mesoamerica MALARIA

saludmesoamerica.org

Regional Malaria Elimination Initiative Nicaragua

Baseline Measurement (2019-20)

September 2020

Table of Contents

Acronyms

BMGF - Bill & Melinda Gates Foundation
CAPI - Computer-assisted personal interview
CHAI - Clinton Health Access Initiative
Col-vol - *Colaborador voluntario* (volunteer collaborator)
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
SILAIS - *Sistema Local de Atención Integral de la Salud*, department-level administrative unit
SIMALARIA - Nicaragua national malaria surveillance database
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 Nicaragua, 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 Nicaragua. Hospitals and administrative headquarters associated with selected primary care facilities in the public health service network were included in the sample to capture 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.

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

Table E1: Nicaragua data collection summary

Point of data collection	Number completed	Measurement completed
Health Posts, Health Centers, and Primary Hospitals	43	Suspected case medical record review
		Supplies and equipment
		Aggregate case and lab production reporting (if diagnostic capacity)
		Lab certification and quality control (if diagnostic capacity)
Suspected malaria cases reviewed	*1094*	
Municipal Headquarters	11	Confirmed case medical record review: diagnosis and treatment
Confirmed malaria cases reviewed	*1025*	
SILAIS Reference Laboratories	5	Lab certification and quality control
		Aggregate case and lab production reporting
		Supplies and equipment
National Reference Laboratory	1	Lab certification and quality control
		Supplies and equipment
Communities	32	Fever and confirmed malaria cases
		Vector control coverage

Point of data collection	Number completed	Measurement completed
Households interviewed	*949*	

Summary of results

Malaria prevention

In order to protect the populations most at risk of malaria infection, the public health system in Nicaragua 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
Nets	11	56.4%	2.8%
Spray	5	32.8%	8.8%
Both	3	37.6%	28.1%
None	13	23.8%	1.7%

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 and malaria medications 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
Antimalarial medications	43	25	58.1	(43 - 72)
Sampling and biosafety equipment	32	25	78.1	(60 - 89)
Sample submission forms	12	10	83.3	(51 - 96)
Rapid diagnostic tests (RDTs) for onsite testing	36	13	36.1	(22 - 53)
Microscopy equipment	13	12	92.3	(59 - 99)
Equipment for staining and testing	13	11	84.6	(54 - 96)
Reagents for staining	13	2	15.4	(4 - 46)
Units with all required equipment and medications	**46**	**7**	**15.2**	**(7 - 29)**

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 for 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)	62	27	43.5	(26 - 63)
Suspected case with malaria test (medical record review)	891	723	81.1	(78 - 84)

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 the health region headquarters. The review captured all cases from 2018 with records found at regional headquarters included in the sample. The indicator for timely diagnosis of malaria compares the date of initiation of fever or other symptoms with the date of diagnosis (if the patient received both an RDT and a TBF, with the earlier diagnosis date) 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
Cases diagnosed within 48 hours of onset	997	277	27.8	(25 - 31)
3 days	997	117	11.7	(10 - 14)
4-5 days	997	191	19.2	(17 - 22)
6-7 days	997	122	12.2	(10 - 14)
Over 7 days	997	215	21.6	(19 - 24)
Indicator result: Cases diagnosed within 48 hours of onset	997	277	27.8	(25 - 31)

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 (if the patient received both an RDT and a TBF, with the earlier date) with the date of treatment initiation (Table E6). Cases for which the first dose of the treatment corresponding to the malaria diagnosis was given one day or less after diagnosis are

considered to have timely treatment initiation. Cases with diagnosis date, treatment initiation date, or *Plasmodium* species 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	1025	929	90.6	(89 - 92)
First dose treatment within 24 hours of diagnosis	971	788	81.2	(79 - 83)
Correct treatment administered within 24 hours of diagnosis	971	737	75.9	(73 - 78)

The indicator for complete and supervised treatment of malaria identifies the cases with evidence that all doses of the treatment scheme corresponding to the malaria diagnosis were administered to the patient, and that at least one dose was supervised by any health care provider (Table E7). Cases with *Plasmodium* species, 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	1025	63	6.1	(5 - 8)
Evidence of at least one supervised dose	1025	132	12.9	(11 - 15)
Indicator Result: Complete treatment with supervision	1025	63	6.1	(5 - 8)

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 or all 52 weekly 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	28	2	7.1	(2 - 25)
Laboratory production reporting to standard	13	3	23.1	(7 - 53)
External quality control: 2018 National Lab Evaluation form observed	1	1	100	(-)
Facilities passing direct quality control (DQC) component	16	4	25	(9 - 52)
Facilities passing indirect quality control (IDQC) component	16	11	68.7	(43 - 87)

Key findings

The results of the Nicaragua 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 malaria transmission or 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 Nicaragua draws closer to malaria elimination.

Chapter 1: Introduction

1.1 Overview

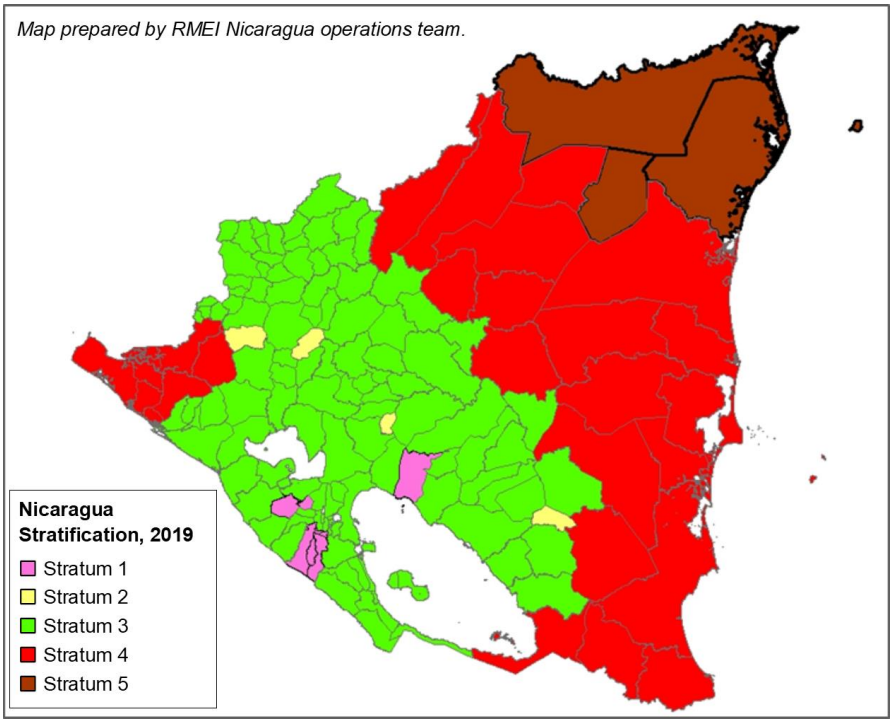
The Regional Malaria Elimination Initiative (RMEI) is a regional public-private partnership administered by the Inter-American Development Bank (IDB) seeking to accelerate progress toward malaria elimination in Mesoamerica, the Dominican Republic, and Colombia. One of its defining features is the application 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, 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 Nicaragua, and harness partnerships with PAHO and the Global Fund. 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 Nicaragua, active, residual, and inactive foci were defined, and each municipality was assigned to a stratum 1 through 5, 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. Municipalities will 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 Nicaragua 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: Nicaragua malaria stratification: Definition and distribution of strata

