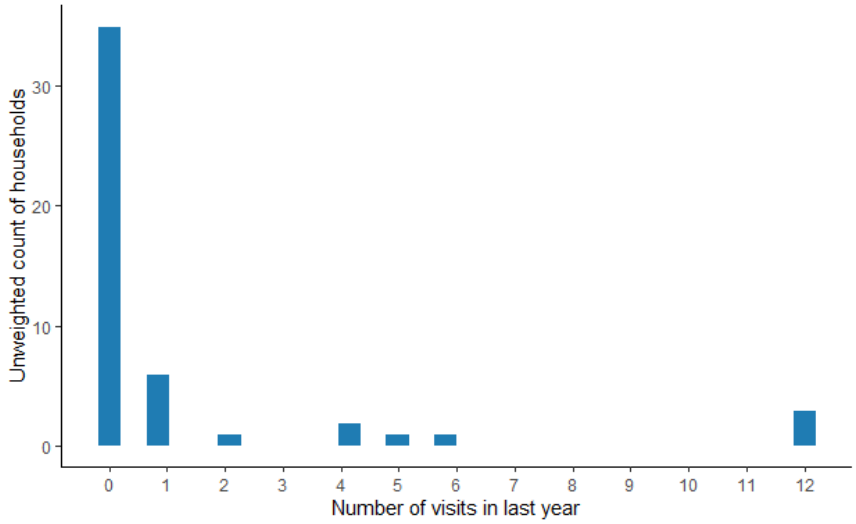
A key component of malaria detection in many regions in Belize is the volunteer collaborator program. Volunteer collaborators, or “col-vols”, are community members who are trained to carry out malaria detection activities such as screening, taking blood samples for thick blood film tests, and referring patients to health facilities or to community-based vector control technicians. They also sometimes oversee malaria treatment after a malaria case has been confirmed. In the Belize baseline survey, 14.9% of households know of a col-vol in their community. Of those who knew of a col-vol, 25.5% reported receiving a home visit by that volunteer during the year before the date of the survey (Table 3.27). The number of visits received from the col-vol is shown in Figure 3.4.

Table 3.27: Knowledge of col-vols

	N	n	%	95% CI
Know of col-vol in own community[1]	355	51	14.9	(10 - 22)
Visited by col-vol in last year[2]	49	14	25.5	(11 - 48)

[1]56 households responded that they 'do not know' of col-vols in the community.
[2]Two households responded that they 'do not know' of col-vol visit in last year.

Figure 3.4: Number of visits from col-vols in last year



Malaria testing and treatment is provided free of charge through the Ministry of Health in Belize, and 78.7% of respondents are aware of this benefit (Table 3.28). Because cost and knowledge of where services are available may be barriers to seeking care, the survey asked respondents where someone could access testing and treatment. Respondents could indicate multiple health facility types they knew provided the service, and interviewers classified them according to the options in the survey. A majority of households knew that they could seek malaria care at public hospitals (Table 3.29, Table 3.30).

Table 3.28: Knowledge of free-of-cost malaria healthcare

	N	n	%	95% CI
Aware malaria diagnosis and treatment are provided free by the government[1]	325	254	78.7	(73 - 84)

[1]28 households responded 'do not know' regarding knowledge of free malaria healthcare.

Table 3.29: Knowledge of where to go for malaria testing

	N	n	%	95% CI
Where can someone go to be tested for malaria?				
Public Sector: Government hospital	353	285	81.7	(73 - 88)
Public Sector: Government primary level health center	353	76	20.3	(13 - 31)
Private medical sector: Private doctor	353	25	7.4	(3 - 17)
Private medical sector: Private hospital/clinic	353	16	5.2	(3 - 10)
Public Sector: Fieldworker/Community Health Worker	353	6	1.8	(1 - 5)
Public Sector: mobile clinic	353	2	0.9	(0 - 3)
Private medical sector: mobile clinic	353	1	0.6	(0 - 4)
Other	353	1	0.3	(0 - 2)
Don't know	353	11	2.6	(1 - 5)

Table 3.30: Knowledge of where to go for malaria treatment

	N	n	%	95% CI
Where can someone receive treatment for malaria?				
Public Sector: Government hospital	336	296	89.5	(84 - 93)
Public Sector: Government primary level health center	336	58	16.3	(10 - 26)
Private medical sector: Private doctor	336	35	10.5	(5 - 21)
Private medical sector: Private hospital/clinic	336	18	5	(2 - 11)
Public Sector: Fieldworker/Community Health Worker	336	4	1	(0 - 3)
Public Sector: mobile clinic	336	2	0.9	(0 - 4)
Private medical sector: Pharmacy	336	2	0.6	(0 - 3)
Private medical sector: mobile clinic	336	1	0.6	(0 - 4)
Traditional healer	336	2	0.6	(0 - 2)
Other	336	1	0.1	(0 - 1)
Don't know	336	5	1	(0 - 3)

3.3 Risk factors for malaria

Certain lifestyles, professions, and living conditions raise an individual's risk for malaria infection. Traveling may expose people to infection if they move from an area with relatively less malaria transmission, to an area with more transmission. Travel by individuals also raises the risk that malaria transmission could be re-introduced to receptive areas where it has been interrupted. Some households reported members who migrated for work (Table 3.31). Among individuals in surveyed households, 16.6% reported travel outside the community in the last two weeks (Table 3.32). According to respondents, most household members did not participate in any of the risk activities listed in Table 3.33 in the two months prior to the survey.

Table 3.31: Temporal migration within surveyed households

	N	n	%	95% CI
At least one member migrates seasonally	411	79	20.5	(14 - 29)
At least one member migrates weekly	411	55	13.1	(8 - 22)

Table 3.32: Recent travel by individuals in surveyed households

	N	n	%	95% CI
Individual traveled outside community in last 2 weeks[1]	1532	235	16.6	(11 - 24)

[1]Four people responded 'do not know' to recent travel.

Table 3.33: Exposure to risky activities by individuals in surveyed households

	N	n	%	95% CI
Individuals participating in malaria risk activities				
None of these	1536	1265	83.9	(76 - 89)
Cultivating crops or working in the fields	1536	186	11.1	(7 - 18)
Gathering firewood in the forest	1536	105	5.9	(3 - 12)
Sleeping outdoors overnight	1536	17	1.2	(1 - 3)
Producing charcoal	1536	16	0.9	(0 - 5)
Working in timber/lumber industries in the forest	1536	6	0.4	(0 - 1)
Collecting shellfish	1536	4	0.1	(0 - 1)
Working in a mine	1536	1	0	(-)
Don't know	1536	7	0.4	(0 - 1)

Respondents were also asked what can be done to protect against malaria (Table 3.34), and what practices they follow in their own households (Table 3.35). The respondent replied in free form, and the interviewer classified the answers according to the options in the survey. The responses again show evidence of some conflation of malaria prevention measures with arbovirus prevention measures, though many responses also referred to use of repellents that protect against all mosquito vectors. Only 3.3% of households said they do not use any malaria prevention measures at home.

Table 3.34: Protective measures known by household

	N	n	%	95% CI
Methods known to protect against malaria				
Use mosquito coils	335	108	31.1	(24 - 40)
Eliminate mosquito breeding areas (tires, bottles, or others)	335	92	28.4	(22 - 36)
Avoid mosquito bites	335	87	25.8	(20 - 33)
Use insect repellent	335	71	21.8	(17 - 28)
Fumigate or spray house with insecticides	335	50	16.4	(10 - 26)
Keep house surroundings clean	335	43	13.9	(10 - 19)
Put mosquito screens on the windows	335	45	13.4	(10 - 17)
Sleep under a mosquito net	335	33	9.4	(5 - 17)
Cut the grass around the house	335	30	9.3	(6 - 13)
Can't be prevented	335	30	8.5	(5 - 16)
Fill in puddles (stagnant water)	335	18	6.1	(4 - 10)
Clean water storage tanks with bleach	335	14	4.2	(2 - 8)
Add bleach temephos (Abate) to the water tank	335	7	2.1	(1 - 4)
Sleep under an insecticide-treated mosquito net	335	7	2	(1 - 5)
Take preventive medication	335	2	0.4	(0 - 2)
Other	335	4	1.1	(0 - 3)
Don't know	335	7	2.2	(1 - 5)

Table 3.35: Protective measures used by household

	N	n	%	95% CI
Primary methods used in household to protect against malaria				
Use mosquito coils	335	173	49.3	(40 - 59)
Eliminate mosquito breeding areas (tires, bottles, or others)	335	125	38.2	(30 - 47)
Fumigate or spray house with insecticides	335	60	19.5	(12 - 30)
Use insect repellent	335	54	17.4	(14 - 22)
Avoid mosquito bites	335	46	15.3	(11 - 21)
Cut the grass around the house	335	39	12.1	(8 - 19)
Keep house surroundings clean	335	39	11.8	(8 - 18)
Put mosquito screens on the windows	335	28	9.4	(6 - 15)
Fill in puddles (stagnant water)	335	17	5.9	(3 - 10)
Sleep under a mosquito net	335	21	5.8	(3 - 11)
Clean water storage tanks with bleach	335	15	4	(2 - 8)
Does nothing to protect from malaria	335	11	3.3	(2 - 6)
Add bleach or temephos (Abate) to the water tank	335	4	1.4	(1 - 4)
Take preventive medication	335	1	0.3	(0 - 2)
Sleep under an insecticide-treated mosquito net	335	1	0.1	(0 - 1)
Organize community cleaning work days	335	0	0	(-)
Other	335	8	2.1	(1 - 5)
Don't know	335	3	0.8	(0 - 3)

Chapter 4: Vector control activities

This chapter provides a descriptive summary of vector control measures used in the households selected for the RMEI-Belize Baseline LQAS Survey. All estimates reported in this chapter are weighted by the inverse probability of selection (see details in Appendix C) and account for clustering in variance calculations, except where otherwise noted. For this reason, many proportions reported are not equal to the ratio of numerator to denominator.

4.1 Vector control measures carried out in Belize households

Vector control plans in Belize included offering IRS and ITN measures to households in various communities in malaria strata 3 and 4. The interventions are usually planned for each year as a part of the annual malaria strategy with input from local and central level vector control technicians and funding partners. Interventions are planned and budgeted to cover a full community at the same time, with a set goal for acceptance or uptake rate. Intervention plans can sometimes be dynamic to malaria transmission, for example in the case of reactive measures to a confirmed case.

In Belize, the community sample was designed to capture data from one community associated with each of 16 primary care facilities with vector control measures implemented during 2019. Health facilities were listed for selection to the sample based on whether interventions were carried out in the communities in their service area according to data received from the central-level Ministry of Health. According to these data, twelve communities should have received IRS and three communities should have received both IRS and ITN interventions. In total, fifteen communities with planned vector control interventions were selected for the LQAS survey. The sixteenth community in the original sample also received interventions according to the central-level data received, however the facility associated with this community was replaced for logistical reasons as described in chapter 2. The community associated with this replacement facility had no vector control interventions listed in the central-level data.

4.2 Mosquito net use

As a part of the interview, respondents were asked how many mosquito nets their household owns. Then, for each net reported, the interviewer requested to observe the net (noting the brand and condition in the survey) and went through a series of questions about each net, including where it came from, how it is cared for, and who used the net the previous night. In the case that the respondent declined to show the net, questions on net brand and condition were asked to the respondent directly.

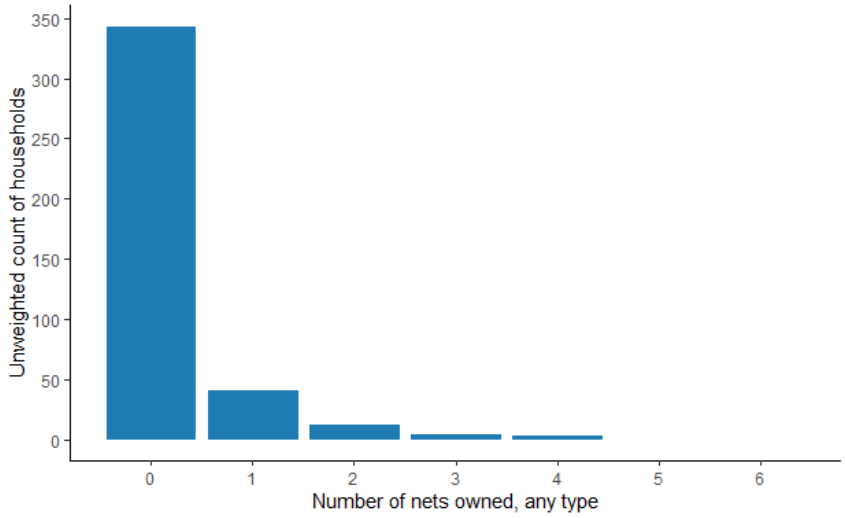
4.2.1 Ownership of nets by surveyed households

As Table 4.1 shows, 16.5% of households own at least one treated or untreated mosquito net. The number of nets owned (regardless of type) is shown in Figure 4.1.

Table 4.1: Ownership of mosquito nets by households

	N	n	%	95% CI
Households with at least one mosquito net	411	67	16.5	(11 - 24)

Figure 4.1: Number of nets owned by households, unweighted count



Respondents were asked where they obtained each mosquito net. As shown in Table 4.2, most nets treated with insecticide were obtained from health personnel, in a facility or in the community. Most untreated nets were purchased in a store (91%, in Table 4.3).

Table 4.2: Source of insecticide-treated nets

	N	n	%	95% CI
Source of net				
Vector control or malaria program	24	17	70.8	(50 - 86)
Government health facility	24	7	29.2	(14 - 50)

Table 4.3: Source of untreated nets

	N	n	%	95% CI
Source of net				
Shop/market	89	81	91	(83 - 95)
Gifted from friend/family/acquaintance	89	5	5.6	(2 - 13)
Home-made	89	2	2.2	(1 - 9)
Don't know	89	1	1.1	(0 - 8)

In addition to the insecticide treatment wearing off after a period of years, the fabric of mosquito nets also deteriorates over time and is prone to damage. A net with holes, especially large holes, does not protect as well as an intact net. The condition of nets observed directly by field personnel is shown in Table 4.4, and the condition of nets that respondents declined to show to field personnel is shown in Table 4.5.

Table 4.4: Condition of observed nets

	N	n	%	95% CI
Condition of mosquito net as observed				
No holes	48	42	87.5	(75 - 94)
Only thumb-sized holes	48	5	10.4	(4 - 23)
Net never used	48	1	2.1	(0 - 14)

Table 4.5: Reported condition of nets not observed

	N	n	%	95% CI
Condition of mosquito net as reported				
No holes	65	49	75.4	(63 - 84)
Only thumb-sized holes	65	12	18.5	(11 - 30)
Net never used	65	3	4.6	(1 - 14)
Don't know	65	1	1.5	(0 - 10)

Insecticide-treated nets should be washed infrequently, and should not be dried in direct sunlight, which goes against common housekeeping practices in the region. Figure 4.2 shows how many times insecticide-treated nets have been washed since acquired (if more than 20 times, 20 is indicated). Table 4.6 shows how the respondent reported drying each net after washing.

Figure 4.2: Care of insecticide-treated nets - washing (unweighted count)

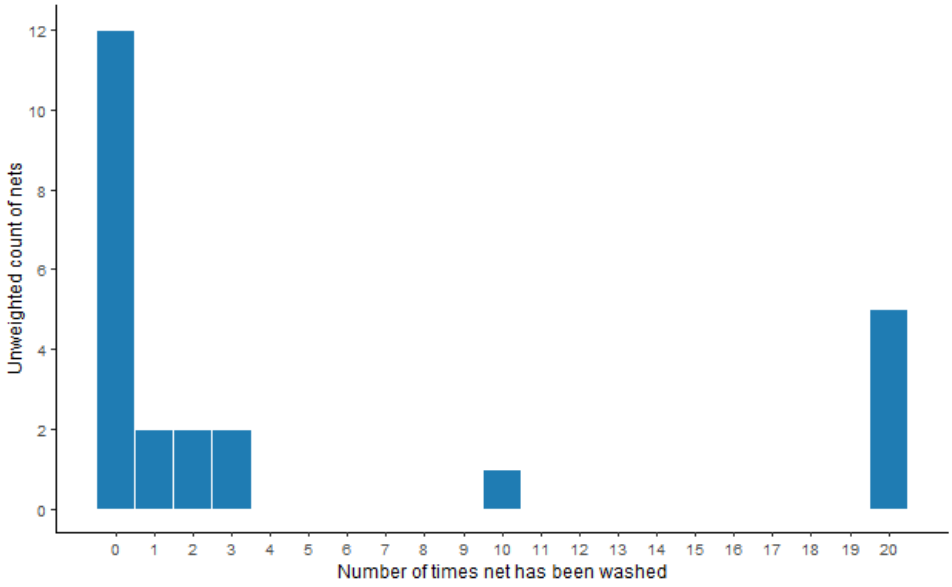


Table 4.6: Care of insecticide-treated nets - drying

	N	n	%	95% CI
Method of drying net				
In the shade	12	5	41.7	(18 - 70)
In the sun	12	4	33.3	(13 - 63)
Indoors	12	3	25	(8 - 56)
In a dryer	12	0	0	(-)

4.2.2 Use of nets by individuals in surveyed households

In order for the household to be fully protected, all household members should sleep under an insecticide-treated net for the entire night. Table 4.7 shows the reported use of nets on the night prior to the survey. Among all usual household members who slept in the house the previous night, 0.4% were reported to have slept under a mosquito net treated with insecticide. Among children under age 5 who were usual members of the household and slept there the previous night, 1.1% were reported to have slept under a net treated with insecticide.