Stratum	Number of municipalities	Definition
1	9	Non-receptive
2	4	Receptive, no autochthonous cases, no risk of importation
3	111	Receptive, risk of importation, no autochthonous cases
4	26	Receptive, presence of autochthonous cases in last 3 years (<= 3 cases per epidemiological week)
5	3	Receptive, presence of autochthonous cases in last 3 years (> 3 cases per epidemiological week)

Figure 1.1: Nicaragua malaria stratification: national



In Nicaragua, malaria burden has persisted over recent years, with cases concentrated in the northeast of the country. In 2018, the reference year for the baseline measurement, Nicaragua had nearly 16,000 confirmed cases of malaria according to national public health surveillance data. Nicaragua has historically depended on a vertically integrated malaria program that operates in close coordination with programs for other vector-transmitted diseases, and receives grant support from the Global Fund. Nicaragua has an established network of community health volunteers called *"colaboradores voluntarios"* ("col-vol", volunteer collaborator) who collaborate in case detection in communities with active malaria transmission and with limited access to health services. In the malaria elimination phase, Nicaragua will transition malaria detection and case management to be more closely horizontally integrated with 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 Nicaragua 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 selected regional headquarters.

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 Nicaragua 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 prepare for sample selection and data collection, IHME and IDB conducted a joint multi-day fact-finding visit in Nicaragua in April-May 2019. During the exploratory visit, the team visited a range of health facilities in endemic and non-endemic areas. 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 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 Nicaragua, the sample includes health posts, health centers, primary-level hospitals, municipal health offices, SILAIS (*Sistema Local de Atención Integral de la Salud*, department-level administrative unit) headquarters and reference laboratories, and the national reference laboratory. Households within the catchment area of health posts and health centers 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
Health Posts, Health Centers, and Primary Hospitals	Suspected case medical record review
	Supplies and equipment
	Aggregate case and lab production reporting (if diagnostic capacity)
	Lab certification and quality control (if diagnostic capacity)
Municipal Headquarters	Confirmed case medical record review: diagnosis and treatment
SILAIS Reference Laboratories	Lab certification and quality control
	Aggregate case and lab production reporting
	Supplies and equipment
National Reference Laboratory	Lab certification and quality control
	Supplies and equipment
Households	Fever and confirmed malaria cases
	Vector control coverage

Another point of care critical to systems of malaria detection and treatment in Nicaragua are services provided by the *"colaborador voluntario"* (col-vol) and the *medicador(a)*. These volunteer community health workers provide fever screening and malaria testing via rapid diagnostic test or thick blood film preparation, and malaria treatment administration and supervision, out of their own homes or around their communities. Col-vol posts were considered for inclusion in the measurement sample, because col-vols prepare thick blood film 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 indicators. All the necessary records to be reviewed for a patient with malaria detected by a col-vol, or with treatment supervised by a *medicadora*, will be filed at a health facility or vector control office rather than at the col-vol's home. Further, the volume of data that could be collected at a col-vol post is minimal compared to a health establishment, 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. Thus, col-vol posts were not part of the baseline data collection. 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 municipal health unit, where review took place, in Nicaragua.

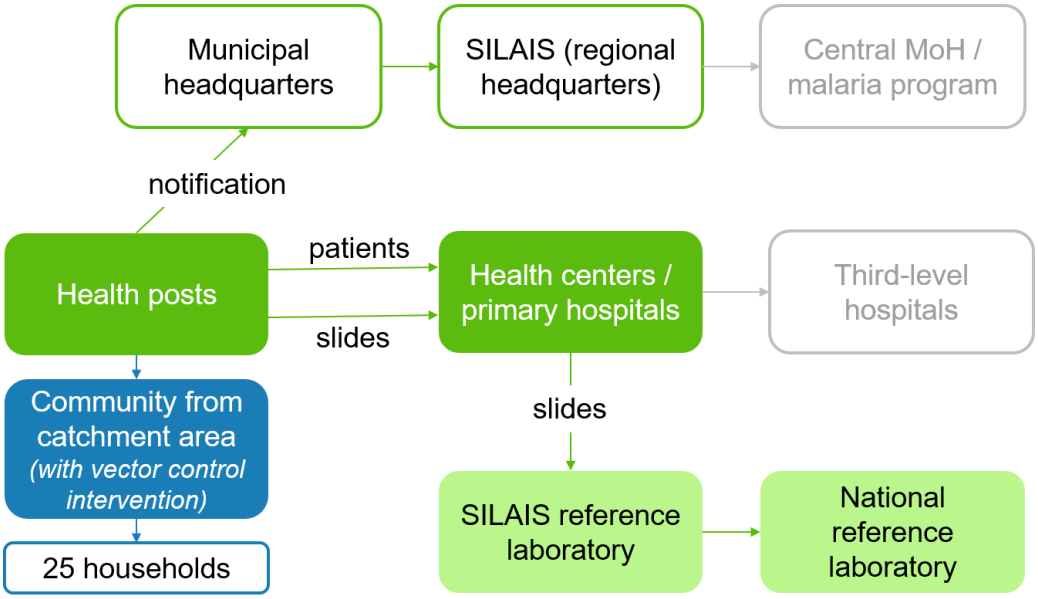
Chapter 2: Survey Methodology

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 not nationally representative of the population nor the public health care system, but rather targeted toward the areas identified for interventions through the Initiative. Since the Initiative aims to eliminate malaria, its success depends on reducing the burden in zones with high malaria transmission. We expect to return to some of these zones in future measurement rounds to monitor changes in practice. In Nicaragua, the sample is made up of facilities and communities in malaria strata 3, 4, and 5 (see strata definitions in Table 1.1). We focused on zones with autochthonous malaria cases 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 (*"puesto de salud,"*) at random as the primary sampling unit, and then selected the other health services linked with it in malaria service provision, such as family health centers (*centros de salud familiar*) and primary hospitals, reference laboratories, and administrative 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 health posts and health centers.

Figure 2.1: RMEI-Nicaragua baseline health system structure



2.1.1 Health facility sample selection

In Nicaragua, malaria stratification was completed at the municipality level. Primary care facilities in municipalities classified as malaria strata 3, 4, and 5 were eligible to enter the sampling frame. In order to ensure inclusion in the sample of the three most endemic municipalities in Nicaragua (classified as malaria stratum 5), the sample of primary care facilities was drawn in three strata: facilities in malaria stratum 5, facilities in malaria stratum 4, and facilities in malaria stratum 3. All facilities in malaria strata 4 and 5 were assumed to have vector control measures (ITN distribution or IRS) implemented in their catchment areas per a directive IHME received from the Ministry of Health. Detailed information on vector control interventions implemented at the locality level in Nicaragua were not received from the Ministry of Health in time to use for selection of health facilities.

Because only a few health posts have microscopy capabilities, a substantial sample of health centers and primary hospitals were also selected to the sample to match the selected health posts to ensure a sufficient denominator to measure laboratory inputs, equipment, and reporting. When the number of matched hospitals/health centers exceeded the number of slots in the sample, a random sample was selected among matched hospitals/health centers, including only one per municipality.

The initial sampling frame for the health facility survey is the list of facilities that provide primary care services for malaria. In order to ensure necessary information is captured for all indicators, for each selected facility we included the ancillary units from the reporting chain (municipal offices, SILAIS offices and labs, and referral basic-level facilities) associated with a selected primary care facility for measurement, up to a fixed sample size defined to balance budget considerations with statistical power for analysis. For example, once a local-level ambulatory facility was selected at random, several related units were identified for inclusion (or for random selection, if more than one qualifies). These include the health center or hospital to which it refers severe malaria cases, the reference laboratory responsible for its microscopy quality control, and the municipal headquarters where confirmed malaria cases from the facility are investigated and filed. Matched municipal headquarters were selected among those with autochthonous cases during 2018. Matched SILAIS were selected among the six that must report malaria cases to the central level. We assigned each administrative unit (*"sede municipal", "SILAIS"*) to the maximum stratum found in its service area (SILAIS with any municipalities in stratum 4 are therefore assigned to stratum 4). 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 visits to administrative offices to review confirmed cases of malaria and household measurement in the zones with the most autochthonous transmission.

2.1.2 Substitutions within the sample

We selected two backup facilities per municipality in case sampled facilities 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 municipality or a neighboring municipality when possible. If substitutes were not available in the same municipality, we replaced with a randomly selected facility from the same malaria stratum. In the Nicaragua baseline, three primary care facilities were replaced during data collection. Where replaced units were planned for the community survey, the community survey was carried out in a locality associated with the replacement facility rather than the original facility.

One primary care facility was replaced due to a long-term interruption in service provision at the facility - it was not open or staffed during the data collection team's visit. The other two primary care facilities were replaced because they were inaccessible to the data collectors due to inclement weather and flooding. In all of these cases, the household surveys were conducted in communities served by the replacement facilities. The final sample totals 60 facilities and 32 communities.

2.1.3 Community and household sample selection

Health centers in Nicaragua provide both primary care services (to the population living in the immediate neighborhood) and basic-level referral services (to the entire municipality), so although health centers were selected to the sample by matching with health posts, they were eligible to have the LQAS survey carried out in their catchment areas. One community was selected for the Lot Quality Assurance Sampling (LQAS) household survey from the catchment area of each of the first 32 primary care facilities (health posts and health centers) selected to the facility 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. Field staff used an automated survey module to enter information about eligible communities in the catchment area, usually provided by vector control technicians at each selected facility. The module automated the selection of one eligible community and provided the random and calculated inputs (random starting point, calculated skip interval) for 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	1108	949	85.6	(83 - 88)
Members absent	1108	67	6	(5 - 8)
Unoccupied dwelling	1108	66	6	(5 - 8)
Refused	1108	12	1.1	(1 - 2)
Other	1108	14	1.3	(1 - 2)

2.1.4 Medical record review sample selection

For confirmed cases of malaria, the sample was designed to include review of a random selection of confirmed cases from 2018 in the selected municipal offices, unless fewer than 100 confirmed cases were available in the given office, in which case all cases found were reviewed. After data collection started, reviews completed were found to be falling short of the budgeted quota because many municipalities were found to have fewer than 100 cases. The quota of randomly selected cases was then increased to 250 in the municipalities of the North Caribbean Coast Autonomous Region with high malaria transmission (Prinzapolka, Puerto Cabezas, and Waspán). Twenty-seven cases were also collected at the SILAIS headquarters of the Chinandega health region, which includes municipalities in the sampling frame. Field staff collected information from all documents available at the municipal office, including case notification and investigation forms, lab records, and treatment follow-up forms. Table 2.2 shows the number of cases expected at each municipal office in the sample (based on counts of cases by municipality in SIMALARIA surveillance system data provided to IHME by the Ministry of Health), and the number of case reviews completed during data collection.

Table 2.2: Confirmed case collection

SILAIS (Health region)	Municipal headquarters	Confirmed cases according to surveillance database	Confirmed cases captured during collection
Bilwi	Prinzapolka	269	250
	Puerto Cabezas	13,432	248
	Waspán	999	250
Chinandega	(collected at SILAIS headquarters)	-	27
	Villanueva	0	0
Las Minas	Bocana de Paiwás	10	9
	Rosita	636	100

SILAIS (Health region)	Municipal headquarters	Confirmed cases according to surveillance database	Confirmed cases captured during collection
	Siuna	212	100
Matagalpa	Waslala	2	3
RAACS	Bluefields	15	22
Rio San Juan	San Carlos	8	16
Zelaya Central	El Rama	0	0

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 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, medical records or attention forms, and lab records. Table 2.3 shows the total number of suspected cases reviewed (966), the number of cases selected based on diagnosis or principal complaint but found to be ineligible based on diagnostic exclusion criteria (128), and the cases selected and requested at facilities for which no paperwork could be located for review (139). In some facilities in Nicaragua, all eligible cases from the entire year 2018 were selected for review, because there were relatively few attentions with eligible diagnoses.

During fact-finding and subsequently at suspected case sampling in many facilities in areas with high malaria burden, it became clear that the protocol was to test all patients presenting with fever for malaria and that these patients were not registered in a general attention registry, but rather on the E2 blood sample form or TBF logbook alone. For this reason, there were no attention registries or fever logbooks from which to sample suspected cases. Instead, at these facilities, data collectors used the E2 forms and/or laboratory logbooks to sample suspected cases, with the caveat that all fever cases at the facility in question must have been included in these sources to be considered validly sampled.