Table 4.7: Use of net for sleeping previous night

	N	n	%	95% CI
Total				
Slept under treated net	1488	15	0.4	(0 - 2)
Slept under untreated net	1488	145	10.5	(6 - 18)
Under 5				
Slept under treated net	125	2	1.1	(0 - 6)
Slept under untreated net	125	31	24	(14 - 38)
Pregnant				
Slept under treated net	17	0	0	(-)
Slept under untreated net	17	0	0	(-)
Reported usually sleeping under net during pregnancy	17	0	0	(-)

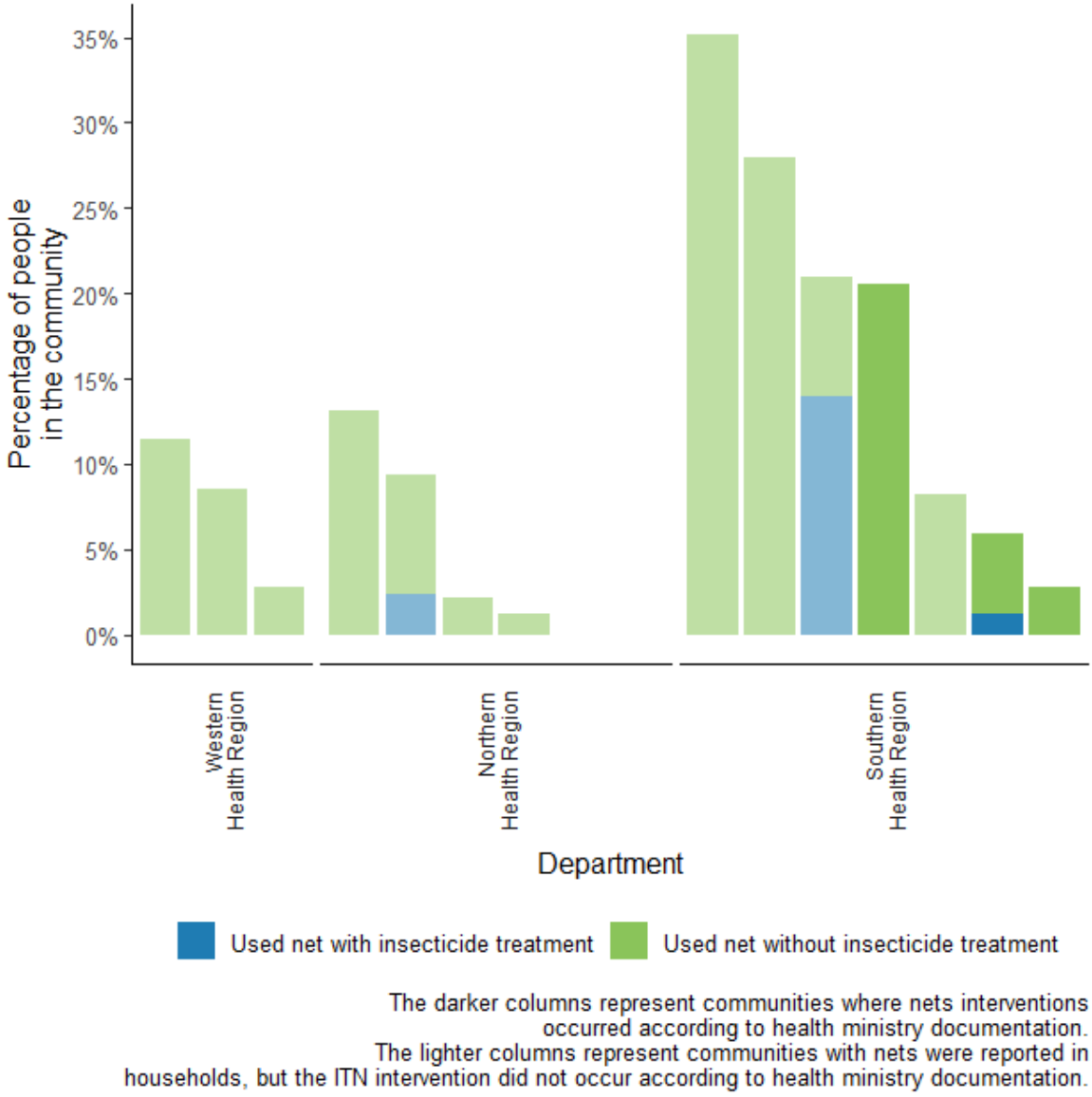
When households had nets that were not used the previous night, or reported that not all household members slept under a net, they were asked why they do not sleep under a mosquito net. The reasons given are shown in Table 4.8. Most frequently, households reported they did not have enough mosquito nets for all members to use or that it was too hot to sleep under a net.

Table 4.8: Reasons for not using net

	N	n	%	95% CI
Reasons for not sleeping under mosquito net				
Don't have enough nets	41	14	34.2	(19 - 53)
Too hot	41	10	23.8	(12 - 41)
Net too expensive	41	4	9.3	(4 - 20)
It is bad for the skin, it causes irritation	41	3	6.7	(2 - 18)
Not necessary, using fan instead	41	2	5.4	(2 - 17)
Saving net for later	41	3	4.2	(1 - 17)
No mosquitoes	41	1	2.8	(0 - 16)
Feel closed in/afraid	41	1	2.8	(0 - 16)
Net too small	41	1	2.8	(0 - 16)
Sleep in a hammock and available mosquito nets do not work	41	1	2.8	(0 - 19)
Other	41	2	8	(2 - 33)
Don't know	41	4	10.9	(4 - 29)

Figure 4.3 shows by health region the proportion of individuals who slept in the household the previous night using a mosquito net in each of the communities surveyed. The communities expected to receive the net intervention are highlighted in darker colors. In Belize, the communities that received the net intervention, according to local vector control staff at the corresponding health facility in the sample, had more insecticide-treated net use than the communities that did not receive the intervention. Untreated net use is notable in some communities. The baseline measurement was not designed to produce representative estimates at the health region level, so results by region should be interpreted with discretion.

Figure 4.3: Net use by department and community



4.3 Indoor Residual Spraying

The other key vector control intervention of the Initiative is to offer to spray the interior walls of the dwelling against mosquitoes (usually with deltamethrin or a comparable insecticide). Insecticide application is usually carried out by staff or contractors of the vector control program every 4 to 6 months during the intervention time frame. The interviewer asked respondents if their household had been offered insecticide application to the interior of the dwelling during the last year. As seen in Table 4.9, 28.6% of households were offered IRS, and spraying was carried out in 94.6% of the households where it was offered. The interviewer also asked to see evidence of the most recent spray application, such as a sticker, house card, or chalk mark left by the vector control personnel. Such evidence was observed in only 26% of households that received IRS.

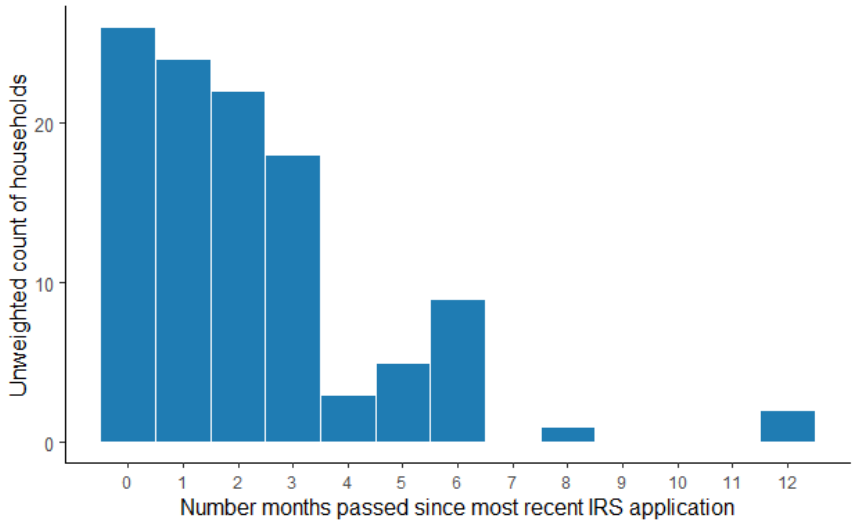
Table 4.9: Households offered and accepting spraying

	N	n	%	95% CI
Offered indoor residual spraying[1]	408	118	28.6	(21 - 38)
Indoor residual spraying conducted[2]	117	111	94.6	(84 - 98)
Evidence observed (card, sticker, mark)	111	29	26	(16 - 40)

[1]Three heads of household responded 'do not know' to whether IRS was offered.
[2]One head of household responded 'do not know' to whether IRS was conducted.

Respondents were asked how long ago the most recent spraying occurred. The results in Figure 4.4 suggest that spraying is carried out at least every six months in most cases.

Figure 4.4: Number of months since most recent spraying occurred



Respondents who were offered IRS, but whose house was not sprayed (an uncommon circumstance), were asked why the spraying was not carried out. The results are shown in Table 4.10.

Table 4.10: Reasons for not accepting spraying

	N	n	%	95% CI
Reason house was not sprayed				
Spraying only occurred outside / in the yard	6	2	32.1	(4 - 85)
No one was at home	6	1	16.7	(2 - 63)
Dangerous for children	6	1	16.7	(2 - 63)
Don't know	6	2	34.6	(3 - 89)

Households receiving IRS were asked whether they washed, painted, or plastered any walls since the most recent application (which diminishes the effectiveness of the insecticide), as shown in Table 4.11.

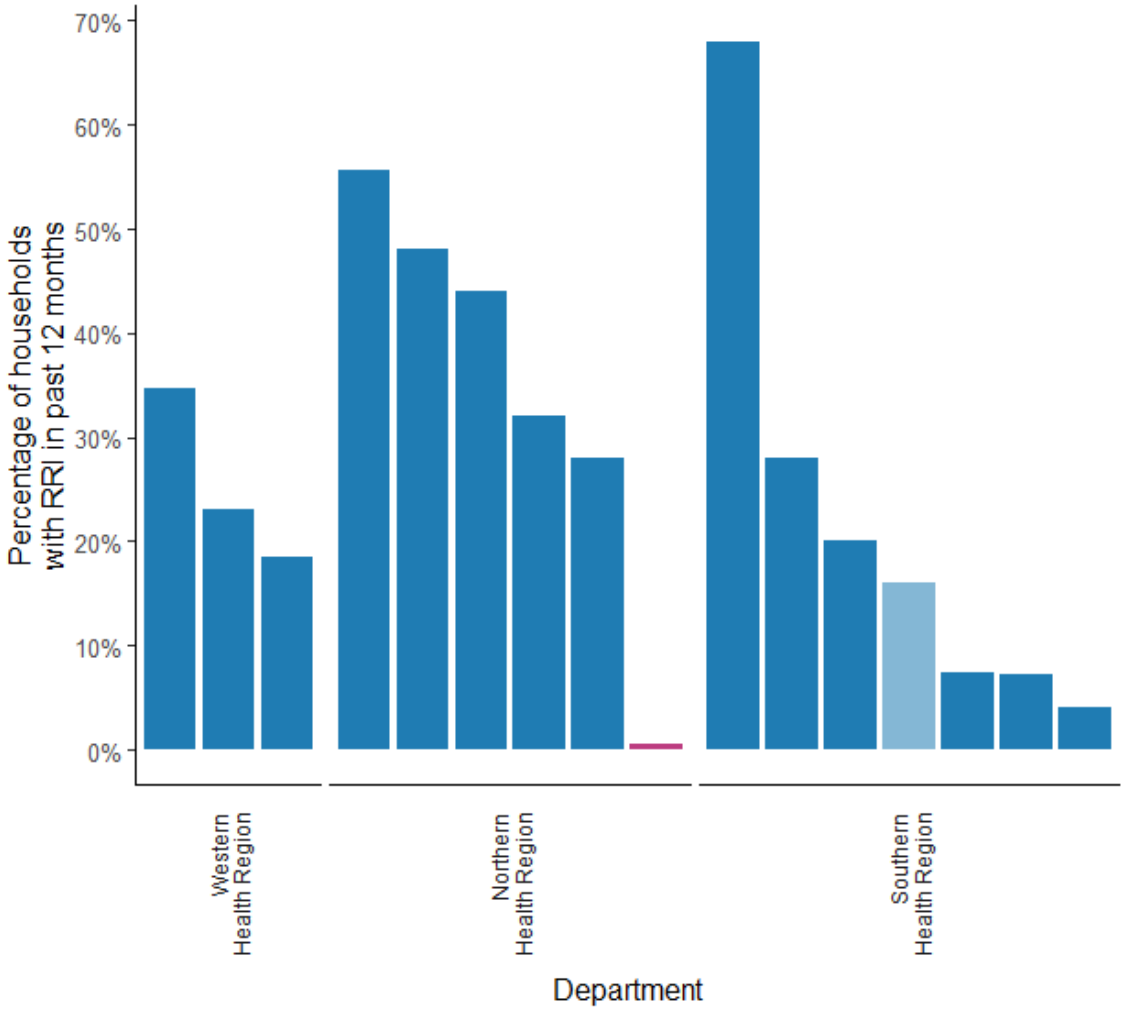
Table 4.11: Post-spraying practices

	N	n	%	95% CI
Walls painted since last IRS[1]	110	3	3	(1 - 12)
Walls washed since last IRS[2]	110	2	1.3	(0 - 7)
Walls plastered since last IRS[3]	109	1	1	(0 - 8)

[1]One head of household responded 'do not know' to whether walls were painted.
[2]One head of household responded 'do not know' to whether walls were washed.
[3]Two heads of household responded 'do not know' to whether walls were plastered.

Figure 4.5 shows by health region the proportion of households that received IRS in each of the communities surveyed. The communities expected to receive the IRS intervention according to health ministry documentation are highlighted in darker colors. In general, IRS is more widespread in Belize communities than net use, as indicated by the vector control program documentation. However, IRS coverage was above 50% in only two communities.

Figure 4.5: Indoor residual spraying by department and community



Darker columns represent communities where IRS occurred according to health ministry documentation.
Lighter columns represent communities with IRS reported in households, but the IRS intervention did not occur according to health ministry documentation.
Communities with no IRS reported in households are shown in red.

4.4 Indicator 6.01: Vector control coverage

Individual-level coverage by one of the two interventions was negotiated as an indicator for RMEI. The indicator is measured on the subset of usual household members who slept in the house the night prior to the survey (because net use is measured for the night prior to the survey) in the communities identified at the local level as targeted for vector control interventions. Individuals are considered covered if they slept under an insecticide-treated net the previous night, or if their home had indoor residual spraying applied within the last 12 months, regardless of which intervention was planned for the community where they reside (there was evidence of both types of interventions in many target communities, as seen in Table

4.12). Table 4.13 shows the indicator results, with 27.9% of individual usual household members in target communities covered by one of the two interventions. The breakdown of the indicator by district is shown in Table 4.14.

Table 4.12: Vector control received by reported intervention

Vector control expected	Communities	Used treated net	House sprayed
IRS	12	1.2%	31%
Both	3	0.4%	16.4%
None	1	0%	16.3%

Table 4.13: Vector control indicator

	N	n	%	95% CI
Usual household members in vector control communities who slept in house last night	1448	1390	95.9	(95 - 97)
Slept under insecticide treated net	1390	15	0.5	(0 - 2)
House sprayed with mosquito treatment past 12 months	1367	385	27.7	(20 - 37)
Omitted from household spraying calculations due to 'do not know' responses	1390	23	1.8	(1 - 5)
Received either vector control to standard	1367	388	27.9	(20 - 38)

Table 4.14: Vector control indicator: result by district

	N	n	%	95% CI
Received either vector control to standard				
Cayo	291	81	27	(21 - 34)
Corozal	253	66	32.2	(18 - 50)
Orange Walk	271	118	43.4	(29 - 59)
Stann Creek	187	31	22.1	(10 - 43)
Toledo	365	92	15	(6 - 33)
Total	1367	388	27.9	(20 - 38)

Chapter 5: Malaria Diagnostic Capacity

This chapter provides a descriptive summary of the health facilities surveyed for the RMEI-Belize Baseline Heath Facility Survey and the malaria diagnostic services they provide.

5.1 Characteristics of health facility sample

As previously described, the health facility sample consisted of 23 primary care facilities and polyclinics and 7 hospitals (Table 5.1). In Belize, vector control offices manage local malaria reporting and vector control programming and are responsible for managing stock of antimalarial medications. These vector control offices are located at seven of the regional hospitals, community hospitals, and district polyclinics in the sample. While these hospitals and adjacent vector control offices were sampled as one unit, the procedures and administrative offices were found to function independently, and are therefore reported separately in the following chapters when necessary. The national malaria reference laboratory is located at the Southern Regional Hospital (included in the sample), so its operations are captured by responses from the hospital or the connected vector control office, when applicable. It is important to note that any content about services provided by health facilities will exclude the vector control offices from the analysis unless explicitly stated.

Table 5.1: Health facility survey sample by facility type

Facility Type	#
Primary care facilities / polyclinics	23
Hospitals	7
Vector control offices	7
Total	37

The health facility interview includes questions about services provided in the facility as summarized in this chapter. The facility director or other responsible party (e.g., the head doctor in an ambulatory facility, the administrative or medical director of a hospital) answers the survey. When conducting the survey, interviewers are trained to emphasize that all questions need not be answered by a single respondent and encourage the primary respondent to invite colleagues who know the topic best to contribute to answering for each section (e.g., human resources personnel, head of nursing, laboratory staff).

Table 5.2 shows the basic primary care services provided by health facilities in the sample. Provision of commonly-demanded health services is likely to influence people's familiarity and confidence to seek care at a local health facility when they experience symptoms of a febrile illness like malaria.

Table 5.2: Primary care services provided

	N	n	%	95% CI
Child care	30	28	93.3	(76 - 98)
Child immunization services	30	26	86.7	(68 - 95)
Family planning services	30	28	93.3	(76 - 98)
Pregnancy testing	30	28	93.3	(76 - 98)
Antenatal care	30	26	86.7	(68 - 95)

Nearly all attention facilities in the sample provided services from Monday through Friday. A smaller number were open on the weekends (Table 5.3). Thirty percent of facilities had services open 24 hours (Table 5.4).

Table 5.3: Workweek of facility

	N	n	%	95% CI
Days of the week service is provided				
Monday	30	29	96.7	(78 - 100)
Tuesday	30	30	100	(-)
Wednesday	30	28	93.3	(76 - 98)
Thursday	30	30	100	(-)
Friday	30	27	90	(72 - 97)
Saturday	30	10	33.3	(18 - 53)
Sunday	30	9	30	(16 - 49)

Table 5.4: Hours of operation

	N	n	%	95% CI
Hours of operation				
Open less than 24 hours	30	21	70	(51 - 84)
Open 24 hours	30	9	30	(16 - 49)

Survey respondents indicated the type and number of personnel employed at the health facility, including primary care facilities, polyclinics, and hospitals. Table 5.5 shows the proportion of facilities that employ at least one of each personnel type. Physicians are employed at 80% of facilities. In terms of laboratory diagnosis, microbiologists are employed at only 3.3% and lab technicians at 36.7% of facilities. Only 10% of health facilities employ epidemiology personnel, and 26.7% employ other statistics personnel, important functions for malaria notification and reporting.

Table 5.5: Facility personnel

	N	n	%	95% CI
Primary care facilities, polyclinics, and hospitals				
General physician	30	24	80	(61 - 91)
Pediatrician	30	9	30	(16 - 49)
Nutritionist /dietician	30	8	26.7	(13 - 46)
Pharmacist	30	16	53.3	(35 - 71)
Auxiliary nurse	30	22	73.3	(54 - 87)
Practical nurse	30	18	60	(41 - 76)
Registered nurse	30	20	66.7	(47 - 82)
Professional midwife	30	21	70	(51 - 84)
Social worker	30	6	20	(9 - 39)
Microbiologist (laboratory)	30	1	3.3	(0 - 22)
Lab technician	30	11	36.7	(21 - 56)
Dispenser at pharmacy	30	13	43.3	(26 - 62)
Epidemiology personnel	30	3	10	(3 - 28)
Other personnel specific for statistics and reporting	30	8	26.7	(13 - 46)
Vector control offices				
Epidemiology personnel	7	2	28.6	(7 - 69)
Other personnel specific for statistics and reporting	7	4	57.1	(22 - 87)

5.2 Rapid diagnostic tests

Rapid diagnostic tests (RDT) are to be introduced in Belize as a part of the Initiative in order to shorten the wait for a malaria test result, particularly in health facilities without microscopic diagnosis. The RDT is

a cassette-type test prepared with a drop of capillary blood and the result is ready within an hour. The rapid tests procured in Belize distinguish between *P. falciparum* and *P. vivax* malaria infections. When a blood sample is taken for an RDT, a thick blood film (TBF) slide is routinely prepared for microscopic diagnosis as well, since the rapid test does not measure parasite density. The slide may be examined at the facility where the patient sought care, or may be sent to a facility with a lab or microscopy post for examination. Use of RDTs was not reported nor was RDT stock observed at any facilities in the Belize baseline survey, which matched expectations based on the fact-finding visit.

5.3 Malaria microscopy

The gold standard for malaria diagnosis is by microscopy. A TBF sample is prepared on a laboratory slide, stained, then examined under a microscope for presence of malaria parasites. The preparation of the slide is simple and is carried out by nurses or lab technicians depending on facility practices. Slides are also prepared in the field by vector control technicians and volunteer collaborators (col-vols). Trained microscopists can identify the parasite density as well as the parasite species in a blood sample prepared correctly. After initiating antimalarial treatment, the parasite density of an infected patient will begin to decrease and eventually drop to zero.

5.3.1 Microscopic diagnosis practices

In Belize, all health care facilities in the sample, including polyclinics and hospitals, are expected to have the capacity to prepare TBF slides. In the health facility interview and observation, 83.3% of health facilities were found to take TBF samples. As seen in Table 5.6, facilities do not have the microscopy capacity to diagnose the samples taken. Instead they are tested at the vector control offices.