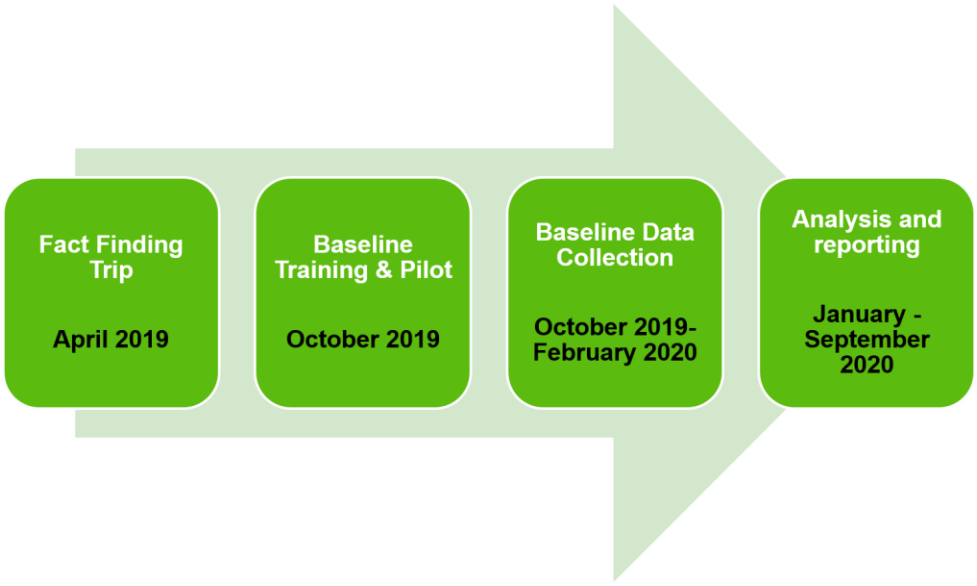
Table 2.3: Suspected case collection

	#
Total suspected cases selected for review	1233
Suspected cases selected but could not be located for review	139
All suspected cases screened for eligibility	1094
Ineligible suspected cases discarded	128
Eligible suspected cases collected	966

2.2 Survey implementation

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

Figure 2.2: RMEI-Nicaragua baseline timeline



2.2.1 Data collection instruments

Questionnaires were initially developed in English, and then translated to Spanish. To best reflect the issues most relevant to the region under study and the local language, we revised the Spanish-language 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 Spanish speakers. In order to allow the participation of non-Spanish speakers in the survey, the data collection team was prepared to contract local interpreters proficient in Miskito, Mayagna, and Rama 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 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. An additional module is used to capture information about the catchment area of the facility and to select the community to be enumerated in the household survey.

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 Nicaragua between September 30 and October 4, 2019. The local agency contracted for data collection in Nicaragua, UNIMER, hired ten doctors and nurses and three 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 Nicaragua 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 a supervisory trip from October 8-12, 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 Nicaragua. 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 Nicaragua Ministry of Health.

2.2.5 Ethical considerations

The study received authorization from by the Nicaragua Ministry of Health to conduct data collection in health facilities and by local authorities to collect data in communities. 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-Nicaragua 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.

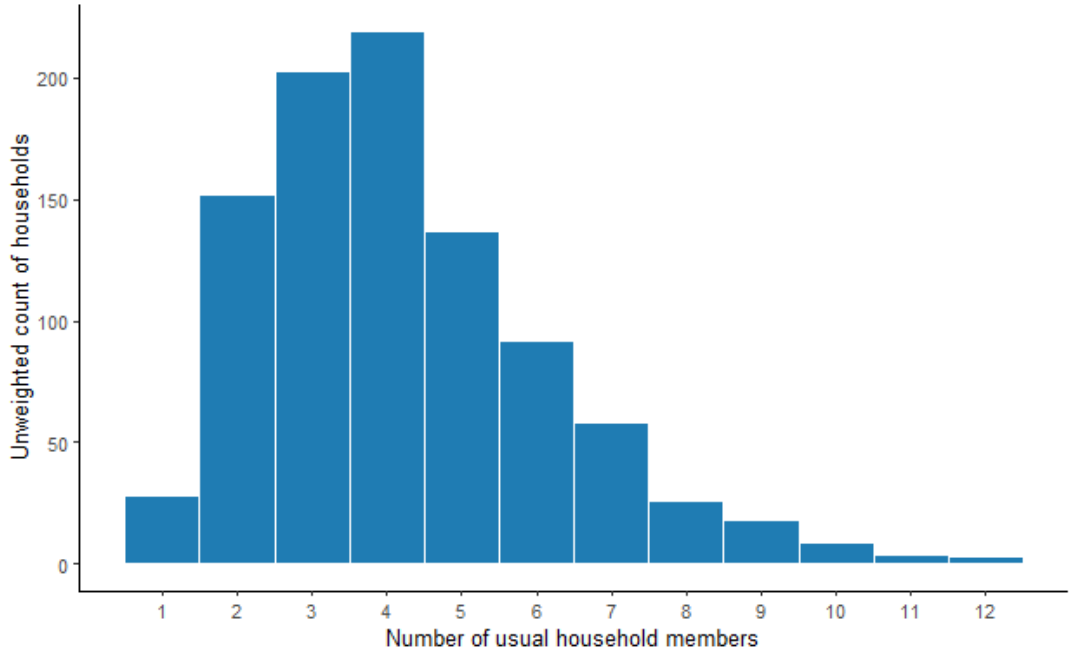
3.1 Characteristics of participating households

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

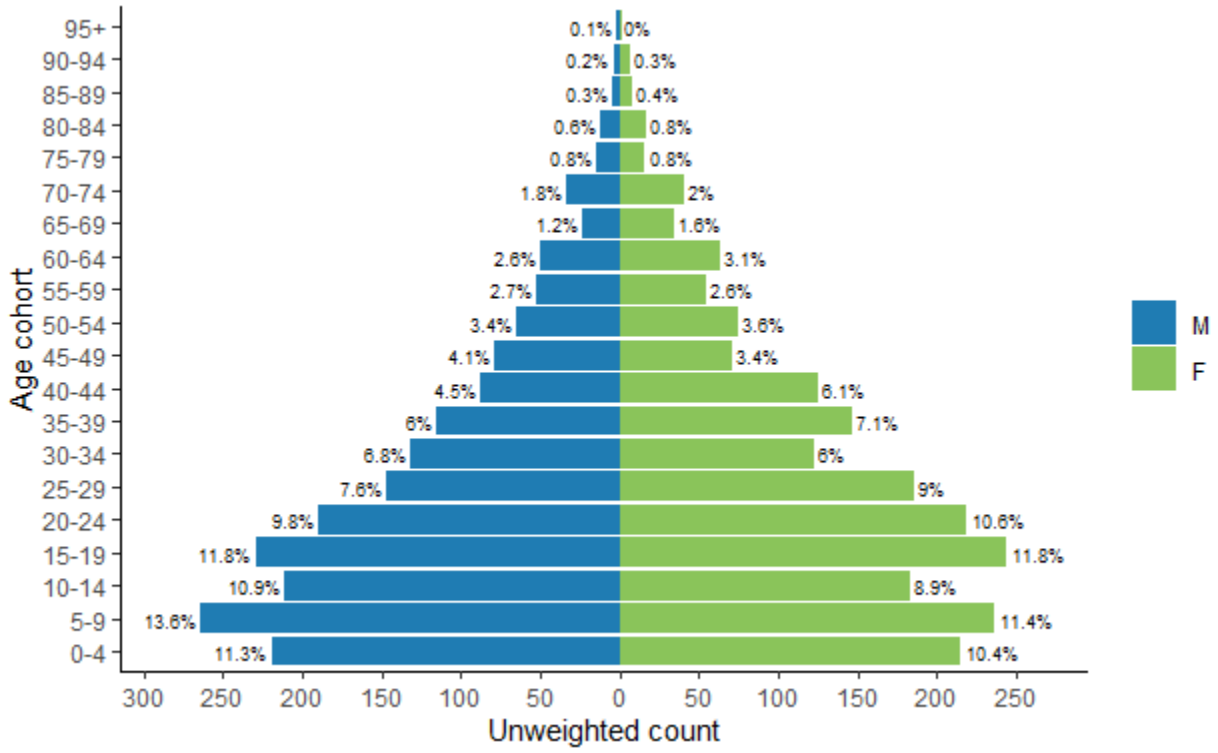
A total of 949 households in the Nicaragua baseline survey completed the interview. The unweighted distribution of the number of members by household is shown in Figure 3.1. The survey sample for Nicaragua has a median household size of 4 and an unweighted average household size of 4.2.

Figure 3.1: Household size, unweighted percent distribution



The unweighted distribution of the de facto household population in the surveyed households in Nicaragua by five-year age groups and by sex is shown in Figure 3.2. Nicaragua 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, 33% of the population in the baseline is under age 15 years, more than half (61%) of the population is in the economically productive age range (15-64), and the remaining 5% 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, languages spoken, and ethnic identity for all usual household members aged 15 or older. Respondents could indicate multiple languages spoken or ethnic identities. The results are shown in Table 3.1, Table 3.2, and Table 3.3 respectively. In Nicaragua, 12.9% of household members had no formal schooling, and 35.9% completed only primary education. Ninety percent speak Spanish and 19.2% speak Miskito. Seventeen percent identify as ethnically Miskito. The following demographic tables show weighted proportions.

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	2674	375	12.9	(9 - 19)
Primary	2674	1101	35.9	(30 - 42)
Secondary	2674	804	32.2	(28 - 37)
Middle or high school	2674	104	4.1	(3 - 7)
Technical	2674	44	1.8	(1 - 3)
University	2674	195	11.2	(6 - 20)
Masters	2674	12	0.5	(0 - 1)
Doctorate	2674	5	0.2	(0 - 1)
Don't know	2674	33	1.2	(1 - 2)
Decline to respond	2674	1	0	(-)

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				
Spanish	2674	2129	90.5	(82 - 95)
Miskito	2674	979	19.2	(9 - 37)
English creole	2674	137	6.6	(2 - 20)
English	2674	26	1.4	(0 - 5)
Mayagna	2674	41	1.3	(0 - 5)
Rama	2674	1	0	(-)
Other	2674	4	0.1	(0 - 0)

Table 3.3: Indigeneity of household members age 15 and older

	N	n	%	95% CI
Indigenous group affiliation of household members age 15 and older[1]				
Mestizo Costa Caribe	2673	538	29.5	(19 - 43)
Mestizo	2673	439	23.4	(13 - 38)
Miskitu	2673	901	16.6	(8 - 31)
None	2673	284	9.1	(4 - 18)
Creole	2673	163	5.3	(2 - 15)
Cacaopera Matagalpa	2673	42	1.6	(0 - 10)
Mayagna	2673	34	0.8	(0 - 6)
Siuna	2673	3	0.3	(0 - 2)
Chorotega Nahua-Mange	2673	1	0.1	(0 - 1)
Garifuna	2673	3	0.1	(0 - 1)
Nagaroteño	2673	1	0.1	(0 - 1)
Rama	2673	1	0	(-)
Juigalpa	2673	1	0	(-)
Don't know	2673	290	13.7	(7 - 25)
Decline to respond	2673	5	0.2	(0 - 1)

[1]Indigeneity not captured for one usual household member over 15 years of age.

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 Nicaragua, as seen in Table 3.4, Table 3.5, and Table 3.6, most homes are built with walls of plywood, sheet metal (zinc/alucin) roofs, and earth/sand floors.

Table 3.4: Exterior wall material as observed

	N	n	%	95% CI
Main material of exterior walls of dwelling				
Plywood	949	554	44.5	(28 - 62)
Cement block	949	146	22.6	(13 - 37)
Quarry stone	949	66	7.9	(4 - 16)
Stone with lime/cement	949	33	5.5	(3 - 10)
Polished wood	949	24	4.4	(2 - 12)
Brick/covered adobe	949	16	2.3	(1 - 7)

	N	n	%	95% CI
Cane/palm/trunks	949	4	0.5	(0 - 4)
Uncovered adobe	949	4	0.4	(0 - 2)
Prefabricated material	949	3	0.3	(0 - 1)
Palm/bamboo	949	1	0.1	(0 - 1)
Cardboard/waste material	949	1	0.1	(0 - 1)
Other	949	97	11.3	(6 - 21)

Table 3.5: Roofing material as observed

	N	n	%	95% CI
Main material of roof of dwelling				
Sheet metal (zinc/Alucin)	949	898	95.7	(89 - 98)
Clay tile	949	16	1.9	(0 - 7)
Thatch/palm leaf/cane	949	18	0.6	(0 - 2)
Cement fiber/asbestos sheet	949	2	0.3	(0 - 2)
Cardboard/waste material	949	4	0.1	(0 - 1)
Wood planks	949	1	0	(-)
Other	949	10	1.3	(0 - 4)

Table 3.6: Flooring material as observed

	N	n	%	95% CI
Main material of floor of dwelling				
Earth/sand	949	267	29.5	(19 - 43)
Wood planks	949	316	18.7	(12 - 28)
Cement sheet/board	949	119	15.1	(11 - 20)
Cement brick or tile	949	94	14.1	(8 - 23)
Ceramic tiles	949	77	12.4	(7 - 21)
Parquet or polished wood	949	26	4.3	(1 - 15)
Mud brick	949	23	3	(1 - 9)
"Embarrada"	949	7	0.6	(0 - 2)
Granite/stone	949	1	0.1	(0 - 1)
Not observed	949	1	0	(-)
Other	949	18	2.1	(1 - 6)

Many houses (76.7%) have open roof eaves. Most have no glass in windows (79.5%), screens in windows (91.1%), nor screens in doors (98.6%).

Table 3.7: Open or closed roof eave as observed

	N	n	%	95% CI
Open gap between wall and roof eave	949	772	76.7	(69 - 83)

Table 3.8: Glass in windows as observed

	N	n	%	95% CI
Do windows have glass panes?				
None	949	806	79.5	(71 - 86)
Yes, in all windows	949	54	9.5	(4 - 20)
There are no windows in the house	949	66	7.1	(4 - 13)
Yes, but only in some windows	949	23	3.9	(3 - 6)

Table 3.9: Screens in windows as observed

	N	n	%	95% CI
Do windows have screens?				
None	949	865	91.1	(86 - 95)
There are no windows in the house	949	66	6.9	(4 - 13)
Yes, in all windows	949	8	1.1	(1 - 2)
Yes, but only in some windows	949	10	0.9	(0 - 2)

Table 3.10: Screens in doors as observed

	N	n	%	95% CI
Do doors have screens?				
None	949	938	98.6	(96 - 100)
Yes, in all doors	949	6	1	(0 - 3)
Yes, but only in some doors	949	5	0.4	(0 - 2)

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 3.11 shows that while 59.5% of homes had clean surroundings without standing water on the day of the survey, 9% had natural water bodies within or bordering the yard.