Table 5.6: Microscopy and thick blood film sampling according to interview + observation (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
Primary care facilities, polyclinics, and hospitals				
Unit takes thick blood film samples	30	25	83.3	(65 - 93)
Unit has microscopy capacity	30	0	0	(-)
Vector control offices				
Unit takes thick blood film samples	7	1	14.3	(2 - 61)
Unit has microscopy capacity	7	6	85.7	(39 - 98)

According to the interview alone and as seen in Table 5.7, 83.3% of all facilities have personnel that take TBF samples in-facility, and 16.7% have personnel that take TBF samples in the community.

Table 5.7: Thick blood film sampling according to interview (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
Health personnel in this facility take thick blood film samples in-facility	30	25	83.3	(65 - 93)
Health personnel take thick blood film samples in the community	30	5	16.7	(7 - 35)

As malaria microscopy for diagnosis is conducted at vector control offices, primary care facilities, polyclinics, and hospitals that take TBF samples were asked about whether samples were sent elsewhere and to what location. Table 5.8 shows the practices for sending TBF samples at health facilities that take samples.

Table 5.8: Thick blood film sample sending practice and locations (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
Samples sent elsewhere for initial diagnosis of malaria[1]	24	24	100	(-)
Regional laboratory	24	11	45.8	(27 - 66)
Vector control office	24	8	33.3	(17 - 55)
Another health facility	24	2	8.3	(2 - 29)
Senior malaria microscopist	24	2	8.3	(2 - 29)
National laboratory	24	1	4.2	(1 - 26)

[1]One facility representative responded 'do not know' to whether samples were taken for sending elsewhere.

5.3.2 Indicator 7.01: Supplies and equipment for malaria testing and treatment

In order to be able to detect and treat malaria, facilities must have certain basic supplies and equipment on hand. The indicator negotiated for RMEI considers whether these required basic inputs were observed at the facilities in the sample. The requirements vary by facility type, as detailed in Table 5.9.

As expected from the fact-finding visit, no stock of antimalarial medications was observed in any primary care facilities, polyclinics, or hospitals in Belize. This is because both storage and administration of medications for the treatment of malaria are managed by the vector control program through offices that are located at hospitals and polyclinics. Observation of equipment and medications was planned for all primary care facilities, polyclinics, and hospitals, but not for vector control offices, because it was thought that equipment and pharmacies were shared between vector control offices and their adjoining hospitals or polyclinics. Thus, due to an omission in data collection processes, data collectors did not seek to observe antimalarial stock at vector control offices but rather at health facility pharmacies. For this reason, we cannot determine the status of antimalarial storage for vector control offices and antimalarial stock was not considered a requirement for Indicator 7.01 for any health facility surveyed.

Table 5.9: Indicator P7.01: Required components by facility type

Component	Primary care facilities / polyclinics (23)	Community hospitals (3)	Regional hospitals / Karl Heusner Memorial Hospital (4)	Vector control offices (8)
Sampling equipment	Required at all	Required at all		
Forms for sending samples	Required at all	Required at all		
Equipment for on-site diagnosis (RDT)	Required in strata 3 and 4 (20/23 units)			
Microscopy equipment				If reported microscopy capacity (6/8 units)
Staining and sample reading equipment				If reported microscopy capacity (6/8 units)
Staining reagents				If reported microscopy capacity (6/8 units)

The indicator results are shown in Table 5.10. Only 16.1% of all the facilities in the sample had all of the inputs required for the corresponding facility type, and none of the primary care units in strata 3 and 4 had RDTs where they were expected according to the indicator definition. Table 5.11 shows performance for the components required for each facility type.

Table 5.10: Indicator P7.01: Equipment and medications

	N	n	%	95% CI
Sampling and biosafety equipment[1]	17	9	52.9	(29 - 75)
Disposable gloves	17	17	100	(-)
Lancets	17	16	94.1	(66 - 99)
Microscope slides (frosted or non-frosted)	17	9	52.9	(29 - 75)
Sample submission forms[2]	7	4	57.1	(22 - 87)
Rapid diagnostic tests (RDTs) for onsite testing	20	0	0	(-)
Microscopy equipment	6	5	83.3	(34 - 98)
Binocular microscope (with 100x retractable lens)	6	6	100	(-)
Cell counter (manual or automatic)	6	5	83.3	(34 - 98)
Equipment for staining and testing	6	6	100	(-)
Immersion oil	6	6	100	(-)
Staining tray/ container	6	6	100	(-)
Laboratory stopwatch	6	6	100	(-)
Container for mixing dye/ stain	6	6	100	(-)
Pipettes/ droppers/ syringes	6	6	100	(-)
Reagents for staining	6	5	83.3	(34 - 98)
GIEMSA solution (or alternative: Methylene blue + Solution A + Solution B + Methanol)	6	6	100	(-)
Buffer solution or buffered water	6	6	100	(-)
No stockout of reagents in past 3 months	6	5	83.3	(34 - 98)
Units with all required equipment and reagents	31	5	16.1	(7 - 34)

[1]Blood sampling equipment was captured in only 17/26 units.
[2]Forms were only captured in only 7/26 units.

Table 5.11: Comparison: result by facility type

	N	n	%	95% CI
Primary care facilities/polyclinics				
Sampling and biosafety equipment	14	8	57.1	(31 - 80)
Sample submission forms	4	3	75	(22 - 97)
Rapid diagnostic tests (RDTs) for onsite testing	20	0	0	(-)
Units with all required equipment and medications	22	0	0	(-)
Hospitals				
Sampling and biosafety equipment	3	1	33.3	(4 - 86)
Sample submission forms	3	1	33.3	(4 - 86)
Units with all required equipment and medications	3	1	33.3	(4 - 86)
Vector control offices				
Microscopy equipment	6	5	83.3	(34 - 98)
Equipment for staining and testing	6	6	100	(-)
Reagents for staining	6	5	83.3	(34 - 98)
Units with all required equipment and medications	6	4	66.7	(25 - 92)

5.3.3 Stock of microscopy inputs and equipment

The observation module of the health facility survey checked stock of sample-taking and microscopy supplies and equipment. Each item in the observation list had to be observed by the surveyor, checked for functionality, in the case of equipment, and recorded to the electronic module. Table 5.12 and Table 5.13 show the proportion of facilities where each item for sample-taking and microscopy, respectively, was observed on the day of the survey. Some supplies for sample-taking (Alcohol swabs, Cotton-wool swabs, Acetone or Acetone alcohol (antiseptic), Needles, Vacutainer-type needles, Capillary tubes) were sought for observation only in facilities with a microscopy post or laboratory. Table 5.12 includes all primary care facilities, polyclinics, and hospitals, while the 7.01 indicator does not require sampling equipment from regional hospitals and Karl Heusner Memorial Hospital.

Table 5.12: Sample-taking supplies observed

	N	n	%	95% CI
Disposable gloves	21	21	100	(-)
Alcohol swabs	21	21	100	(-)
Cotton-wool swabs	21	17	81	(58 - 93)
Acetone or Acetone alcohol (antiseptic)	21	18	85.7	(62 - 96)
Lancets	21	20	95.2	(71 - 99)
Syringes (for taking blood)	21	17	81	(58 - 93)
Needles	21	15	71.4	(48 - 87)
Vacutainer-type needles	21	9	42.9	(23 - 65)
Capillary tubes	21	13	61.9	(39 - 80)
Sharps box	21	17	81	(58 - 93)
Microscope slides (not frosted)	21	8	38.1	(20 - 61)
Frosted microscope slides	21	10	47.6	(27 - 69)

Table 5.13: Microscopy equipment and supplies observed, among all vector control offices reporting microscopy capacity

	N	n	%	95% CI
Lens-cleaning tissues	6	3	50	(16 - 84)
Spare bulbs (for microscopes)	6	1	16.7	(2 - 66)
Spare fuses (for microscopes)	6	1	16.7	(2 - 66)
Immersion oil	6	6	100	(-)
Oil immersion lens-cleaning solution	6	2	33.3	(8 - 75)
Staining rack	6	6	100	(-)
Drying rack (or sheet)	6	6	100	(-)
Measuring cylinder/disposable graduated cylinder	6	6	100	(-)
Glass or plastic bottles with a lid, that do not allow the passage of light	6	6	100	(-)
Filter paper (or other input to act as filter paper)	6	4	66.7	(25 - 92)
Slide holders or wooden dowels	6	6	100	(-)
Containers for mixing dye or stain	6	5	83.3	(34 - 98)
Concave staining surface	6	5	83.3	(34 - 98)
Staining tray/sheet/container	6	4	66.7	(25 - 92)
Glass petri dish	6	0	0	(-)
Plastic petri dish	6	1	16.7	(2 - 66)
Syringes	6	1	16.7	(2 - 66)
Disposable droppers	6	5	83.3	(34 - 98)
Test tubes with screw caps	6	0	0	(-)

	N	n	%	95% CI
Test tubes without caps (glass or plastic)*	6	0	0	(-)
Safety glasses (including the over-spectacle type)	6	0	0	(-)
Gowns	6	4	66.7	(25 - 92)
Markers	6	4	66.7	(25 - 92)
Detergents	6	5	83.3	(34 - 98)
Timer in laboratory	6	6	100	(-)

*Only observed when test tubes with screw caps were not observed.

Each microscope present at facilities in the sample was observed separately for characteristics. The number of microscopes at each facility is detailed in Figure 5.1. The observed characteristics, by microscope, are shown in Table 5.14.

Figure 5.1: Functional microscopes per facility

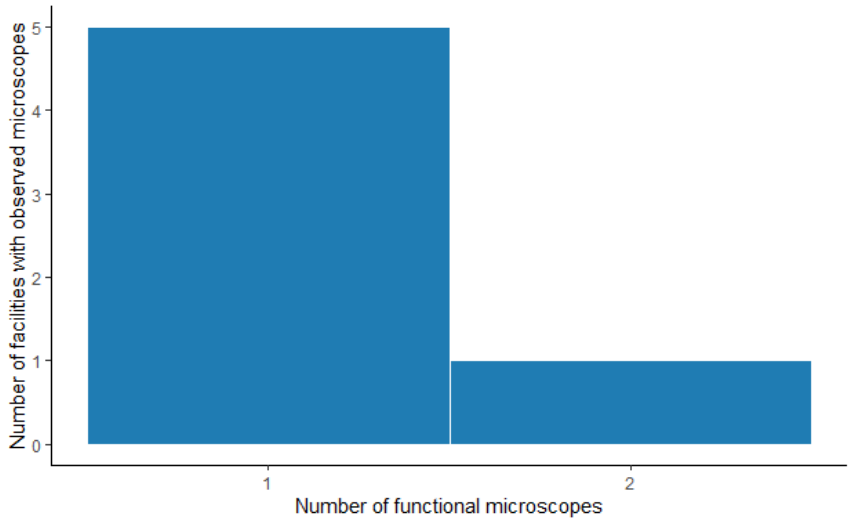


Table 5.14: Microscope characteristics among all observed microscopes

	N	n	%	95% CI
Is this a binocular microscope?	7	7	100	(-)
Is this a light microscope?	7	5	71.4	(30 - 93)
Is this a fluorescence microscope?	7	1	14.3	(2 - 61)
Is this a dark field microscope?	7	0	0	(-)
Is this a solar power microscope?	7	0	0	(-)
Lens observed: 4x	7	7	100	(-)
Lens observed: 10x	7	7	100	(-)
Lens observed: 20x	7	0	0	(-)
Lens observed: 40x	7	7	100	(-)
Lens observed: 100x	7	7	100	(-)
Lens observed: 1000x	7	0	0	(-)
Does the binocular microscope have an oil immersion lens?	7	7	100	(-)

Chapter 6: Malaria Case Detection and Diagnosis

Crucial to any malaria elimination program is quick detection of new malaria cases. Quickly administering treatment to the patient and enacting reactive activities in the community to search for additional cases and to monitor and control vector populations can interrupt the chain of transmission. In Belize, active case detection is carried out by vector control personnel both through planned activities and in response to malaria cases confirmed in areas without ongoing transmission. Passive case detection relies on health facilities to suspect and test for malaria in patients who present with fever or other malaria symptoms, and is a key component of malaria program strategy in the elimination phase.

In Belize, clinical and community health personnel are trained to suspect and test for malaria in patients with high fever in zones with history of local transmission and among patients who have traveled to those zones or to neighboring countries. Other signs that suggest malaria are history of recent fever, chills, and sweating, particularly in an alternating pattern. In addition, zones with ongoing or recent transmission may have volunteer collaborators ("col-vols") based in localities with difficult access to health facilities. Community members experiencing fever or other malaria symptoms can seek out the col-vol, who will take a blood sample if he or she suspects the patient may have malaria.

6.1 Active case detection and outreach

As a part of the health facility interview, respondents were asked about community health workers affiliated with the facility. Most facilities had at least one affiliated community health worker, though only some were involved in malaria service provision.

Table 6.1: Affiliated malaria personnel

	N	n	%	95% CI
Primary care facilities, polyclinics, and hospitals				
Community health workers/volunteer collaborators	30	20	66.7	(47 - 82)
Community health workers/volunteer collaborators involved in malaria activities (such as vector control, diagnosis, case detection, or treatment)	20	7	35	(17 - 59)
Vector control offices				
Community health workers/volunteer collaborators	7	7	100	(-)
Community health workers/volunteer collaborators involved in malaria activities (such as vector control, diagnosis, case detection, or treatment)	7	7	100	(-)

As shown in Table 6.2, 6.7% of primary care facilities and 85.7% of vector control offices reported that facility personnel participate in active searches for malaria. Most vector control offices also reported storing mosquito nets for distribution (85.7%) and employing personnel involved with indoor residual spraying (71.4%). Educational campaigns about malaria were conducted by 85.7% of vector control units.

Table 6.2: Active case detection and community activities

	N	n	%	95% CI
Primary care facilities, polyclinics, and hospitals				
Conducts active search for malaria cases	30	2	6.7	(2 - 24)
Stores insecticide-treated mosquito nets for distribution in the community	30	14	46.7	(29 - 65)
Performs indoor residual spraying	30	2	6.7	(2 - 24)
Conducts educational campaigns about malaria in the community	30	5	16.7	(7 - 35)

	N	n	%	95% CI
Other malaria outreach activities	30	4	13.3	(5 - 32)
Vector control offices				
Conducts active search for malaria cases	7	6	85.7	(39 - 98)
Stores insecticide-treated mosquito nets for distribution in the community	7	6	85.7	(39 - 98)
Performs indoor residual spraying	7	5	71.4	(31 - 93)
Conducts educational campaigns about malaria in the community	7	6	85.7	(39 - 98)
Other malaria outreach activities	7	5	71.4	(31 - 93)

Facilities that reported participation in active search for malaria cases were asked about how active case detection activities are planned in the community. As shown in Table 6.3, most vector control offices reported they do active case detection daily (83.3% of participating offices). The health facility that reported conducting active search according to direction from health authorities indicated that direction came from the national malaria program at the central level.

Only two non-vector control office health facilities reported participating in active case detection: both reported that detection was conducted reactively after a case of malaria is confirmed in the catchment area.

Table 6.3: Determinants of active case detection

	N	n	%	95% CI
Primary care facilities, polyclinics, and hospitals: When do you search for suspected malaria cases in your catchment area?				
After there is a case of malaria in the catchment area	2	2	100	(-)
Based on seasonality	2	1	50	(5 - 95)
When directed from health authorities	2	1	50	(5 - 95)
During community health fairs	2	1	50	(5 - 95)
Vector control offices: When do you search for suspected malaria cases in your catchment area?				
Daily	6	5	83.3	(34 - 98)
During community health fairs	6	2	33.3	(8 - 75)
After there is a case of malaria in the catchment area	6	1	16.7	(2 - 66)

The facilities and vector control offices that reported storing mosquito nets were asked how the nets are distributed, and could list more than one method. The results are summarized in Table 6.4. “Other” responses specified that net distribution was managed by the maternal and child health program or by a “public health nurse”.

Table 6.4: Community net distribution

	N	n	%	95% CI
Primary care facilities, polyclinics, and hospitals: Mode of treated net distribution				
Routinely offered to patients visiting the health facility	14	7	50	(25 - 75)
Offered only to pregnant women	14	3	21.4	(7 - 51)
Vector control personnel distributes the nets in the community	14	1	7.1	(1 - 39)
Other	14	3	21.4	(7 - 51)
Don't know	14	1	7.1	(1 - 39)
Vector control offices: Mode of treated net distribution				
Vector control personnel distributes the nets in the community	6	4	66.7	(25 - 92)

	N	n	%	95% CI
Routinely offered to patients visiting the health facility	6	3	50	(16 - 84)
Personnel from this health facility distributes the nets in the community	6	1	16.7	(2 - 66)
Community health workers puck up the nets to distribute	6	1	16.7	(2 - 66)

Respondents were also asked a series of questions about malaria detection activities in the community and referrals from community health workers. No care facilities reported receiving referrals from col-vols or other community health workers to treat malaria. Diagnosis activities were common in vector control offices, with 85.7% of offices receiving referrals for malaria testing. Some care facilities reported taking thick blood samples in the community (16.7%).

Table 6.5: Community malaria activities - questionnaire

	N	n	%	95% CI
Primary care facilities, polyclinics, and hospitals				
Do you receive referred patients from community health workers or volunteer collaborators for malaria testing?	30	3	10	(3 - 28)
Do you receive referred patients from community health workers or volunteer collaborators for malaria treatment?	30	0	0	(-)
Do health personnel take thick blood film samples in the community?	30	5	16.7	(7 - 35)
Vector control offices				
Do you receive referred patients from community health workers or volunteer collaborators for malaria testing?	7	6	85.7	(39 - 98)

6.2 Passive case detection practices (health facility questionnaire)

Personnel in health facilities are trained to suspect and test for malaria in patients who present with fever or other symptoms to the facility, known as passive case detection. Patients presenting with clinical signs that meet the definition of a suspected malaria case will have a sample taken, usually of capillary blood, to prepare a TBF slide. The slide is examined at the vector control microscopy post and if the *Plasmodium* parasite is detected, treatment with the first-line regimen corresponding to the parasite species begins and the case is notified to the primary care provider and to the central level vector control program. If the health facility the patient visits does not have microscopic diagnostic capacity, or if the patient visits a col-vol for testing, the TBF slide is sent, along with a suspected (fever) case notification form filled by the provider who took the sample, to the district microscopy post for testing, transported by vector control technicians who either visit on a regular basis (usually at least weekly) for pickup or who are notified by phone that a slide is ready for testing. The slide is tested by the lab, and in the case that malaria is confirmed, vector control personnel locate the patient and begin to administer treatment.

During the health facility interview, respondents in facilities that reported conducting malaria tests were asked who decides whether a patient will receive a diagnostic test for malaria, and could indicate more than one personnel type. Table 6.6 shows that nurses most commonly order the test in 96% of health facilities.

Table 6.6: Malaria testing by facility personnel among facilities conducting testing (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
Who decides whether a patient presenting at this facility will receive a malaria test?				
Nurse at triage or pre-clinic	25	24	96	(75 - 99)
Doctor during consult	25	4	16	(6 - 37)
Lab staff or microscopy staff	25	1	4	(1 - 25)

Next, respondents were asked to mention what criteria are used to determine whether a patient gets a malaria test, at triage (Table 6.7) and at consult (Table 6.8). The respondent answered with the criteria they use at the facility and the interviewer marked the corresponding options in the survey without reading them aloud. In both triage and consult, high fever was an important criterion that determined testing (100% and 75% respectively) and chills was also frequently mentioned (in 29.2% of facilities at triage). Few respondents mentioned travel history as a determining factor for malaria testing.