Table 3.11: Maintenance of dwelling surroundings as observed

	N	n	%	95% CI
Status of yard/surroundings of dwelling				
Clean, no trash or standing water	949	508	59.5	(50 - 68)
Trash, tires, or other refuse present, but no standing water	949	191	17	(12 - 23)
Yes, puddles	949	138	16.7	(9 - 28)
Yes, pond or other natural water body	949	152	9	(5 - 16)
Yes, water collected in trash, tires, or other small containers	949	46	4.8	(2 - 10)
Other	949	11	1.7	(1 - 4)

Table 3.12 shows the principal water source of the household as reported by the respondent; 61.5% of households have water piped to their house. The most common type of sanitation facility is a pit latrine (61.8% of households), as seen in Table 3.13.

Table 3.12: Principal water source

	N	n	%	95% CI
Main source of drinking water				
Piped into dwelling	949	439	61.5	(44 - 77)
Protected dug well	949	244	22.8	(13 - 38)
Unprotected dug well	949	66	4.8	(2 - 10)
Tube well or borehole	949	37	3.3	(1 - 7)
Rainwater	949	55	1.9	(0 - 7)
Surface water (river/dam/lake/pond/stream/canal/irrigation channel)	949	39	1.6	(1 - 4)
Piped to yard/plot	949	11	0.8	(0 - 2)
Protected spring	949	4	0.4	(0 - 2)

	N	n	%	95% CI
Unprotected spring	949	12	0.4	(0 - 2)
Large jug of purified water	949	1	0.2	(0 - 1)
Public tap/standpipe	949	1	0.1	(0 - 1)
Other	949	40	2.2	(1 - 7)

Table 3.13: Type of sanitation facility used

	N	n	%	95% CI
Type of toilet used				
Pit latrine	949	681	61.8	(42 - 78)
Flush toilet	949	184	34	(18 - 55)
No facility/bush/field	949	46	2.5	(1 - 6)
Pour flush toilet	949	8	0.6	(0 - 2)
Dry latrine	949	13	0.4	(0 - 2)
Hanging latrine	949	12	0.3	(0 - 2)
Other	949	5	0.3	(0 - 1)

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 3.14. Most households do their cooking in the house (Table 3.15).

Table 3.14: Cooking fuel source

	N	n	%	95% CI
Principal cooking fuel				
Gas tank	949	379	60.9	(49 - 72)
Wood	949	702	60.6	(44 - 75)
Charcoal	949	50	6.5	(2 - 19)
Electricity	949	43	3.9	(2 - 8)
Straw/shrubs/grass	949	2	0.4	(0 - 2)
No food cooked in household	949	2	0.4	(0 - 2)

Table 3.15: Cooking location

	N	n	%	95% CI
Where cooking is done[1]				
In the house	947	683	79.2	(72 - 85)
In a separate building	947	245	18.9	(13 - 27)
Outdoors	947	19	1.9	(1 - 4)

[1]Cooking location not captured for two household.

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 3.16 and Table 3.17 show the proportion of households with at least one of each item. Many households (90.8%) have electricity. Of the 297 households that own livestock, most own poultry (81.2% of households, as in Table 3.17). Table 3.18 shows the proportion of households with agricultural land.

Table 3.16: Household assets

	N	n	%	95% CI
Electricity	949	824	90.8	(77 - 97)
Radio[1]	948	404	37	(30 - 44)
Sound system[1]	948	207	28.4	(20 - 39)
Television[1]	948	493	65.5	(53 - 76)
Home telephone[1]	948	49	8.5	(4 - 19)
Mobile phone[1]	948	685	83	(78 - 87)
Refrigerator[1]	948	299	42.3	(29 - 57)
Washing machine[1]	948	71	12.2	(6 - 25)
Computer[1]	948	75	12.9	(7 - 22)
Electric fan[1]	948	317	46.9	(32 - 62)
Air conditioner[1]	948	4	0.7	(0 - 2)
Watch[1]	948	267	36	(29 - 44)
Guitar[1]	948	19	3	(2 - 5)
Bike[1]	948	156	20.4	(13 - 30)
Motorcycle or scooter[1]	948	118	14.2	(10 - 20)
Animal-drawn cart[1]	948	9	0.9	(0 - 3)
Car[1]	948	31	5.2	(3 - 9)
Truck[1]	948	6	0.9	(0 - 3)
Motor boat[1]	948	10	1.4	(1 - 3)
Bank account[2]	825	36	7.2	(3 - 16)

[1]One head of household declined to respond for these assets.
[2]124 heads of household responded 'do not know' or 'decline to respond' to household bank accounts.

Table 3.17: Livestock ownership

	N	n	%	95% CI
Does this household own any livestock?	941	297	23.6	(16 - 33)
Cattle	297	102	30.3	(20 - 44)
Horses, donkeys or mules	297	96	30.5	(19 - 46)
Goats or sheep	297	9	5.4	(2 - 13)
Chickens or other poultry	297	242	81.2	(73 - 87)
Pigs	297	181	53	(44 - 62)

Table 3.18: Ownership of agricultural land

	N	n	%	95% CI
Does any member of the household own, rent, or share agricultural land?				
No	949	751	83.2	(76 - 89)
Yes, own	949	129	9.2	(6 - 15)
Yes, rent	949	41	3	(1 - 6)
Yes, share	949	10	1.1	(0 - 3)
Don't know	949	7	1.1	(0 - 3)
Decline to respond	949	11	2.3	(1 - 6)

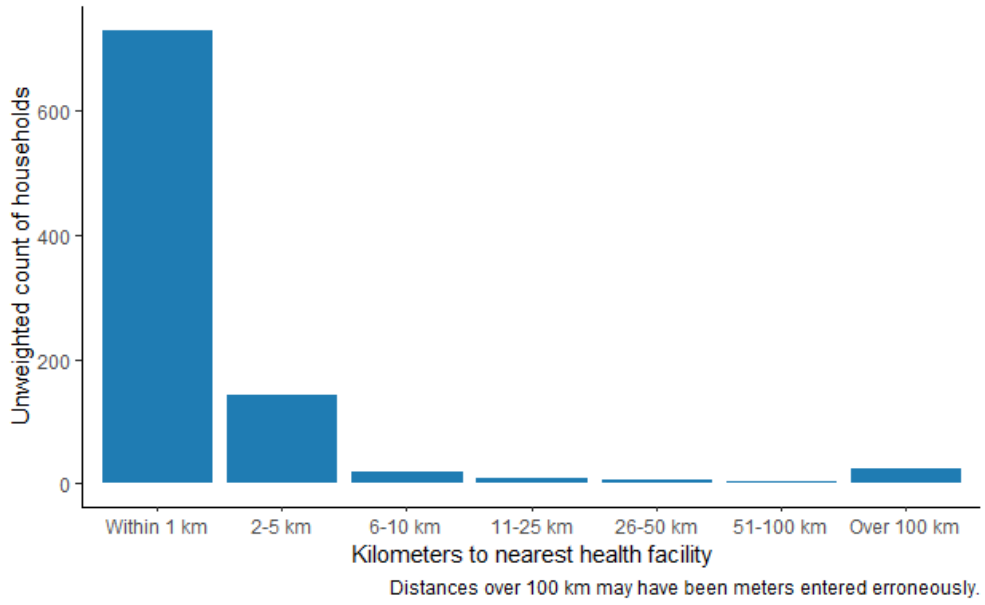
As a part of the interview, respondents estimated their monthly household income (including money earned by all members of the household and received from other sources such as public benefits or remittances). Though some households are hesitant to report their income, the estimates as reported are shown in Table 3.19.

Table 3.19: Monthly household income, all sources

	N	n	%	95% CI
Monthly household income, Nicaragua Córdoba (C$)				
Less than 1000 C$	949	109	6.7	(3 - 14)
1001 - 2500 C$	949	171	15.1	(11 - 20)
2501 - 4500 C$	949	175	20.7	(16 - 26)
4501 - 7000 C$	949	104	14.4	(10 - 21)
7001 - 10,000 C$	949	40	5	(3 - 9)
10,001 - 15,000 C$	949	23	2.7	(2 - 5)
15,001 - 25,000 C$	949	8	1.2	(1 - 2)
25,001 - 40,000 C$	949	1	0	(-)
Don't know	949	163	16.4	(11 - 24)
Decline to respond	949	155	17.8	(10 - 30)

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.

Figure 3.3: Distance to nearest health facility, unweighted percent distribution



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 3.21 shows, most respondents had heard of malaria before (82%). Respondents were asked the cause of malaria (Table 3.22) and the mode of transmission of malaria (Table 3.23) and interviewers could register more than one response. Most respondents are aware of the role of mosquitoes in malaria transmission.

Table 3.21: Malaria awareness

	N	n	%	95% CI
Heard of illness called malaria[1]	937	753	82	(75 - 87)

[1]Twelve heads of household responded 'do not know' to whether they had heard of malaria.

Table 3.22: Knowledge of cause of malaria

	N	n	%	95% CI
In your opinion, what causes malaria?				
Mosquito bites	753	694	92	(87 - 95)
Dirty surroundings	753	133	18.5	(14 - 25)
Stagnant water	753	84	14.8	(9 - 24)
Weedy surroundings	753	65	10	(6 - 16)
Eating dirty food/drinking dirty water	753	14	2.2	(1 - 4)
Cold or changing weather	753	12	1.9	(1 - 4)
Malaria parasite (plasmodium)	753	9	1.6	(1 - 3)
Anopheles mosquito bite	753	11	1.1	(1 - 2)
Working in the forest or the fields	753	6	1.1	(1 - 3)
Contaminated air	753	6	1	(0 - 2)
Other	753	16	2.1	(1 - 5)
Don't know	753	30	4.3	(2 - 9)

Table 3.23: Knowledge of malaria transmission

	N	n	%	95% CI
How is malaria transmitted?				
By mosquitoes	753	687	92.1	(88 - 95)
Stagnant water	753	143	17.3	(12 - 25)
Eating dirty food/drinking dirty water	753	19	3.6	(1 - 9)
Poor personal hygiene	753	33	3.1	(2 - 6)
Passes from one person to another	753	20	2.9	(2 - 5)
Contaminated air	753	9	0.9	(0 - 2)
Other	753	6	0.8	(0 - 2)
Don't know	753	38	5	(3 - 9)

Respondents were also asked the main sign or symptom of malaria and more than one response could be registered (Table 3.24). 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 3.24: Knowledge of malaria symptoms

	N	n	%	95% CI
Main sign or symptom of malaria known				
Fever	753	686	90.2	(86 - 93)
Headache	753	457	56.1	(49 - 63)
Chills	753	364	40.5	(30 - 52)
Body ache or joint pain	753	305	39.7	(33 - 47)
Nausea and vomiting	753	250	34.8	(31 - 39)
Dizziness	753	56	6.6	(4 - 10)
Diarrhea	753	53	5.5	(3 - 9)
Body weakness	753	55	4.9	(3 - 7)
Loss of appetite	753	45	4.5	(3 - 8)

	N	n	%	95% CI
Pale eyes or skin	753	33	4.4	(2 - 9)
Sweating	753	31	1.9	(1 - 4)
Seizures	753	16	1.1	(0 - 3)
Cough	753	15	0.9	(0 - 2)
Other	753	11	1.9	(1 - 4)
Don't know	753	34	5.8	(4 - 9)

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 3.25).

Table 3.25: 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	753	453	68.9	(57 - 79)
One person	753	96	8	(5 - 12)
2-4 people	753	85	9.5	(6 - 15)
5-10 people	753	41	2.9	(2 - 5)
11-100 people	753	19	2.3	(1 - 8)
More than 100 people	753	1	0	(-)
Don't know	753	58	8.4	(6 - 12)

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, 41.6% had heard messages about malaria during the last year. Of those who had heard messages, the specific information heard is detailed in Table 3.26. Some of the responses indicate that people may confuse messages about preventing dengue or other arboviruses with malaria prevention messages. However, many had learned to seek medical attention for fevers and about using a mosquito net.

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 3.27.

Table 3.26: Malaria messages heard in last year

	N	n	%	95% CI
Messages seen or heard in last year				
If have fever go to health facility	338	274	76.3	(63 - 86)
Eliminate breeding sites/clean up trash	338	96	34.3	(24 - 46)
Sleep under a net every night to protect yourself against malaria	338	88	29.3	(19 - 43)
Nets are used to protect from mosquitoes	338	85	29	(22 - 38)
Sleep under an insecticide-treated mosquito net	338	87	27.2	(21 - 35)
Malaria kills	338	60	20.3	(11 - 34)
Be sure to tuck the borders of the net under the mattress	338	18	8	(4 - 16)
Wash nets only when they are dirty	338	15	7.3	(4 - 12)

	N	n	%	95% CI
Treatment for severe malaria is available free of charge	338	10	5.9	(3 - 11)
Always test before treating malaria	338	13	4	(2 - 7)
Nets are being distributed free of charge	338	5	1.5	(0 - 5)
Dry nets in the shade, not in direct sunlight	338	2	1.4	(0 - 5)
Anopheles mosquitoes transmit malaria by biting people at night	338	5	1.1	(0 - 4)
The nets being distributed have insecticide in them and if treated, they will last at least 3 years	338	1	0.8	(0 - 4)
Don't wash nets more than 4 times per year	338	1	0.2	(0 - 1)
Other	338	7	3.7	(1 - 12)
Don't know	338	5	2.9	(1 - 8)