Table 6.7: Malaria testing criteria at triage (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
What criteria must a patient meet in order to get a blood sample taken for malaria test during triage or pre-clinic?				
High fever	24	24	100	(-)
History of recent fever	24	9	37.5	(20 - 59)
Chills	24	7	29.2	(14 - 51)
Sweating	24	6	25	(11 - 47)
Fever for more than 3 days	24	4	16.7	(6 - 38)
History of recent travel to areas with endemic malaria	24	3	12.5	(4 - 34)
Fever without rash	24	2	8.3	(2 - 29)
Fever without respiratory symptoms	24	2	8.3	(2 - 29)
Profuse sweating	24	1	4.2	(1 - 26)
Fever without nonspecific digestive symptoms (vomiting, abdominal pain, loss of appetite)	24	1	4.2	(1 - 26)
Other	24	2	8.3	(2 - 29)

Table 6.8: Malaria testing criteria at consultation (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
What criteria must a patient meet in order for the doctor to order a malaria test during the consultation?				
High fever	4	3	75	(22 - 97)
History of recent fever	4	1	25	(3 - 78)
Chills	4	1	25	(3 - 78)
Sweating	4	1	25	(3 - 78)
Fever without nonspecific digestive symptoms (vomiting, abdominal pain, loss of appetite)	4	1	25	(3 - 78)
Other	4	1	25	(3 - 78)

6.3 Fever cases with blood test (LQAS)

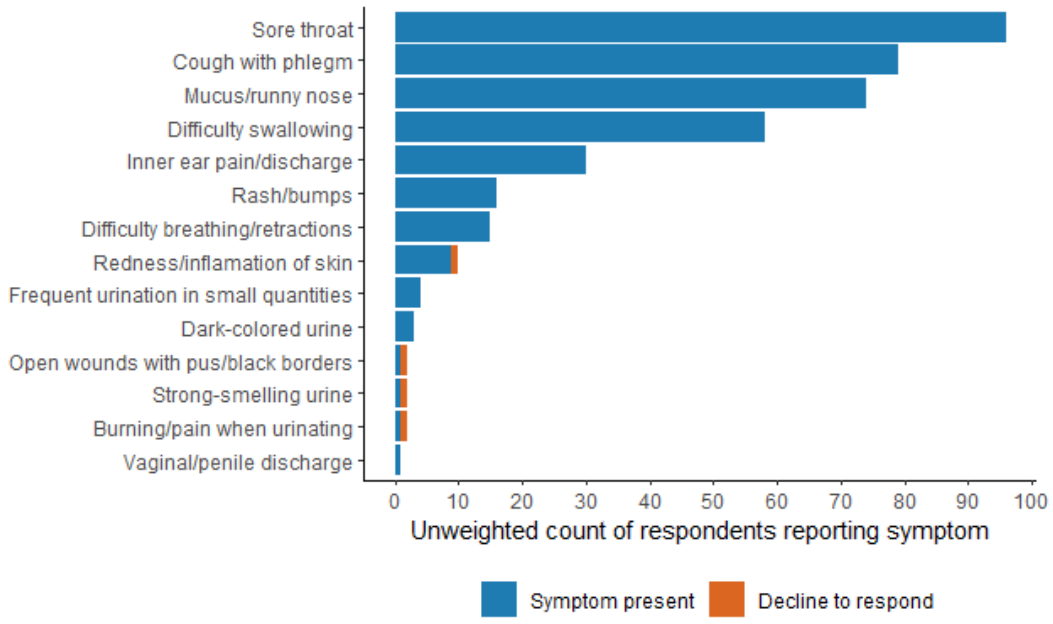
In the community survey (LQAS), interviews with households included questions about history of fever during the two weeks prior to the survey for all usual members of the household. The estimates from the LQAS survey reported in this section are not weighted due to the very small size of the sub-sample of eligible fevers.

If the primary interview respondent reported that a household member had a recent fever, the interviewer asked to speak to the person who had the fever, or in the case that a child or adolescent had a fever, with the child's primary caregiver. If the person with the fever was not available and the primary respondent knew the details of their recent fever, that person was permitted to respond on behalf of the fever patient. The respondent answered questions about other symptoms suffered during the febrile illness and whether and where they sought medical attention. As seen in Table 6.9, 12.1% of the individuals whose households were selected for the LQAS survey experienced a fever during the two weeks prior to the date of the survey. However, not all patients with fever need to be tested for malaria according to suspected case definitions: patients with respiratory symptoms, urinary symptoms, or skin symptoms suggesting an infection unrelated to malaria will receive a clinical diagnosis and treatment without needing to test to rule out malaria. Of the 186 respondents who reported experiencing fever, the majority experienced other symptoms that suggested a condition other than malaria. Only 56 people, or 30.1% of the individuals reporting fever, were free of other symptoms excluding them from having to receive a malaria test. The simultaneous symptoms reported by respondents who experienced a recent fever are detailed in Figure 6.1.

Table 6.9: Eligible fever cases reported in LQAS household survey

	N	n	%	95% CI
LQAS respondents	1548	1548	100	(-)
Fever cases in the last two weeks	1531	186	12.1	(9 - 17)
Fever without exclusion symptoms	186	56	30.1	(20 - 43)

Figure 6.1: Exclusion symptoms experienced by respondents reporting fever



6.3.1 Indicator 2.02: Fever cases with blood test (household)

Because it may be difficult for community members to know or remember which specific blood tests were ordered or carried out by a medical professional they visited, individuals who reported that a blood sample was taken during their illness are considered to have had a malaria test for the purpose of the indicator.

All respondents reporting fever without exclusion symptoms were asked whether, during the illness, a blood sample was taken from their finger, heel, earlobe, or vein. As shown in Table 6.10, 18.9% of

respondents with an eligible fever (with no exclusion symptoms) had a blood sample taken. The indicator is broken down by district in Table 6.11.

Table 6.10: Indicator 2.02: Fevers with blood sample

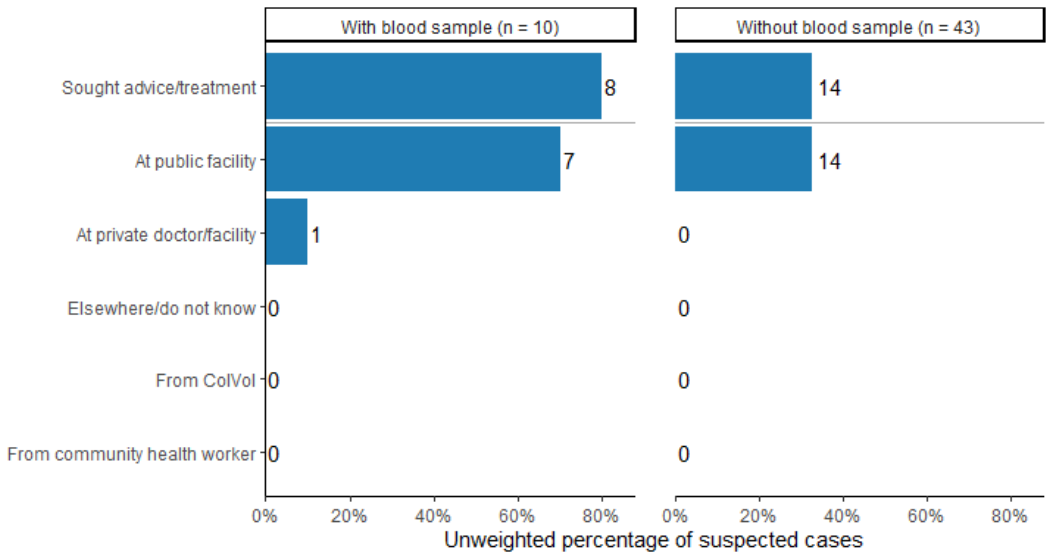
	N	n	%	95% CI
Fever cases in past two weeks	1531	186	12.1	(9 - 17)
Fevers with no exclusion symptoms	186	56	30.1	(20 - 43)
Omitted due to 'do not know' responses	56	3	5.4	(1 - 24)
Fevers with any blood sample	53	10	18.9	(8 - 40)
Capillary blood test	53	7	13.2	(5 - 32)
Venal blood test	53	4	7.5	(3 - 16)

Table 6.11: Indicator 2.02: result by district

	N	n	%	95% CI
Fevers with any blood sample				
Cayo	4	1	25	(2 - 84)
Corozal	17	2	11.8	(2 - 49)
Orange Walk	1	0	0	(-)
Stann Creek	6	1	16.7	(2 - 68)
Toledo	25	6	24	(7 - 58)
Total	53	10	18.9	(8 - 40)

Figure 6.2 shows care-seeking behavior among respondents with fever. Respondents with fever who reported receiving a blood test are shown in the left panel, and respondents with fever who did not receive a blood test in the right panel. Most of those who received a blood test sought treatment at a public health facility.

Figure 6.2: Treatment sought by respondents with fever cases



The calculation for Indicator 2.02 is presented in Table 6.12 both excluding cases with symptoms suggesting an illness other than malaria (18.9%) and including all fever cases reported from the past two weeks (23.5%).

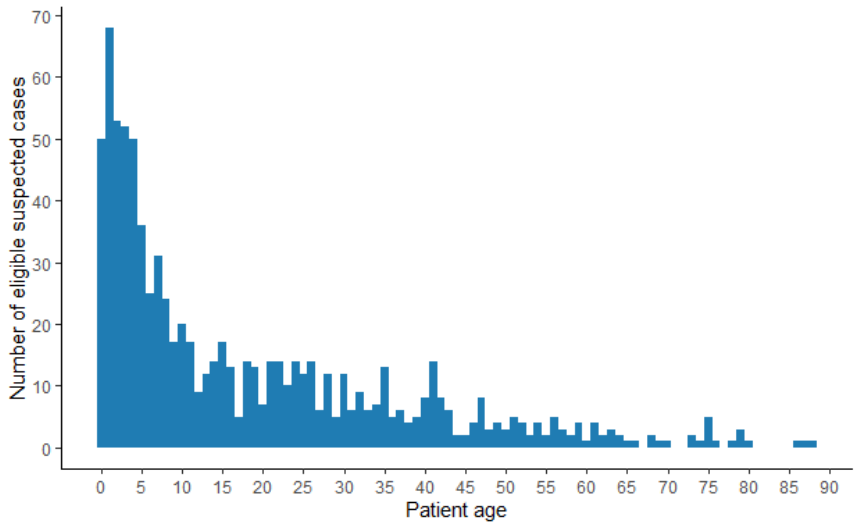
Table 6.12: Indicator 2.02: Fevers with blood sample, with and without exclusion symptoms

	N	n	%	95% CI
Fevers (with no exclusion symptoms) with any blood sample	53	10	18.9	(8 - 40)
All fevers with any blood sample	183	43	23.5	(15 - 35)

6.4 Suspected malaria cases with parasitological test (medical record review)

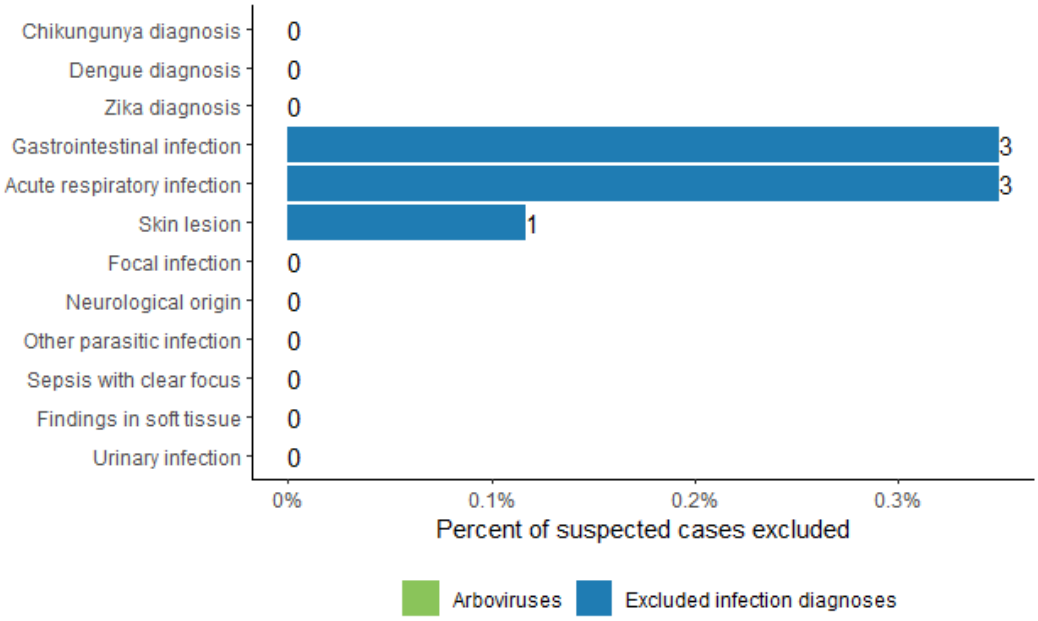
For a clinical comparison to the indicator measured in the LQAS survey, the health facility survey included a review of medical records of patients with fever or other malaria symptoms (suspected cases of malaria). In each facility that provided care to patients, field personnel selected eligible patient visits based on attention registries or diagnosis databases according to the process described in Chapter 2 and Appendix C. The eligible time window for review was the calendar year 2018. Suspected cases with an eligible diagnosis or principal complaint (details in Appendix B, Indicator 2.01) were selected at random, and all relevant records of the patient's visit were sought out for completion of a chart review module. For each case, field staff reviewed attention registries, laboratory records, and patient medical records (electronic and paper) as available and entered information related to the diagnosis, symptoms, and lab tests to the electronic survey module. No information that could identify the patients was collected. The patient age distribution of eligible suspected cases can be seen in Figure 6.3. Many of the suspected cases identified were in patients under age 10, likely because fevers are more prevalent in children or heath care is sought for them more often than for adults.

Figure 6.3: Suspected cases patient age



Some of the sampled records were eligible to be selected based on information on the attention registry, such as a primary or initial diagnosis from the inclusion list, but upon review of the full chart, were found to be ineligible due to a diagnosis of another identified infection with clear cause or a diagnosis of arbovirus with a positive viral test result documented. The frequency of diagnoses of exclusion among cases ruled ineligible after sample selection is shown in Figure 6.4. Each of these ineligible records was replaced with an alternate record selected to a back-up sample in order to ensure completion of the total quota for medical record reviews in each facility. In some primary care facilities, field personnel found an inadequate number of eligible attentions from the year 2018 to meet the quota, and all eligible cases from 2018 were reviewed. As described in chapter 2, suspected case sampling issues meant that no suspected cases were collected from facilities in stratum 2.

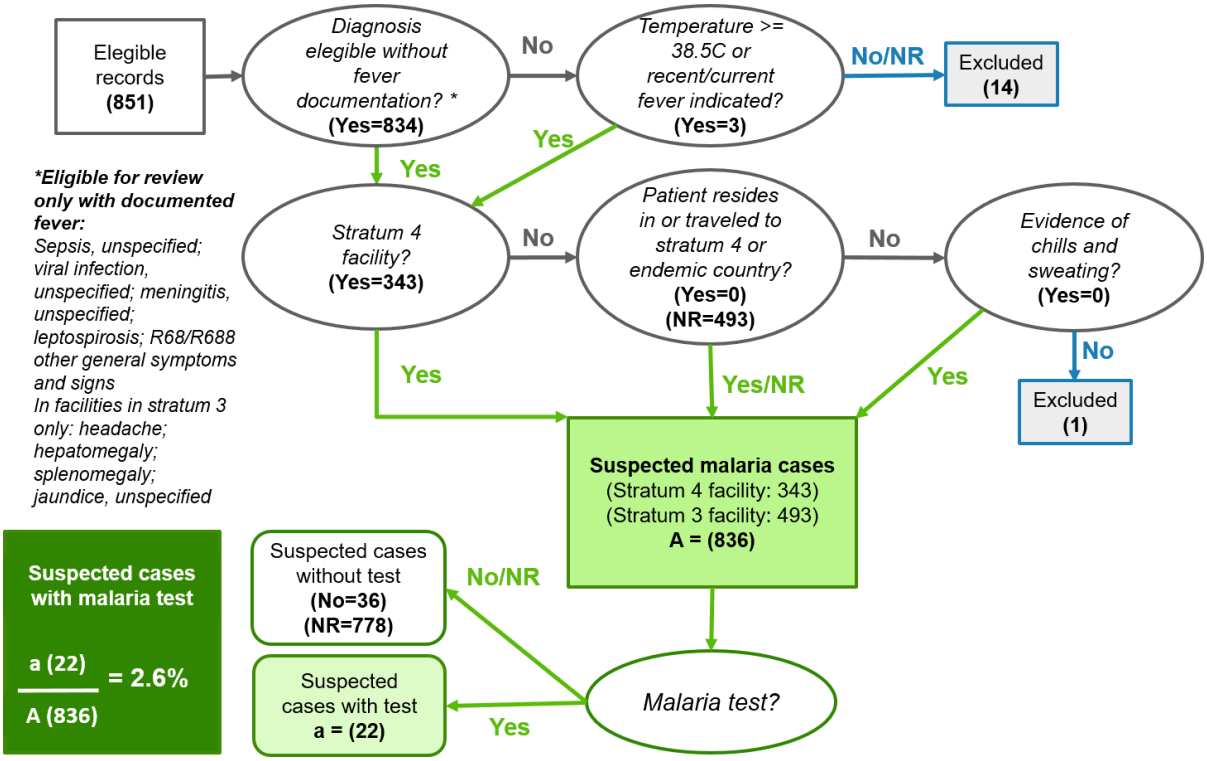
Figure 6.4: Exclusion diagnoses for review of suspected malaria cases



6.4.1 Indicator 2.01: Suspected malaria cases with parasitological test (medical record review)

IHME conducted a second eligibility review of the data collected from medical records in order to identify the cases eligible for inclusion in indicator 2.01 (suspected cases with malaria test) according to a decision algorithm shown in Figure 6.5. Facilities in malaria stratum 4 are subject to a different suspected malaria case definition than facilities in malaria strata 2 and 3, where patients presenting with fever do not require a test to rule out malaria unless they traveled to an endemic area or show other malaria symptoms like chills and sweating. Additionally, certain inclusion diagnoses only meet the suspected case definition (that is, malaria should be ruled out before making a clinical diagnosis of another condition) if the patient presented with fever or had a history of recent fever. Thus, additional ineligible records were identified and excluded from the indicator during the eligibility review.

Figure 6.5: Eligibility of suspected cases reviewed for Indicator 2.01



In total in Belize, 836 of the 851 suspected cases reviewed were eligible for consideration in indicator 2.01.

For the purposes of the indicator, cases with evidence that a malaria test was ordered or that a sample was taken, as well as cases with a malaria test result registered, were considered to have had a parasitological test. The test could be a rapid diagnostic test or thick blood film, and some patients had evidence of both tests in the record. As shown in Table 6.13, 2.6% of patients with suspected malaria had evidence that a malaria test was received. Of these 22 patients with evidence of a test, 0% received an RDT and 100% a TBF. For comparison, Table 6.14 shows the results by malaria stratum and Figure 6.6 shows the results by department. The baseline measurement was not designed to produce representative estimates at the department level, so results by department should be interpreted with discretion.

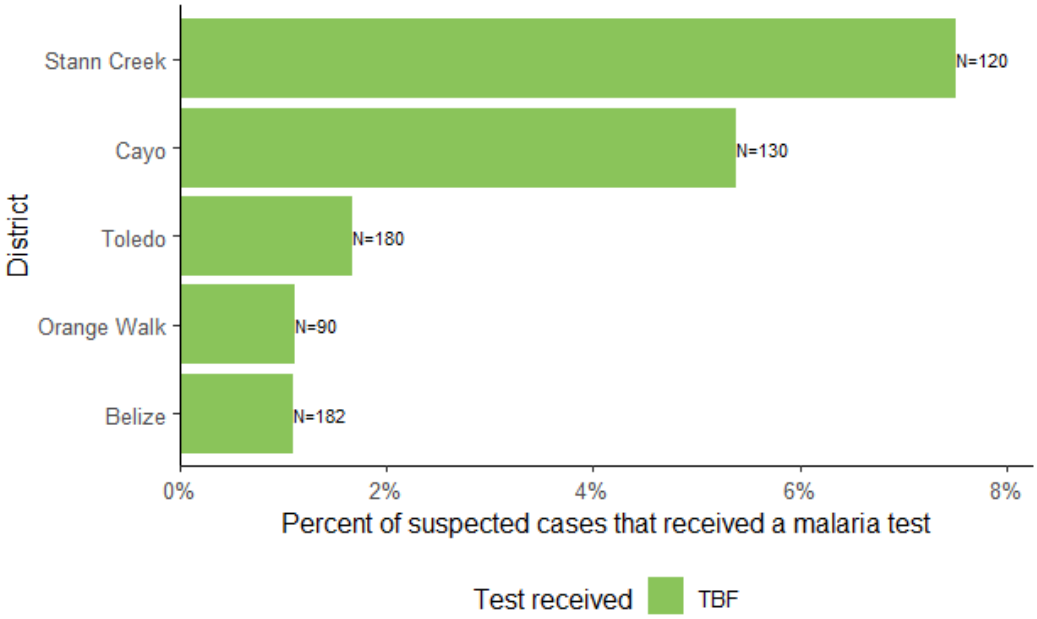
Table 6.13: Indicator 2.01: Suspected cases with malaria test

	N	n	%	95% CI
Suspected case with malaria test	836	22	2.6	(2 - 4)
Rapid diagnostic test	22	0	0	(-)
Thick blood film	22	22	100	(-)

Table 6.14: Comparison: result by facility stratification

	N	n	%	95% CI
Suspected cases with malaria test				
Stratum 3	493	15	3	(2 - 5)
Stratum 4	343	7	2	(1 - 4)
Total	836	22	2.6	(2 - 4)

Figure 6.6: Comparison: result by department



6.5 Malaria diagnosis (medical record review)

Early diagnosis of malaria is essential to interrupt transmission in a timely manner and to ensure the patient receives treatment before illness becomes more severe or complicated. The health facility survey included a record review of confirmed malaria cases. All seven confirmed malaria cases that occurred in Belize in 2018 were located at vector control offices and all available records were reviewed, including fever case notification forms, case investigation (case reporting) forms, and any patient charts, laboratory records, or treatment forms filed at the vector control unit. Forms reviewed for each case are shown in Table 6.15. More details on confirmed cases are found in chapter 7.

Table 6.15: Confirmed case forms reviewed

Case	Paper medical record / history notes	Log books	Malaria case reporting form
Case 1	Yes	No	No
Case 2	Yes	No	No
Case 3	Yes	No	No
Case 4	Yes	No	Yes
Case 5	Yes	No	Yes
Case 6	No	Yes	Yes
Case 7	Yes	No	No

6.5.1 Indicator 4.02: Time to diagnosis for confirmed cases (medical record review)

As a part of each record review module, field staff recorded the date of symptom onset, date of fever onset, and date of diagnosis from the medical record, log books, and case reporting forms. Diagnosis within two days (48 hours) of symptom onset was negotiated as an indicator for RMEI. Table 6.16 shows the onset to diagnosis status for each of the seven cases. If diagnosis was recorded more than seven days before or more than 30 days after fever onset, the case is excluded from the indicator because of the suspicion of recording error (on the investigation form or in the survey module). This suspected error affected 2 cases. Table 6.17 shows the tabulated indicator result. Only 20% of cases were diagnosed within 48 hours of symptom onset.

Table 6.16: Indicator 4.02: Symptom onset to diagnosis for each case

Case	Symptom onset date recorded	Diagnosis date recorded	Days from onset to diagnosis	Diagnosed within 48 hours
Case 6	Yes	Yes	1	Yes
Case 2	Yes	Yes	11	No
Case 1	Yes	Yes	19	No
Case 4	Yes	Yes	27	No
Case 3	Yes	No	-	No
Case 7	Yes	Yes	37	Excluded
Case 5	Yes	Yes	52	Excluded

Table 6.17: Indicator 4.02: onset to diagnosis within 48 hours

	N	n	%	95% CI
Total confirmed malaria cases	7	7	100	(-)
Excluded due to suspected inscription/data entry error (<-7 day or >30 day window)	7	2	28.6	(4 - 78)
Denominator: Confirmed cases without suspected error	5	5	100	(-)
Both dates registered	5	4	80	(17 - 99)
Cases diagnosed within 48 hours of onset	5	1	20	(1 - 83)
Over 7 days from onset to diagnosis	5	3	60	(12 - 94)
Indicator result: Cases diagnosed within 48 hours of onset	5	1	20	(1 - 83)

All confirmed cases in Belize were diagnosed through thick blood film sample microscopy. The personnel who took the blood sample for diagnosis varied across cases and are reported in Table 6.18.

Table 6.18: Personnel who performed diagnosis of confirmed cases, TBF

	N	n	%	95% CI
Who took the TBF?				
Microscopist	7	2	28.6	(4 - 78)
Nurse	7	2	28.6	(4 - 78)
Community Health Worker (CHW)	7	2	28.6	(4 - 78)
Lab tech/ microbiologist	7	1	14.3	(1 - 74)

6.5.2 Indicator E2.04: Time to notification for confirmed cases (medical record review)

Notification within 24 hours of diagnosis was negotiated as an indicator for RMEI. Though not all collected cases had a reviewed notification form, all cases did have a valid notification date recorded. As shown in Table 6.19, 85.7% of confirmed case records in Belize had both diagnosis and notification dates registered and 57.1% were notified within 24 hours of diagnosis.

Table 6.19: Indicator E2.04: Notification within 24 hours of diagnosis

	N	n	%	95% CI
Diagnosis date registered	7	6	85.7	(26 - 99)
Notification date registered	7	7	100	(-)
Both dates registered	7	6	85.7	(26 - 99)
Notification within 24 hours of diagnosis	7	4	57.1	(15 - 91)

Chapter 7: Malaria treatment and follow-up care

In Belize, routine malaria treatment is managed by the vector control program. At the fact-finding visit, IHME learned that the vector control program manages all treatment stock and administration, usually delivering doses to the patient's home for confirmed cases. Supervision of ingestion of all doses is the norm in Belize in order to ensure each patient completes the radical cure. In some cases, col-vols may assist with delivery and supervision of some doses, for example on the weekend or in very remote areas without vector control personnel based in the locality. Rarely, the patient may be expected to visit a health facility in order to receive medication or follow-up malaria tests instead of receiving services through home visits, and to treat severe malaria or chloroquine-resistant *P. falciparum*, the patient may be admitted to the hospital. Some primary care facilities without microscopy capacity and some col-vols stock small amounts of chloroquine and administer a presumptive dose to patients with fever awaiting a malaria test result.

The survey results in the following sections align to some extent with these expectations, though they suggest varying levels of knowledge of standard practices by personnel in health facilities that may diagnose malaria cases infrequently. While some personnel indicated that treatment may be administered in-facility, no antimalarial medications were actually obsevered in any health facilities. Responses may be obfuscated by the fact that vector control offices often share physical facilities with hospitals and polyclinics, meaning personnel may be indicating that services are conducted through the vector control program at the same facility.

7.1 Treatment administration practices

The health facility interview includes questions about malaria service provision (in all primary care facilities, polyclinics, and hospitals). Respondents listened to the list of activities shown in Table 7.1 and were asked to indicate whether personnel at the facility provide each service (yes or no). Some facilities report that they prescribe treatment via their own pharmacies (33.3%) and supervise treatment at the facility (16.7%). Other responses indicated that treatment is managed by vector control personnel in home-visits to the patient, which may have been why many facility personnel responded "none of the above" to the list of available responses. Treatment practices were asked only of primary care facilities, polyclinics, and hospitals, and not of vector control offices.

Table 7.1: Services provided by facilities for malaria treatment (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
Services provided for malaria treatment				
Prescribe treatment to pharmacy at this facility	30	10	33.3	(18 - 53)
Provide prescription to external pharmacy	30	2	6.7	(2 - 24)
Give medication to take at home (unsupervised)	30	2	6.7	(2 - 24)
Supervise ingestion (in the facility)	30	5	16.7	(7 - 35)
Call or visit the home to ask if treatment was taken (without supervising ingestion)	30	1	3.3	(0 - 22)
None of the above	30	14	46.7	(29 - 65)
Other	30	3	10	(3 - 28)

In countries nearing malaria elimination, it is important to supervise all doses of treatment to ensure the patient completes the radical cure. If the respondent reported that personnel supervise ingestion in-facility, the interviewer asked how many doses are supervised at the facility. At 20% of facilities that supervise treatment regardless of type, all doses are supervised at the facility, and at 40% of these facilities only the first dose is supervised in-facility (Table 7.2). Respondents at facilities that supervise some but not all doses in-facility were asked who is responsible for administering the remaining doses

(Table 7.3). Most commonly, vector control personnel or community health workers administer the medication to the patient at home.

Table 7.2: Doses supervised in-facility (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
Doses supervised in-facility				
Only the first dose	5	2	40	(9 - 81)
All doses	5	1	20	(2 - 71)
Don't know	5	2	40	(9 - 81)

Table 7.3: Personnel responsible for subsequent administrations (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
Administration of subsequent doses				
Treatment is administered by vector control personnel at the patient's home	2	1	50	(5 - 95)
Treatment is administered by community health workers or volunteer collaborators at the patient's home	2	1	50	(5 - 95)
Don't know	2	1	50	(5 - 95)

All facilities that provide malaria care were asked if personnel ever administer malaria treatment before a positive test result, and 37.5% replied that they do. Respondents reported that community personnel administer presumptive treatment in 21.4% of facilities.

Table 7.4: Presumptive treatment (primary care facilities, polyclinics, and hospitals)

	N	n	%	95% CI
Do clinical staff in this facility ever give antimalarial treatment for suspected malaria without waiting for a positive malaria test result? (Among facilities that provide treatment services on-site)	16	6	37.5	(17 - 63)
Do community health workers, volunteer collaborators, or vector control personnel associated with this facility ever treat suspected malaria without waiting for a positive malaria test result? (Among all facilities excluding national lab)[1]	28	6	21.4	(10 - 41)

[1]Two facility representatives responded 'do not know' to presumptive treatment by community workers.

7.2 Storage and stock of antimalarial medications

As expected from the fact-finding visit, no stock of antimalarial medications was observed in any primary care facilities, polyclinics, or hospitals in Belize. This is because both storage and administration of medications for the treatment of malaria are managed by the vector control program through offices that are located at hospitals and polyclinics. Observation of equipment and medications was planned for all primary care facilities, polyclinics, and hospitals, but not for vector control offices, because it was thought that equipment and pharmacies were shared between vector control offices and their adjoining hospitals or polyclinics. Thus, due to an omission in data collection processes, data collectors did not seek to observe antimalarial stock at vector control offices but rather at health facility pharmacies. For this reason, we cannot determine the status of antimalarial storage for vector control offices and antimalarial stock was not considered a requirement for Indicator 7.01 (as presented in Chapter 5) for any health facility surveyed.

Responses from the questionnaire confirm that all vector control offices store antimalarials. Practices related to antimalarial storage and distribution at vector control offices are displayed in Table 7.5, Table 7.6, Table 7.7, Table 7.8, and Table 7.9.

Table 7.5: Antimalarials medications stored among vector control units, questionnaire

	N	n	%	95% CI
Questionnaire: Does this facility store medications to treat malaria?	7	7	100	(-)

Table 7.6: Antimalarial delivery for severe or chloroquine-resistant cases

	N	n	%	95% CI
If a case of severe or drug-resistant malaria is detected in this facility, how does the patient get special antimalarial medication that is not stored here?				
Treatment is delivered to the patient's home by vector control or malaria program staff	7	4	57.1	(22 - 87)
Treatment is delivered to this health facility by vector control or malaria program staff	7	3	42.9	(13 - 78)

Table 7.7: Determination of malaria medication needs among vector control units

	N	n	%	95% CI
How is the quantity of malaria medication needed by this facility determined?				
Quantity determined by national malaria program	7	5	71.4	(31 - 93)
Facility determines quantity and orders	7	2	28.6	(7 - 69)

Table 7.8: Medication order reliability among vector control units

	N	n	%	95% CI
During the past 6 months, have you always, almost always, or almost never received the amount of each medicine that you ordered (or that you are supposed to routinely receive)?				
Always	7	6	85.7	(39 - 98)
Almost always	7	1	14.3	(2 - 61)

Table 7.9: Malaria medication shortages among vector control units

	N	n	%	95% CI
If there is a shortage of a specific malaria medication between routine orders, what is the most commonly used procedure in this facility?				
Special order	7	6	85.7	(39 - 98)
Borrow from another health facility	7	1	14.3	(2 - 61)

7.3 Confirmed cases: Time to treatment initiation

According to the targets of malaria elimination programs, the first dose of antimalarial treatment should be administered to the patient no later than 24 hours after diagnosis in order to interrupt community transmission as rapidly as possible. The review of confirmed malaria cases captured from 2018 the dates

of diagnosis and of treatment initiation and completion, as well as the medications administered, dosage, and the number of doses provided. Details about confirmed cases can be seen in Table 7.10.

Table 7.10: 2018 confirmed cases detailed

Case	Species	Classification	Detection source	Residence	Travel history, 30 days
Case 1	*P. vivax*	Imported	Not registered	Surinam	Caye Caulker, Belize, Belize
Case 2	*P. falciparum*	Imported	Not registered	Belmopan, Cayo, Belize	Mississippi, North Carolina, Rhode Island; USA
Case 3	*P. vivax*	Autochthonous / indigenous / local	Passive search	Armenia, Cayo, Belize	None
Case 4	*P. vivax*	Imported	Active search	Silk Grass Village, Stann Creek, Belize	Peten, Guatemala
Case 5	*P. vivax*	Autochthonous / indigenous / local	Active search	Trio, Toledo, Belize	Red Bank, Stann Creek, Belize
Case 6	*P. vivax*	Imported	Passive search	Managua, Nicaragua	Dangriga, Stann creek, Belize
Case 7	*P. vivax*	Imported	Not registered	Puerto Cabezas, Nicaragua	Caye Caulker, Belize, Belize

Antimalarial treatment is prescribed according to the test result. In Belize, first-line regimens of chloroquine and primaquine are used for both *Plasmodium vivax* malaria and *Plasmodium falciparum* malaria without chloroquine resistance (including all locally transmitted *P. falciparum* cases in the Central American region). For imported *P. falciparum* or mixed infection cases from countries with chloroquine resistance, an artemisinin-based regimen is used. Only one of seven cases from Belize was *P. falciparum*, and while it was imported, it was not determined to have originated from a region with chloroquine-resistant strain of *P. falciparum*. All confirmed cases in Belize received the appropriate first-line regimen according to the species diagnosed (Table 7.11).

Table 7.11: Confirmed cases: Appropriate treatment by parasite species

Case	Species	Chloroquine administered	Primaquine administered
Case 1	P. vivax	Yes	Yes
Case 2	P. falciparum	Yes	Yes
Case 3	P. vivax	Yes	Yes
Case 4	P. vivax	Yes	Yes
Case 5	P. vivax	Yes	Yes
Case 6	P. vivax	Yes	Yes
Case 7	P. vivax	Yes	Yes

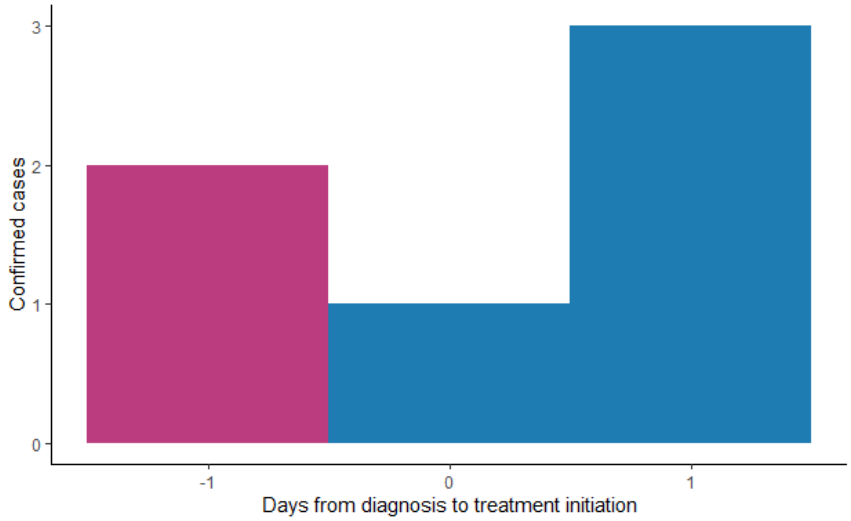
Table 7.12 shows the timing of administration of the first dose of antimalarial treatment. In 85.7% of the cases reviewed, both diagnosis and treatment date were registered. Evidence of any antimalarial treatment within one day of diagnosis was found in 57.1% of cases reviewed.

Table 7.12: Confirmed cases: Treatment timeliness

	N	n	%	95% CI
Diagnosis date registered	7	6	85.7	(26 - 99)
Treatment start date registered	7	7	100	(-)
Both dates registered	7	6	85.7	(26 - 99)
Any treatment within 24 hours of diagnosis	7	4	57.1	(15 - 91)

Figure 7.1 shows the number of days from the date of diagnosis to the date of treatment initiation. Cases with treatment initiation on the same day of diagnosis or one day after are shown in blue. Cases with treatment initiation before diagnosis (by RDT or microscopy) are not considered timely, because presumptive treatment is contrary to the norms established through RMEI in Belize.

Figure 7.1: Confirmed cases: diagnosis to treatment initiation time frame



An indicator negotiated for RMEI measures the proportion of cases with the first dose of antimalarial treatment administered within one day of diagnosis, as shown in Table 7.13. Among the cases reviewed, 100% had the antimalarial treatment corresponding to the parasite species registered correctly on the forms. In 57.1% of the cases, the first dose of any treatment was registered as administered within one day (24 hours) of diagnosis, and in 57.1% of the cases, the first dose of the appropriate treatment was registered as administered within one day of diagnosis.

Table 7.13: Indicator 4.01: Timely treatment initiation

	N	n	%	95% CI
Total malaria cases	7	7	100	(-)
Correct treatment administered for species	7	7	100	(-)
Diagnosis and treatment dates registered	7	6	85.7	(26 - 99)
First dose treatment within 24 hours of diagnosis	7	4	57.1	(15 - 91)
Correct treatment administered within 24 hours of diagnosis	7	4	57.1	(15 - 91)

7.4 Confirmed cases: Adequate and complete treatment

In order to ensure radical cure with chloroquine and primaquine, patients must take medication daily for a period of 3-14 days, even though symptoms may start to subside within a few days of treatment initiation. In Belize, the national norm requires treatment according to parasite species, following these regimens:

- For *P. vivax* cases and *P. ovale* cases: 3 days of chloroquine and 14 days of primaquine
- For *P. falciparum* cases without documented resistance to chloroquine: 3 days of chloroquine and one day of primaquine
- For mixed infections cases without documented resistance to chloroquine: 3 days of chloroquine and 14 days of primaquine
- For imported *P. falciparum* cases from areas with documented resistance to chloroquine: 3 days of artemisinin-based treatment (artemether + lumefantrine) and one day of primaquine
- For mixed infections cases from areas with documented resistance to chloroquine: 3 days of artemisinin-based treatment (artemether + lumefantrine) and 14 days of primaquine
- For severe malaria cases: If IV treatment with artesunate started, when completed: 3 days of artemisinin-based treatment (artemether + lumefantrine)

7.4.1 Completion of malaria treatment

Table 7.14 shows treatment completion by parasite species as registered on the forms observed at the vector control offices. Four *P. vivax* cases and zero *P. falciparum* cases had evidence of complete treatment. 57.1% of all reviewed cases had recorded evidence of adequate and complete treatment. Treatment details for each case can be seen in Table 7.15.

Table 7.14: Confirmed cases: Complete treatment by malaria species

	N	n	%	95% CI
Total cases with adequate treatment complete	7	4	57.1	(15 - 91)
P. vivax cases with adequate treatment complete	6	4	66.7	(17 - 95)
P. falciparum (non-resistant) with adequate treatment complete	1	0	0	(-)

Table 7.15: Indicator 4.03: treatment details

Case	Species	Chloroquine doses	Primaquine doses	Evidence of dose supervision	Doses supervised
Case 1	*P. vivax*	3	5	Yes	Chloroquine: 3 Primaquine: 5
Case 2	*P. falciparum*	3	14	Yes[1]	Chloroquine: - Primaquine: -
Case 3	*P. vivax*	3	14	Yes	Chloroquine: 3 Primaquine: 14
Case 4	*P. vivax*	3	14	No	Chloroquine: - Primaquine: -
Case 5	*P. vivax*	3	14	No	Chloroquine: - Primaquine: -
Case 6	*P. vivax*	3	15	Yes	Chloroquine: 4 Primaquine: 14
Case 7	*P. vivax*	3	14	Yes	Chloroquine: 3 Primaquine: 14

[1]Case had evidence of dose supervision registered, but not number of supervised doses.

Adequate and complete antimalarial treatment with supervision was negotiated as an indicator for RMEI. Cases with evidence of at least one dose of antimalarial treatment supervised are considered to have treatment supervision. In Belize, new treatment administration registries have been introduced as a part of RMEI, but no standard supervision record was in use during 2018. The malaria case reporting form shows the doses that have been administered, but does not provide a space to register supervision. Table 7.16 shows the indicator results. Only 57.1% of cases reviewed had evidence of complete and adequate treatment, and 71.4% had evidence of any supervision. This evidence could be a note on the case investigation form that one or more doses was supervised, or a separate form included in the patient's record at the district office. Overall, 28.6% of cases reviewed had evidence that treatment was adequate, complete, and supervised.

Table 7.16: Indicator 4.03: Complete treatment with supervision

	N	n	%	95% CI
Denominator: Total malaria cases	7	7	100	(-)
Adequate treatment and number of doses administered	7	4	57.1	(15 - 91)
Evidence of at least one supervised dose	7	5	71.4	(22 - 96)
Indicator Result: Complete treatment with supervision	7	2	28.6	(4 - 78)

7.5 Malaria case investigation

In the elimination phase, every confirmed case of malaria must be investigated by qualified personnel in order to identify the origin of the case and to plan a local-level response. The aggregate information from case investigations also informs surveillance planning at the regional and national levels.

7.5.1 Case investigation practices

In Belize, the malaria environmental investigation is usually carried out by a vector control technician after diagnosis is made. It includes an interview with the patient and an analysis of the information provided in order to classify the malaria case. The case investigation form is filled with the responses of the interview, as well as health care information such as the date, place, and results of malaria tests, and tracking of treatment administration and follow-up tests. A copy of the case investigation is filed at the vector control offices and at the central malaria program. In Belize, case investigation data was often captured from the medical record, though case investigation forms were reviewed for only three of seven cases.

7.5.2 Case detection source and classification

During the confirmed case medical record review, field personnel reviewed seven cases; case investigation information was recorded and captured for all but one. Case investigation details can be seen in Table 7.17.

Table 7.17: Confirmed case detection

Case	Species	Classification	Detection source	Case investigation
Case 1	*P. vivax*	Imported	Not registered	Completed
Case 2	*P. falciparum*	Imported	Not registered	Completed
Case 3	*P. vivax*	Autochthonous / indigenous / local	Passive search	Completed
Case 4	*P. vivax*	Imported	Active search	Completed
Case 5	*P. vivax*	Autochthonous / indigenous / local	Active search	Not registered
Case 6	*P. vivax*	Imported	Passive search	Completed
Case 7	*P. vivax*	Imported	Not registered	Completed

7.6 Case management

7.6.1 Patient follow-up testing: medical record review

All but one case in Belize had evidence of follow-up testing conducted post-treatment. Three cases had only one follow-up test. Follow-up testing details can be seen in Table 7.18.

Table 7.18: Follow-up testing after malaria treatment: medical record review

Case	Species	Follow-up testing conducted?	Number of follow-up tests	Days from treatment to first follow-up test	Days from treatment to last follow-up test	Result of last follow-up test
Case 1	*P. vivax*	Yes	1	3	-	Negative
Case 2	*P. falciparum*	Yes	1	3	-	Negative
Case 3	*P. vivax*	Yes	5	3	28	Negative
Case 4	*P. vivax*	Not registered	-	-	-	-
Case 5	*P. vivax*	Yes	5	Not registered	Not registered	Not registered
Case 6	*P. vivax*	Yes	3	3	14	Negative
Case 7	*P. vivax*	Yes	1	3	-	Not registered

7.7 Case response

Information extracted from the case investigation also allows vector control programs to plan community activities in response to a confirmed malaria case. Details on the case response for cases where the investigation was completed are displayed in Table 7.19. Family memebers were not always tested for malaria, and the active case detection details suggest that there is variation in the case response procedure across cases.

Table 7.19: Medical record review case response

Case	Patient used mosquito net	Patient home was sprayed	Family members tested for malaria	Active case detection conducted	Number of houses visited for ACD	Malaria tests taken during ACD	Houses sprayed during ACD
Case 1	Not registered	No	1 / 2	Yes	1	None	None
Case 2	Not registered	Not registered	Not registered	Not registered	-	-	-
Case 3	Yes	Yes	2 / 3	Yes	Not registered	Not registered	Yes (number not registered)
Case 4	Not registered	No	3 / 3	Yes	190	Not registered	Not registered
Case 6	No	Yes	1 / 3	Yes	Not registered	Not registered	Yes (number not registered)
Case 7	Yes	Yes	0 / 2	Yes	46	Not registered	None

Chapter 8: Surveillance, Notification, and Reporting

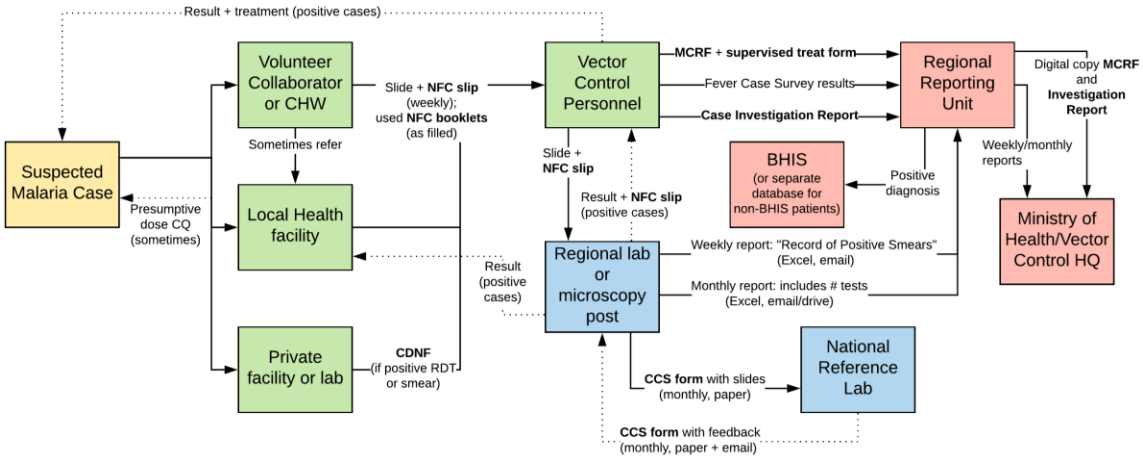
This chapter provides an overview of the malaria surveillance system in Belize based on the fact-finding visit and health facility surveys, and summarizes results related to case reporting and laboratory reporting and quality control indicators.

8.1 Background

The fact-finding trip in July 2019 allowed for an understanding of notification and reporting flows at the local, regional, and central levels. The trip focused on identifying how individual cases are notified (including positive and negative test results for suspected cases) and understanding the weekly and/or monthly reporting requirements to which facilities are subject. This regular, aggregate reporting allows the regional and central levels to stay aware of malaria transmission activity, and the data can be used as an input for planning and directing resources where they are most needed.

Figure 8.1 shows the information flows beginning with a patient with malaria symptoms. The left side of the diagram shows sample-taking and examination practices, already discussed in Chapters 5 and 6. Once a slide has been examined, the patient must be informed of the test result. Additionally, the laboratory is obligated to prepare regular reports of malaria test results. Negative results are informed in aggregate, once weekly or once monthly. Positive results are notified immediately to the central-level vector control program and to health personnel at the point where the sample was taken. Any positive results will also be included in aggregate monthly or weekly laboratory reporting. Facilities with capacity to diagnose malaria are obligated to prepare monthly or weekly case reports, and to send these reports to the malaria program.

Figure 8.1: Belize surveillance system flow diagram



DEFINITIONS:

NFC slip = Notification of Fever Case slip, used when taking blood samples. Half-sheet accompanies slide from point of care to point of diagnosis and stub remains in booklet.

CDNF = Communicable Disease Notification Form, used by private labs or facilities to notify public system of a positive case of a notifiable disease.

MCRF = Malaria Case Reporting Form. Confirmed case reporting, investigation, and treatment tracking form for positive cases. Current version used throughout 2018.

CCS = Cross-Checking of Slides form used for indirect quality control. Includes 100% of positive samples taken and 10% of negative samples (every 10th slide) taken.

BHIS = Belize Health Information System. Database for all suspected cases.

8.2 Notification of malaria test results

8.2.1 Notification to patient among facilities that send slides elsewhere for diagnosis

The health facility interview included questions about notification of malaria test results. As described in Chapter 5, health facilities that do not have microscopic diagnostic capacity in-facility (or have it in-facility

only at certain days or hours) send thick blood film slides to a microscopy post or laboratory for initial diagnosis, typically operated by a regional vector control office. Most facilities indicated that vector control personnel are responsible for notifying patients of negative test results. Table 8.1 shows the personnel responsible for notification of a negative test result among the 6 facilities that send slides elsewhere for examination and reported they receive negative test results for the slides they send. Respondents could indicate more than one answer.

Table 8.1: Notification to patient of negative test results (among primary care facilities, polyclinics, and hospitals that send slides elsewhere for examination and receive notice of negative test results): personnel

	N	n	%	95% CI
Who notifies the patient of a negative test result?				
The patient is not notified	6	3	50	(16 - 84)
Vector control personnel	6	2	33.3	(8 - 75)
Health personnel from this facility	6	1	16.7	(2 - 66)

In the case of a positive test result, 11 facilities that send slides elsewhere for examination reported they receive positive test results for the slides they send. Positive test result notification was the responsibility of vector control personnel where the test was sent.

Table 8.2: Notification to patient of positive test results (among primary care facilities, polyclinics, and hospitals that send slides elsewhere for examination): personnel

	N	n	%	95% CI
Who notifies the patient of a positive test result?				
Vector control personnel	11	11	100	(-)

8.3 Malaria surveillance data and reporting

All health facilities in the sample were asked if they have access to an electronic health information system (known as Belize Health Information System or *BHIS*) as shown in Table 8.3. Fifty percent of primary care facilities, polyclinics, and hospitals and 71.4% of vector control offices reported access. Facilities with access to any electronic information system were asked if they have access to a system for entering information about malaria, and 13.3% of health units and hospitals and 20% of vector control units reported access to a system used for malaria information.

Table 8.3: Access to electronic information systems

	N	n	%	95% CI
Primary care facilities, polyclinics, and hospitals				
Access to an electronic health information system for capturing and/or consulting health statistics	30	15	50	(32 - 68)
Access to an electronic health information system for entering malaria-specific information	15	2	13.3	(3 - 42)
Vector control offices				
Access to an electronic health information system for capturing and/or consulting health statistics	7	5	71.4	(31 - 93)
Access to an electronic health information system for entering malaria-specific information	5	1	20	(2 - 71)

8.3.1 Indicator 2.03: Malaria case reporting

RMEI indicator 2.03 has two parts: case reporting and laboratory reporting. According to the negotiated definition for case reporting, vector control offices in Belize that conduct malaria diagnosis must send

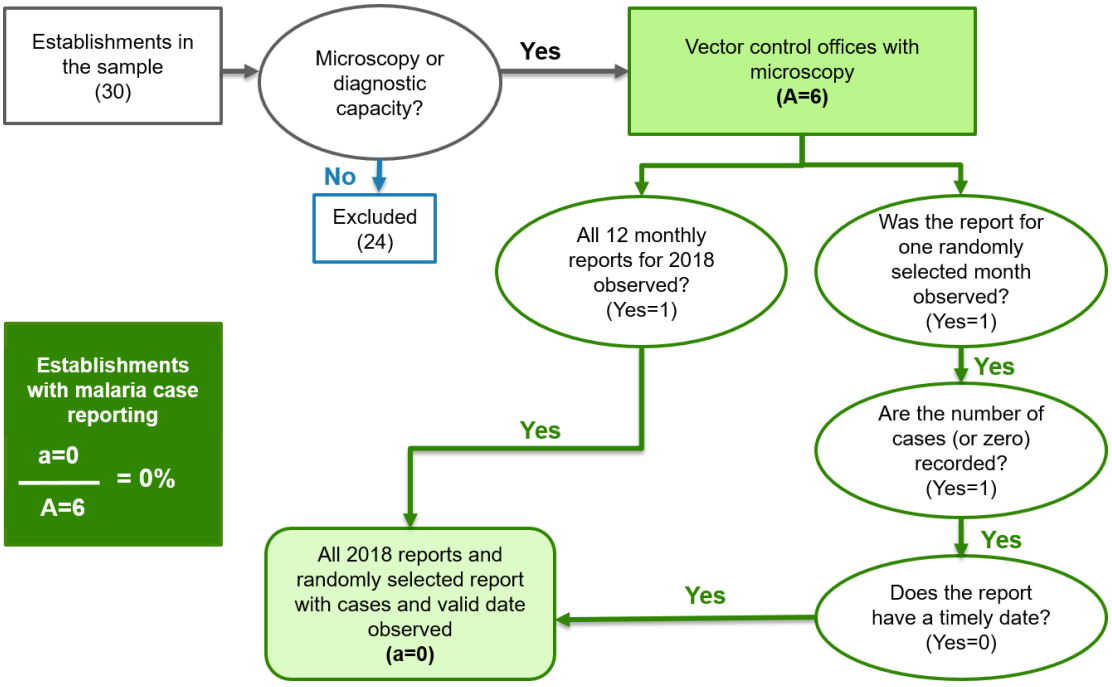
monthly reports to the central-level vector control that include the aggregate number of malaria cases detected during the month, or a notification that zero malaria cases were detected. The report is to be sent within the first 12 days of the following month and have the date sent from the facility recorded on the report. The report can be specific to malaria or combined with other notifiable diseases, so long as the exact number of malaria cases can be determined from the report.

Field personnel conducted an audit of all malaria case reports from 2018 stored at vector control offices in the sample. They began by discerning whether the facility prepared monthly or weekly reports during 2018. They then sought to observe all 12 monthly reports for the year 2018. If a month was missing, they looked for written evidence of why the report was not submitted (for example, if the only microscopist was on holiday). Next, the electronic survey module presented a randomly selected month. Surveyors sought to find the reports corresponding to this month, and then proceeded to enter detailed information from the report to the survey module, such as the number of malaria cases reported (or whether zero cases were reported) and the date sent or received as listed on the report (or as listed in a logbook of official correspondence sent and received, in facilities that use such a book). Health facility eligibility and completion of indicator according to a decision algorithm is shown in Figure 8.2.

Table 8.4 shows the results of the case reporting component of the indicator, which requires the following:

- that the reports be in a monthly format
- that all 12 reports be observed for the year 2018
- that the report be observed for the selected month with send date
- that all the send date is verified to be within the first 12 days of the following month

Figure 8.2: Eligibility of health facilities for Indicator 2.03 (case reporting)



Six vector control offices are eligible for consideration in the indicator. The results are shown in Table 8.4 and no units met all the requirements of the indicator.

Table 8.4: Indicator 2.03: Case reporting

	N	n	%	95% CI
Vector control offices with diagnostic capacity	7	6	85.7	(39 - 98)
Units indicating reporting of malaria cases	6	6	100	(-)
At least one monthly report from 2018 observed	6	2	33.3	(8 - 75)
All 12 monthly reports from 2018 observed	6	1	16.7	(2 - 66)
Report for randomly selected month observed	6	1	16.7	(2 - 66)
Number of cases (or zero) recorded for report of randomly selected month	6	1	16.7	(2 - 66)
Date for report of randomly selected month observed	6	1	16.7	(2 - 66)
Date for report of randomly selected month is valid[1]	6	0	0	(-)
Result: Malaria case reporting to standard	6	0	0	(-)

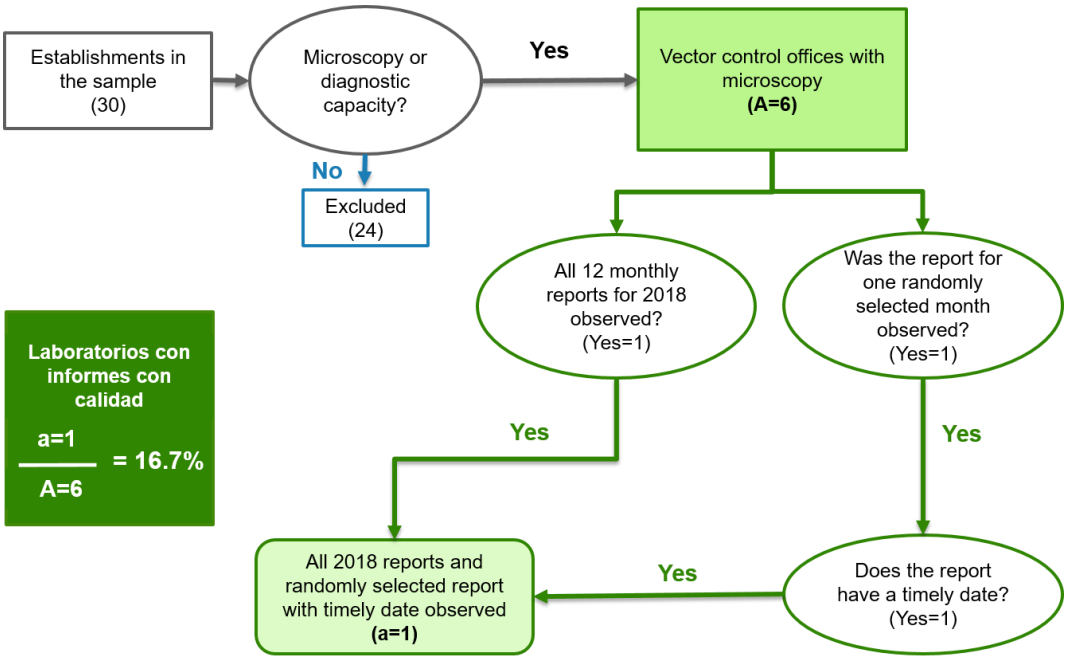
[1]One unit had weekly reports available, for which all 52 were observed. One send date for reports of the randomly selected month was invalid.

8.3.2 Indicator 2.03: Laboratory production reporting

The other component of Indicator 2.03 is the observation of monthly laboratory production reports that show the number of TBF slides examined and the number of RDTs performed. All facilities that conduct malaria diagnosis must send these reports to the malaria program within the first 12 days of the following month. The observation of the laboratory reports during the survey was conducted in the same way as the case reports. Health facility eligibility and completion of indicator according to a decision algorithm is shown in Figure 8.3. The indicator required:

- that the reports be in a monthly format
- that all 12 reports be observed for the year 2018
- that the report be observed for the randomly selected month with send date
- that the send date is verified to be within the first 12 days of the following month

Figure 8.3: Eligibility of health facilities for Indicator 2.03 (laboratory reporting)



Six vector control offices are eligible for consideration in the indicator. The results are shown in Table 8.5; one unit met all the requirements of the indicator.

Table 8.5: Indicator 2.03: Lab reporting

	N	n	%	95% CI
Vector control offices with diagnostic capacity	7	6	85.7	(39 - 98)
At least one monthly report from 2018 observed	6	2	33.3	(8 - 75)
All 12 monthly reports from 2018 observed	6	1	16.7	(2 - 66)
Report for randomly selected month observed	6	1	16.7	(2 - 66)
Date for report of randomly selected month observed	6	1	16.7	(2 - 66)
Date for report of randomly selected month is valid	6	1	16.7	(2 - 66)
Result: Laboratory production reporting to standard[1]	6	1	16.7	(2 - 66)

[1]One unit had weekly reports available, for which all 52 were observed. All send dates for reports of the randomly selected month was invalid.

8.4 Indicator 3.02: Laboratory quality control

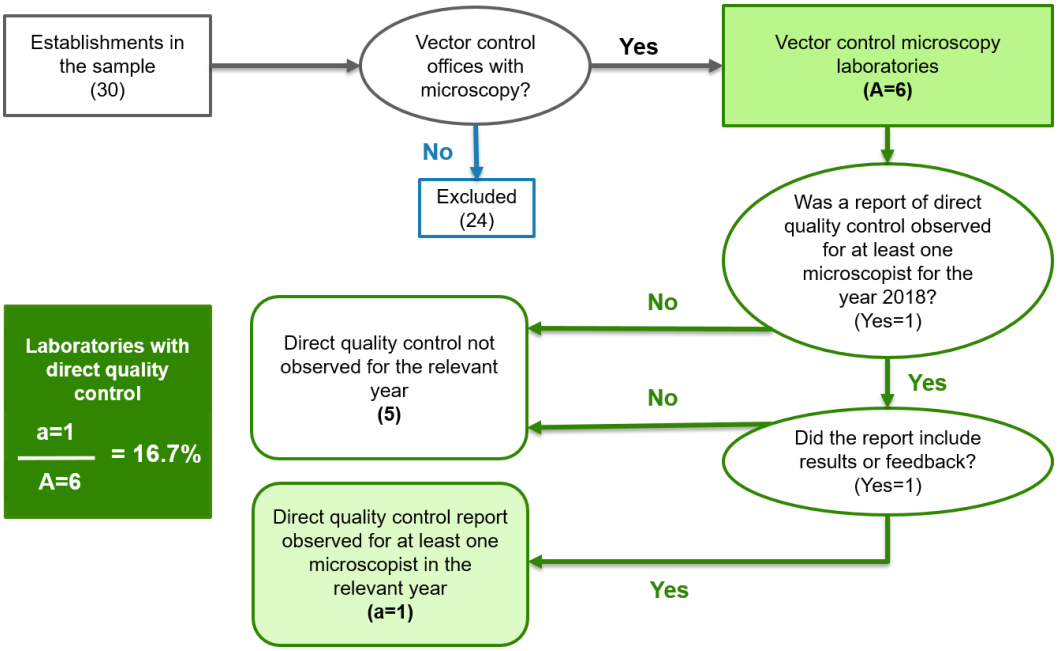
The RMEI indicators also require participation of the national reference laboratory for malaria in an external quality control certification with the Pan American Health Organization, which was observed at the Belize national reference laboratory at the Southern Regional Hospital for the year 2018.

Additionally, all vector control laboratories that diagnose malaria through microscopy must participate in direct and indirect quality control exercises with their corresponding regional reference laboratory, and personnel of the regional laboratory must participate in the same exercises with the national reference laboratory. Thus, six laboratories are eligible for the indicator.

The first exercise, direct quality control, is a yearly slide panel exam administered by the reference laboratory in which the evaluated microscopist must examine several slides (for which the results are known by the reference laboratory) and submit the test result of each with parasite density and species. The reference laboratory then checks the results submitted and provides feedback to the evaluated microscopist. Based on the fact-finding visit, we were aware that this assessment was not conducted universally in Belize during 2018 due to limited availability of positive samples to use in the panel.

Health facility eligibility was determined according to a decision algorithm shown in Figure 8.4. According to Table 8.6, complete evidence of participation in direct quality control was observed at 16.7% of local and regional laboratories. The evidence required was a report of the results of the 2018 exam received back from the reference laboratory with feedback.

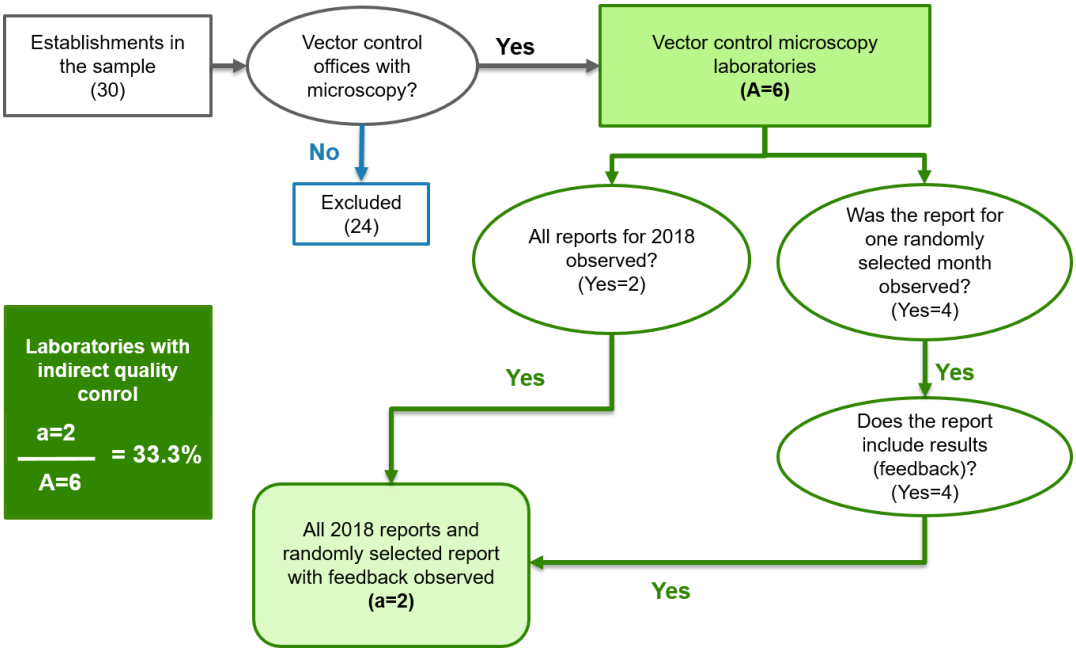
Figure 8.4: Eligibility of health facilities for Indicator 3.02 (direct)



The second exercise, indirect quality control, is a cross-check by a senior microscopist of a set proportion of the slides initially diagnosed by each vector control laboratory. Based on the fact-finding visit, we were aware that in Belize during 2018, the indirect quality control exercise took the form of a peer exchange for slide review since the national reference laboratory had not yet been established. Laboratories must send 10% of the slides (every 10th slide examined) with a negative test result for malaria and 100% of the slides with a positive test result for cross-checking each month. Health facility eligibility was determined according to a decision algorithm shown in Figure 8.5. While 66.7% of laboratories reported participating in quality control, only 33.3% met the standards of the indicator based on the reporting observation. The evidence required was:

- that all 52 reports (or written evidence that no slides were examined in a given week without a report) be observed for the year 2018 for reports in a weekly format OR
- that all 12 reports be observed for the year 2018 for reports in a monthly format
- that the report be observed for a randomly selected month in 2018 (or the corresponding four epidemiological weeks), with results or feedback from the reference laboratory.

Figure 8.5: Eligibility of health facilities for Indicator 3.02 (indirect)



The detailed results of the indicator are shown in Table 8.7 and Table 8.8.

Table 8.6: Indicator 3.02: Quality control

	N	n	%	95% CI
External quality control: 2018 National Lab Evaluation form observed	1	1	100	(-)
Direct	6	1	16.7	(2 - 66)
Indirect	6	2	33.3	(8 - 75)

Table 8.7: Indicator 3.02: Indirect and direct quality control

	N	n	%	95% CI
Facilities with microscopy	37	6	16.2	(7 - 33)
Facilities passing direct quality control (DQC) component	6	1	16.7	(2 - 66)
Facilities that report participating in DQC	6	1	16.7	(2 - 66)
Feedback for at least one assessment in 2018 was observed	6	1	16.7	(2 - 66)
Feedback report with results was dated 2018	6	1	16.7	(2 - 66)
Facilities passing indirect quality control (IDQC) component	6	2	33.3	(8 - 75)
Facilities that report participating in IDQC	6	6	100	(-)
Randomly selected month report was observed	6	4	66.7	(25 - 92)
Cross-checked results and feedback were observed on randomly selected report	6	4	66.7	(25 - 92)
All reports observed for 2018	6	2	33.3	(8 - 75)
Facilities passing both direct and indirect quality control	6	0	0	(-)

Table 8.8: Indicator 3.02: Indirect quality control in detail

	N	n	%	95% CI
Facilities with microscopy	37	6	16.2	(7 - 33)
At least one report was observed for 2018	6	4	66.7	(25 - 92)
Reports are monthly	6	4	66.7	(25 - 92)
1-3 reports observed	6	0	0	(-)
4-7 reports observed	6	2	33.3	(8 - 75)
8-11 reports observed	6	0	0	(-)
12 reports observed	6	2	33.3	(8 - 75)
All reports observed for 2018	6	2	33.3	(8 - 75)

Chapter 9: Challenges, Conclusions, and Recommendations

9.1 Challenges and limitations

9.1.1 Challenges for health facility data collection

In Belize, field personnel were able to gain authorization to interview in selected health facilities. Many facilities did not have slides for sample taking in stock, and none had the RDTs that were planned for introduction as a part of RMEI. Storage and administration of malaria treatments are managed by the vector control program in Belize, and as mentioned in Chapters 5 and 7, data collectors did not seek to observe antimalarial stock at vector control offices but rather at health facility pharmacies. For this reason, we cannot determine the status of antimalarial storage for vector control offices and antimalarial stock was not considered a requirement for Indicator 7.01.

9.1.2 Challenges for suspected case review

A key challenge for the review of suspected malaria cases was identification of a sufficient number of eligible cases, particularly in smaller health facilities. In 13 primary care facilities, no eligible suspected cases from 2018 were available for review. Interviewers were able to use BHIS diagnosis databases to draw the sample of suspected cases in all hospitals and polyclinics and in half of the 10 primary care facilities with records available. Lists of fever cases were not available in the remaining five facilities, so the field team usually had to select the sample of suspected cases based on daily attention logbooks or registration sheets. Due to the low number of medical records available for review in some facilities, the sample size was increased at subsequent facilities to compensate, but the overall quota of 900 completed suspected case medical records was not met.

Counter to expectations from all facilities interviewed at the fact-finding visit, data collection found that in many facilities, information about malaria testing was recorded only in lab logbooks or fever case notification booklets, and test orders and results were not transferred to BHIS nor to paper medical records. Thus, it is possible that some patients presenting with fever have a blood sample taken and a malaria test examined, but no record of the procedure is maintained.

9.1.3 Challenges for case and laboratory reporting review

In Belize, there are nationally standard electronic practices for case and laboratory reporting, but paper or electronic evidence of timely reports from 2018 was observed at few facilities. One facility prepared weekly reports, but the RMEI indicators require a monthly report be observed.

Evidence of quality control participation to standard was also observed at relatively few laboratories. Based on the fact-finding trip, we anticipated that participation in direct quality control would be low because the assessment is not administered to each laboratory on an annual basis due to a shortage of positive malaria slides to use in the panel. Indirect quality control was also known to be taking place as an inconsistent, peer-review process during 2018, prior to the recent establishment of the Belize National Malaria Reference Laboratory at Southern Regional Hospital.

Case and laboratory reporting formats do not typically include the date sent or received, and electronic submission has changed from an email-based process (with time stamp) to data entry to an online shared document (with no time stamp), complicating the attempt to evaluate timeliness of submission. Additionally, field personnel were sometimes unable to observe the forms from the year 2018 when facility personnel were unable to find the files. This was a particular problem where there had been changes in laboratory or statistics personnel since 2018.

9.1.4 Challenges for household data collection

Household data collection in Belize encountered few logistical challenges. In terms of the measurement of vector control intervention coverage, interviewers found that mosquito nets they observed were

generally not labeled with a brand name (unless they were still in their original packaging and unused). Evidence of the completion and date of indoor residual spraying (such as a “house card” signed by vector control personnel) was rarely observed. Recall bias has the potential to affect results for both vector control and case detection indicators, as respondents may have trouble remembering the details of a recent fever, or the time frame when IRS was applied to their home. For most of the fevers reported during the last two weeks, the respondent also reported exclusion symptoms, therefore the sub-sample size for the case detection indicator is small.

9.2 Key findings and recommendations

Migration to electronic information systems must take into account the effectiveness of current paper-based practices. Forms should be reviewed in order to ensure essential information, such as records of treatment supervision and follow-up testing for malaria patients, is captured. But more importantly, the pipeline from practices taking place in health facilities to the final electronic database should be reviewed and improved to ensure the highest quality data is accessible at all relevant levels of the system, including basic medical history such as malaria test dates and results that is essential to the provision of quality care. The emphasis must be on ensuring complete and precise data at the lowest levels of information, and in enabling effective data storage, processing, quality control, and analysis for decision-making at the district, region, and central levels.

Because malaria and other infectious disease programs have been managed for decades as parallel, vertically integrated systems, some disconnects between service provision in health facilities and through the vector control program persist. Different groups manage different activities for case detection, case management, and vector control, and there is not always a clear coordination plan. While patient medical records have transitioned to an electronic system, registers of malaria tests and records for confirmed cases are managed by the vector control program in a separate paper-based system. To reach malaria elimination, stakeholders will have to work to bridge gaps and reduce fragmentation in service provision.

Some practices and procedures are not standardized in Belize, in particular adherence to laboratory quality control participation and in terms of detection and record-keeping protocols for patients with fever presenting at a health facility (suspected malaria cases). At the local level, there is a notable variation in practices among health facilities, and sometimes a lack of understanding of central-level operations and goals. It is crucial to reach a shared understanding of how each part of the system connects with the others in order to reach success in malaria elimination and other projects in the Mesoamerican region.

Appendix A: Indicator Matrices

A.1 Performance indicator matrix

#	Indicator	N	%	CI
2.01	Suspected cases with malaria test (MRR)	836	2.6	(2 - 4)
2.03	Case reporting with quality	6	0	(-)
	Lab production reporting	6	16.7	(2 - 66)
3.02	Quality control (external)	1	100	(-)
	Quality control (direct)	6	16.7	(2 - 66)
	Quality control (indirect)	6	33.3	(8 - 75)
4.01	Treatment within 24 hours	7	57.1	(15 - 91)
4.03	Treatment complete and supervised	7	28.6	(4 - 78)
6.01	Vector control coverage	1367	27.9	(20 - 38)
7.01	Equipment and instruments for diagnosis and treatment	31	16.1	(7 - 34)

A.2 Monitoring indicator matrix

#	Indicator	N	%	CI
M2.02	Fever cases with blood sample	53	18.9	(8 - 40)
E2.04	Notified within 24 hours of detection	7	57.1	(15 - 91)
E3.03	Equipment and instruments for sampling, diagnosis and RDTs	31	16.1	(7 - 34)
M4.02	Diagnosis within 48 hours	5	20	(1 - 83)
E4.05	Health facilities without stockouts of first-line treatments	0		-
E6.03	Population protected by IRS	1465	27.4	(25 - 30)
E6.05	Population protected by ITNs	1488	1	(1 - 2)

#	Indicator	N	Median	CI
E4.03	Median time between onset of symptoms and start of treatment (days): surveillance type not registered	2	8	(-)
	Median time between onset of symptoms and start of treatment (days): passive surveillance	2	10	(-)
	Median time between onset of symptoms and start of treatment (days): active surveillance	1	27	(-)

Appendix B: Indicator Definitions

This section defines the indicators verified in IHME surveys, and excludes others that are measured by expert review.

P2.01: Suspected malaria cases with parasitological test

Source: Medical record review of suspected cases of malaria

Denominator: Cases with suspicion of malaria (registered fever or eligible diagnoses)

Sampling by ICD code - diagnoses eligible for review

- A41.9 Sepsis, unspecified organism
- A68 Relapsing fevers
- A68.9 Relapsing fever, unspecified
- A98.5 Hemorrhagic fever with renal syndrome
- B34.9 Viral infection, unspecified
- B50 *Plasmodium falciparum* malaria
- B50.0 *Plasmodium falciparum* malaria with cerebral complications
- B50.8 Other severe and complicated *Plasmodium falciparum* malaria
- B50.9 *Plasmodium falciparum* malaria, unspecified
- B51 *Plasmodium vivax* malaria
- B51.0 *Plasmodium vivax* malaria with rupture of spleen
- B51.8 *Plasmodium vivax* malaria with other complications
- B51.9 *Plasmodium vivax* malaria without complication
- B52 *Plasmodium malariae* malaria
- B52.0 *Plasmodium malariae* malaria with nephropathy
- B52.8 *Plasmodium malariae* malaria with other complications
- B52.9 *Plasmodium malariae* malaria without complication
- B53 Other specified malaria
- B53.0 *Plasmodium ovale* malaria
- B53.1 Malaria due to simian plasmodia
- B53.8 Other malaria, not elsewhere classified
- B54.X Unspecified malaria
- G03.9 Meningitis, unspecified
- R16 Hepatomegaly and splenomegaly, not elsewhere classified
- R16.1 Splenomegaly, not elsewhere classified
- R16.2 Hepatomegaly with splenomegaly, not elsewhere classified
- R17.X Unspecified jaundice
- R50 Fever of other and unknown origin
- R50.0 Fever with chills
- R50.1 Persistent fever
- R50.8 Other specified fever
- R50.9 Fever, unspecified
- R51.X Headache
- R68 Other general symptoms and signs
- R68.8 Other general symptoms and signs
- A27 Leptospirosis
- A27.0 Leptospirosis icterohemorrhagica

- A278 Other forms of leptospirosis
- A279 Leptospirosis, unspecified
- A90.X Dengue fever [classical dengue]
- A91.X Dengue hemorrhagic fever
- A92 Other mosquito-borne viral fevers
- A92.0 Chikungunya virus disease
- A92.8 Other specified mosquito-borne viral fevers
- A92.9 Mosquito-borne viral fever, unspecified

Sampling by presumptive or final diagnosis - diagnoses eligible for review

- Fever (acute, relapsing, persistent, unspecified, etc.)
- Malaria (*P. falciparum*, *P. vivax* or unspecified)
- Leptospirosis
- Dengue (classical, hemorrhagic or unspecified)
- Chikungunya
- Mosquito-borne fever
- Viral infection, unspecified
- Meningitis
- Hepatomegaly
- Splenomegaly

Sampling by principal complaint - motives eligible for review

- Fever
- Malaria
- Dengue
- Chikungunya

Numerator: Cases with evidence a malaria test was ordered

Exclusions:

1. Health facility in stratum 2 and 3 + documented patient residence in strata 1, 2, or 3 + documented lack of travel history to stratum 4 nor endemic country + no evidence of intermittent symptoms (fever+chills+sweating)

2. Diagnoses ineligible without a documented fever:

All health facilities:

Sampling by ICD code

- A41.9 Sepsis, unspecified organism
- B34.9 Viral infection, unspecified
- G03.9 Meningitis, unspecified
- R68 Other general symptoms and signs
- R68.8 Other general symptoms and signs
- A27 Leptospirosis
- A27.0 Leptospirosis icterohemorrhagica
- A27.8 Other forms of leptospirosis
- A27.9 Leptospirosis, unspecified

Sampling by presumptive or final diagnosis

- Leptospirosis

- Viral infection, unspecified
- Meningitis

Only health facilities in stratum 2 and 3:

Sampling by ICD code
- R16 Hepatomegaly and splenomegaly, not elsewhere classified
- R16.1 Splenomegaly, not elsewhere classified
- R16.2 Hepatomegaly with splenomegaly, not elsewhere classified
- R17.X Unspecified jaundice
- R51X Headache

Sampling by presumptive or final diagnosis
- Hepatomegaly
- Splenomegaly

3. Diagnoses ineligible for record review (febrile illnesses with defined etiology):

- Arbovirus with positive viral test
  - Dengue
  - Chikungunya
  - Zika
  - Acute respiratory infection
- Gastrointestinal infection
- Fever of neurological origin
- Skin lesion
- Urinary infection
- Findings in soft tissues
- Focal infection
- Other parasitological infection

M2.02: Fever cases with blood sample

Source: Household survey

Denominator: People in stratum 3 and 4 communities who reported fever during the two weeks prior to the survey

Numerator: People who reported a blood sample was taken from their finger, heel, earlobe, or vein during their febrile illness

Exclusions: People who reported the presence of respiratory, urinary, or skin symptoms during their febrile illness (Sore throat, difficulty swallowing, ear pain and secretions, cough with discharge or phlegm, mucus or nasal secretions, intercostal retractions or retractions of the thorax muscles, pain or discomfort urinating, strong smelling urine, dark colored urine, genital itch, frequent urination and in small quantities, vaginal or penile secretions, pimples or rash, redness or inflammation of the skin or presence of pus in the skin, open wounds with presence of pus or black borders)

P2.03a: Malaria case reports with quality standards

Source: Health facility observation

Denominator: Vector control offices with self-reported diagnostic capacity (microscopy or RDTs)

Numerator: Vector control offices with monthly epidemiological surveillance reports observed

- Reports list the aggregate number of malaria cases or report of zero cases
- Reports observed for all 12 months of the year 2018
- Reports in randomly selected month list sending date
- All observed dates within first 12 days of the following month

P2.03b: Malaria laboratory production reports with quality standards

Source: Health facility observation

Denominator: Vector control offices with self-reported diagnostic capacity (microscopy or RDTs)

Numerator: Vector control offices with monthly laboratory production reports observed

- Reports list the malaria samples taken (thick blood film or RDT)
- Reports observed for all 12 months of the year 2018
- Reports in randomly selected month list sending date
- All observed dates within first 5 days of the following month

P3.02a: National laboratory participates in external quality control

Source: Health facility observation

Denominator: National malaria reference laboratory

Numerator: Laboratory with observation of Diagnostic Performance Results Report from the Pan American Health Organization dated 2018 or 2019**

Exclusions: N/A

P3.02b: Laboratories that participate in direct quality control

Source: Health facility observation

Denominator: Vector control offices with self-reported microscopic diagnostic capacity

Numerator: Vector control offices with observation of Laboratory Assessment Results Report (for slide panel exam) from the reference laboratory for at least one microscopist responsible for malaria diagnosis, dated 2018

Exclusions: N/A

P3.02c: Laboratories that participate in indirect quality control

Source: Health facility observation

Denominator: Vector control offices with self-reported microscopic diagnostic capacity

Numerator: Vector control offices with monthly (or weekly) slide cross-check reports observed

- Reports observed for all 12 months or 52 weeks of the year 2018
- Reports in randomly selected month have results and feedback from the reference laboratory

Exclusions: N/A

P4.01: Malaria cases with treatment within 24 hours of diagnosis

Source: Medical record review of confirmed cases of malaria

Denominator: Number of confirmed malaria cases reviewed

Numerator: Number of confirmed malaria cases that received first-line antimalarial treatment according to national policy the day of diagnosis or the day after diagnosis, as recorded on case notification or investigation forms

- *P. vivax* or *P. falciparum* from areas without chloroquine resistance: chloroquine + primaquine
- Imported *P. falciparum* cases from areas with documented resistance to chloroquine: artemisinin-based treatment (artemether + lumefantrine) + primaquine
- Severe malaria cases: artesunate or quinine or artemether (or others according to the norm)

Exclusions: Cases with an extreme time interval (suspected of registration errors): treatment begun more than 7 days before or more than 30 days after diagnosis date

M4.02: Malaria cases with diagnosis within 48 hours of start of symptoms

Source: Medical record review of confirmed cases of malaria

Denominator: Number of confirmed malaria cases reviewed

Numerator: Number of confirmed malaria cases that were diagnosed within two days or less after fever or other symptoms began, as recorded on case notification or investigation forms

Exclusions: Cases with an extreme time interval (suspected of registration errors): diagnosis more than 7 days before or more than 30 days after symptoms began

P4.03: Malaria cases with complete and supervised treatment

Source: Medical record review of confirmed cases of malaria

Denominator: Number of confirmed malaria cases reviewed

Numerator: Number of confirmed malaria cases that received complete antimalarial treatment according to national policy with at least one dose supervised, as recorded on case notification or investigation forms

- For *P. vivax* cases: 3 days of chloroquine and 14 days of primaquine
- For *P. falciparum* cases without documented resistance to chloroquine: 3 days of chloroquine and one day of primaquine
- For mixed infections cases without documented resistance to chloroquine: 3 days of chloroquine and 14 days of primaquine
- For imported *P. falciparum* cases from areas with documented resistance to chloroquine: 3 days of artemisinin-based treatment (artemether + lumefantrine) and one day of primaquine
- For severe malaria cases: If IV treatment with artesunate started, when completed: 3 days of artemisinin-based treatment (artemether + lumefantrine) and one day of primaquine

Exclusions: If the patient died, treatment will be required until the day prior to death. Cases with death on the day of diagnosis or the following day excluded.

P6.01: Risk group protected with vector control interventions

Source: Household survey

Denominator: People who slept at home the night before the survey in target communities (determined from sampling documentation provided by the Ministry of Health)

Numerator: People protected by either of two vector control interventions (IRS or LLIN)

- Respondent informed that interior walls of dwelling were sprayed in the 12 months prior to the survey
- Respondent informed that the individual slept under an insecticide-treated net the night prior to the survey

Exclusions: People in households with “don’t know” response to indoor residual spraying, who did not sleep under a net the night prior

P7.01: Equipment and supplies for malaria diagnosis and treatment

Source: Health facility observation

Denominator: Points of care and laboratories

Numerator: Points of care and laboratories with supplies for the diagnosis and treatment of malaria observed the day of the survey and without stockout in the three months prior to the survey

Supplies for taking samples and elements for basic biosafety: Disposable gloves + lancets + microscope slides

- All health centers, polyclinics, and community hospitals

Forms for sending slide samples

- All health centers, polyclinics, and community hospitals

Supplies for on-site diagnosis: Rapid diagnostic tests (RDTs)

- All stratum 3 and 4 health centers and polyclinics

Equipment for microscopy: Microscope (with 100x retractable lens) + cell counter (manual or automatic)

- All vector control offices that reported microscopic diagnostic capacity

Supplies for staining and testing: Immersion oil + concave slide or coloring tray/container + laboratory stopwatch (or other method of keeping time) + plastic or glass tubes (or alternative according to country) + syringe/pipette/dropper

- All vector control offices that reported microscopic diagnostic capacity

Reagents for staining: Giemsa or [Methylene blue + Solution A + Solution B + Methanol] + Buffer solution or [buffer tablets + distilled water]

- All vector control offices that reported microscopic diagnostic capacity

Exclusions:

Supplies for taking samples and elements for basic biosafety: Disposable gloves + lancets + microscope slides

- Nine eligible establishments where this information was not captured due to an error in the survey logic are excluded from this component of the indicator.

Forms for sending slide samples

- Nineteen eligible establishments where this information was not captured due to an error in the survey logic are excluded from this component of the indicator.

First-line antimalarial medications: Chloroquine tablets + Primaquine tablets (15 mg or 5 mg) without stockout in the three months prior to the survey

- All vector control offices. Due to an error during data collection, the pharmacy observation module was not conducted at vector control offices, but instead in the pharmacy of the health facilities that adjoin each vector control office. For this reason, antimalarial stock data for vector control offices is missing. Antimalarials were not observed in any hospital pharmacies in Belize. Thus, we do not require observation of antimalarials at any health facility for the Belize baseline indicator calculation.

Antimalarial medications for severe malaria: Quinine or Artesunate [tablets, IV, or rectal] without stockout in the three months prior to the survey

- All regional hospitals and Karl Heusner Memorial Hospital. Due to an error during data collection, the pharmacy observation module was not conducted at vector control offices at these hospitals, but instead in the pharmacy of the hospital that adjoins each vector control office. For this reason, antimalarial stock data for vector control offices is missing. Antimalarials were not observed in any hospital pharmacies in Belize. Thus, we do not require observation of antimalarials at any health facility for the Belize baseline indicator calculation.

Antimalarial medications for cases of P. falciparum from areas of known chloroquine resistant malaria:* Derivatives or artemisinin (artemether + lumefantrine) without stockout in the three months prior to the survey

- Does not apply for any facilities in baseline sample

Appendix C: Sample design and methods

C.1 Sample size

The size of the sample of health facilities for Belize was defined as a part of the funding proposal to cover 30 points of measurement. In the case of the RMEI indicators, the “effective sample size”, or number of observations with data available for a specific indicator, varies from a fraction of the facility sample (e.g., participation in microscopy quality control assessment can only be measured in facilities with microscopy capabilities) to a much larger number (e.g., several hundred records of fever cases reviewed to verify if a malaria test was taken). The sample of 30 points was allocated purposively among different types of facilities based on the findings of the joint IDB-IHME fact-finding visit in order to satisfy minimum anticipated effective sample sizes. The LQAS measurement was defined as a part of the funding proposal to cover 16 communities with 25 households surveyed in each, or a total of 400 households surveyed.

In terms of the ability to calculate indicator estimates precisely, as the size of the sample increases, the marginal return (in terms of estimation power) of each additional observation diminishes. The probability of failing to detect a true impact decreases as sample size increases, but the chance of a “false positive” finding rises. Thus, the statistics of sample size calculations focuses on balancing the risk of these two types of error by identifying the minimum sample size necessary to detect a difference considered to be meaningful, or to calculate an estimate with believable precision. Another important consideration in fixing the sample size for a public health intervention is financial, in order to maximize the resources available to benefit the target population by keeping measurement costs modest. The per-facility cost of data collection is also subject to an economy of scale, but the decrease in cost for the marginal facility is modest after 30 facilities, based on IHME’s data collection experience in the region.

The precision of the indicator estimate is driven by two factors: the size of the sample, and the population variance of the indicator. For a binary indicator, an estimate near 0 or near 1 will have low population variance. An estimate between .25 and .75 will have higher population variance. Because the sample was selected before RMEI indicators had been tracked or reported in Belize, the population variance was difficult to estimate a priori, necessitating review of a range of scenarios where population variance and sample size are allowed to vary, as shown in Figure C.1.

Figure C.1: Sample size and corresponding margin of error by population variance

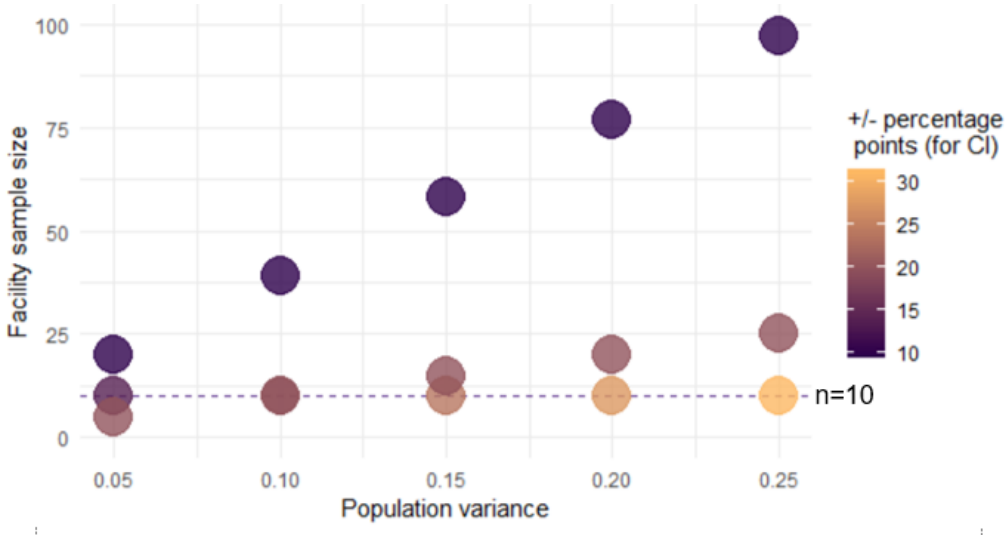


Figure 1. Facility sample sizes and corresponding margins of error across different levels of population variance. Potentially acceptable margins of error range from +/-10 ppts (ideal) to +/-30 ppts (considered high) on either side of the point estimate.

C.2 Sample selection procedures

C.2.1 Selecting health facilities

We prepared the sampling frame of facilities eligible for random selection by identifying all care facilities (health centers, polyclinics, and hospitals) seving communities in malaria strata 2, 3 and 4 based on referral networks and facility lists provided by the Belize Ministry of Health. Because of the very small number of localities in malaria strata 1 and 2, no health facilities are excluded from the sampling frame. Eligible facilities were listed according to whether vector control activities (IRS or ITN distribution) were carried out within the catchment area, as noted in intervention activity lists that the Ministry of Health provided to IHME. The five facilities without microscopy capacity that serve communities in malaria stratum 4 are selected with certainty, and the six facilities with microscopy capacity are selected with certainty. The remainder of the sample is selected at random among ambulatory facilities without microscopy serving malaria strata 2 and 3. Facilities with vector control activities carried out in the catchment area during 2018 had first priority for selection. Once all facilities with vector control activity had been selected, facilities were selected at random among all eligible facilities until the full sample size was reached. The remaining facilities were selected and added, in random order, to an alternate sample to be used in the case a selected facility could not be surveyed and required substitution.

Because the district vector control offices and national malaria reference laboratory are located at community or regional hospitals, they enter the sample based on the criteria described above.

C.2.2 Selecting suspected cases of malaria

The data collection team was responsible for compiling and reviewing the full random sample of medical records at each facility. The sample may be selected in one of three ways, depending on the resources of the facility and the type of registries maintained. First, where the facility keeps a list or registry of all fever attentions, this list can serve as the sampling frame. Second, where there is access to a coded digital database of attentions or diagnoses, the sampling frame is extracted based on a list of eligible codes as seen in Appendix B, Indicator 2.01. If there is no fever list nor electronic database, the sample is selected from daily registries or logbooks of all types of attentions, identifying the eligible complaints or diagnoses in the process. In Belize, the sample was drawn from the BHIS electronic system at most facilities. The time window for the baseline measurement was the calendar year 2018.

Based on the list of eligible attentions extracted from the digital system or the attention records, interviewers selected the sample manually by first counting the total number of attentions and total eligible attentions during a one-month period during 2018. Next, they entered the totals to the Quotas Module to receive a randomly generated start date during 2018 and a calculated skip interval to use to select records. Using the registry or extracted list, they began at the provided start date, and then skipped through the list searching for eligible cases from 2018 according to the provided skip interval. They made a list of selected records to search out and review, but identifiable patient information was never entered to the survey modules.

C.2.3 Selecting confirmed cases of malaria

Due to the small number of malaria cases in Belize during 2018, all cases from 2018 were reviewed at the corresponding district vector control offices.

C.2.4 Selecting communities

IHME used information about vector control interventions and referral networks received from the Ministry of Health to select one community in the catchment area of each of 16 health facilities for the household survey. Health facilities with ITN or IRS interventions since the start of 2018 reported in the catchment area and those in malaria stratum 4 were selected with certainty. The remaining facilities were selected at random among the health facilities in stratum 3 remaining in the sample. Within the selected catchment area, a community that had received ITN or IRS interventions since the start of 2018 was selected at

random among all communities with vector control interventions. If no communities received vector control interventions or intervention status was unknown, a community was selected at random among all communities in the catchment area. A second community from the catchment area was selected as backup in the event that the first community could not be surveyed due to security concerns, logistical challenges, or community refusal of the study.

C.2.5 Selecting households

In order to achieve the desired sample size of 400 households, we sought to complete interviews with residents of 25 randomly selected households in each of the 16 communities selected from the catchment areas of the ambulatory facilities in the health facility sample.

Field staff selected the sample of households using systematic manual sampling techniques with the dwelling as the unit of random selection. In the sample, IHME provided a random integer between 1 and 9 and a randomly selected cardinal direction to use as a starting point, and calculated a skip interval by dividing the total number of households in the community in order to achieve a sample of 25 households completed. If the calculated interval was greater than 9, an interval of 9 was output such that only a single sector of larger communities was surveyed to facilitate field operations. The field team started at the recognized center of the community (such as a plaza, church, or market) and began sample selection in the random direction provided by the sampling module, counting dwellings first to the random start point and subsequently according to the skip interval, along the right hand side of the street. Each selected household was approached to explain the study and request participation. Upon reaching a dead end or reaching the border of the community, field workers made a turn to the right (or turned around) and continued the systematic selection along the right hand side. If a selected dwelling contained more than one household, each of those households was eligible for the survey and counted toward the quota of 25 households per community. If a selected household could not be interviewed due to absence or refusal, it was replaced with the household in the dwelling next door on the right side.

Informed consent was sought from each respondent to the household questionnaire. Occasionally, a survey was refused in course, resulting in a partially complete household result. Because multiple interviewers worked the sample simultaneously, in a handful of instances more than 25 surveys were completed. In the baseline, counts of complete households by community range from 25 to 28 households. Counts of absent households range from 0 to 1 household. Counts of refused households range from 0 to 2 households.

C.3 Sampling weights for the household survey

Household data are weighted by the inverse of the probability of selection according to the Large Country - Lot Quality Assurance Sampling method of Hedt, Olives, Pagano & Valadez (2008) with modifications to adjust to the facility-matched sample design. Estimates in this report take into account sampling weight, clustering, stratification, and the finite population correction.

Where

m = The number of households sampled in community i in the catchment area of facility h

M = The total number of households in the catchment area of facility h

n = The number of communities (each matched to a primary care facility h) sampled in the study region

N = The total number of primary care facilities in the study region

$$Weight = \frac{1}{P(ith\ community\ selected) * P(jth\ household\ selected \mid ith\ community\ selected)}$$

$$= \frac{1}{\frac{n}{N}\left(\frac{m}{M}\right)} = \frac{NM}{nm}$$

This report of the Regional Malaria Elimination Initiative (RMEI) Belize baseline survey was produced in agreement with the Inter-American Development Bank (IDB). All analyses and writing were conducted by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington.

About IHME

The Institute for Health Metrics and Evaluation (IHME) is an independent population health research center at UW Medicine, part of the University of Washington, that provides rigorous and comparable measurement of the world's most important health problems and evaluates the strategies used to address them. IHME makes this information freely available so that policymakers have the evidence they need to make informed decisions about how to allocate resources to best improve population health.

IHME aspires to make available to the world high-quality information on population health, its determinants, and the performance of health systems. We seek to achieve this directly, by catalyzing the work of others, and by training researchers as well as policymakers.

Our mission is to improve the health of the world's populations by providing the best information on population health.

IHME Team

Rebecca Cogen, BA
Data Analyst, IHME

Charbel El Bcheraoui, PhD, MSc
Assistant Professor, IHME

Katie Panhorst Harris, MPA
Evaluation Scientist, IHME

Bernardo Hernandez, MS, DSc
Associate Professor, IHME

Casey Johanns, MPH
Research Manager, IHME

Ali H. Mokdad, PhD, *Principal Investigator*
Professor, IHME

Paulami Naik, MSPH
Data Analyst, IHME

Erin Palmisano, MPH
Senior Research Manager, IHME

Max Thom, BS
Data Specialist, IHME

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