Table 3.27: Source of malaria messages

Source of messages, among those who heard them	N	n	%	95% CI
On the radio[1]	335	196	52.8	(40 - 65)
On TV[1]	335	130	50.5	(36 - 64)
On a poster or billboard[1]	334	56	21.5	(12 - 35)
From a community health worker[1]	336	144	53.1	(39 - 67)
From personnel at a health facility[1]	338	199	68.5	(54 - 80)
At a community event[1]	335	92	28.3	(19 - 40)
At school[1]	335	60	18.8	(11 - 31)
On the internet or social media[1]	335	21	10.9	(3 - 30)
Somewhere else[1]	334	4	2.6	(1 - 6)

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

3.2.3 Knowledge of community resources

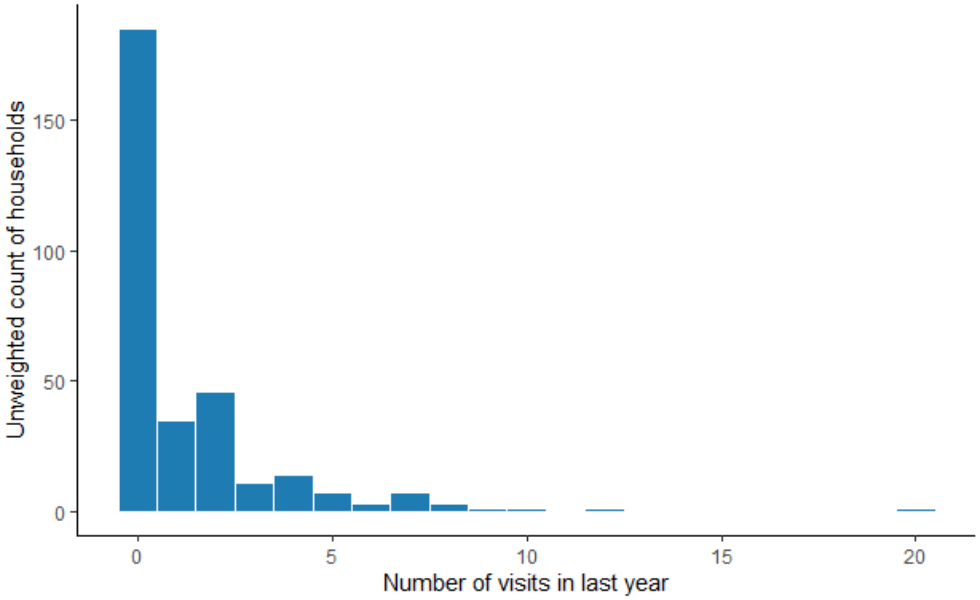
A key component of malaria detection in many departments in Nicaragua is the volunteer collaborator program. Volunteer collaborators (*colaboradores voluntarios*), or “col-vols”, are community members who are trained to carry out malaria detection activities such as screening, taking blood samples for thick blood film or rapid tests, and referring patients to health facilities or to community-based vector control technicians. They or other community health workers known as *medicadores* also sometimes oversee malaria treatment after a malaria case has been confirmed. In the Nicaragua baseline survey, 36.6% of households know of a col-vol in their community. Of those who knew of a col-vol, 57.6% reported receiving a home visit by that volunteer during the year before the date of the survey (Table 3.28). The number of visits received from the col-vol is shown in Figure 3.5.

Table 3.28: Knowledge of col-vols

	N	n	%	95% CI
Know of col-vol in own community[1]	751	325	36.6	(22 - 54)
Visited by col-vol in last year[2]	322	139	57.6	(42 - 72)

[1]198 households responded that they 'do not know' of col-vols in the community.
[2]Three households responded that they 'do not know' of col-vol visit in last year.

Figure 3.5: Number of visits from col-vols in last year



Malaria testing and treatment is provided free of charge through the Ministry of Health in Nicaragua, and 96.2% of respondents are aware of this benefit (Table 3.29). 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 primary care facilities (Table 3.30, Table 3.31).

Table 3.29: Knowledge of free-of-cost malaria healthcare

	N	n	%	95% CI
Aware malaria diagnosis and treatment are provided free by the government[1]	740	714	96.2	(93 - 98)

[1]Thirteen heads of household responded 'do not know' to free-of-cost malaria healthcare.

Table 3.30: Knowledge of where to go for malaria testing

	N	n	%	95% CI
Where can someone go to be tested for malaria?				
Public Sector: Government primary level health center	753	440	63.3	(52 - 74)
Public Sector: Government hospital	753	280	40.1	(28 - 54)
Public Sector: Fieldworker/Community Health Worker	753	77	4.3	(2 - 8)
Private medical sector: Private hospital/clinic	753	11	1.9	(1 - 4)
Private medical sector: Private doctor	753	2	0.4	(0 - 2)
Private medical sector: mobile clinic	753	1	0.3	(0 - 2)
Private medical sector: Pharmacy	753	2	0.2	(0 - 1)
Public Sector: mobile clinic	753	2	0.1	(0 - 1)
Other public sector	753	0	0	(-)
Other private sector	753	0	0	(-)
Traditional healer	753	0	0	(-)
Other	753	2	0.1	(0 - 1)
Don't know	753	4	0.6	(0 - 2)

Table 3.31: Knowledge of where to go for malaria treatment

	N	n	%	95% CI
Where can someone receive treatment for malaria?				
Public Sector: Government primary level health center	738	443	65.8	(53 - 77)
Public Sector: Government hospital	738	285	42.1	(30 - 55)
Public Sector: Fieldworker/Community Health Worker	738	71	3.9	(2 - 8)
Private medical sector: Private doctor	738	4	1.1	(0 - 3)
Private medical sector: Private hospital/clinic	738	4	1	(0 - 3)
Private medical sector: Pharmacy	738	3	0.4	(0 - 2)
Private medical sector: mobile clinic	738	1	0.3	(0 - 2)
Public Sector: mobile clinic	738	1	0	(-)
Other public sector	738	0	0	(-)
Other private sector	738	0	0	(-)
Traditional healer	738	0	0	(-)
Other	738	1	0.1	(0 - 1)

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. Few households reported members who migrated for work (Table 3.32). Among individuals in surveyed households, 8.7% reported travel outside the community in the last two weeks (Table 3.33). According to respondents, most household members did not participate in any of the risk activities listed in Table 3.34 in the two months prior to the survey.

Table 3.32: Temporal migration within surveyed households

	N	n	%	95% CI
At least one member migrates seasonally	947	83	8.9	(7 - 12)
At least one member migrates weekly	947	62	6.9	(5 - 9)

Table 3.33: Recent travel by individuals in surveyed households

	N	n	%	95% CI
Individual traveled outside community in last 2 weeks	3999	265	8.7	(6 - 12)

Table 3.34: Exposure to risky activities by individuals in surveyed households

	N	n	%	95% CI
Individuals participating in malaria risk activities				
None of these	4002	2859	75.7	(70 - 81)
Cultivating crops or working in the fields	4002	756	12.1	(8 - 17)
Working in trade	4002	204	7.9	(5 - 13)
Gathering firewood in the forest	4002	146	2.2	(1 - 5)
Working in fishing	4002	120	1.7	(1 - 3)
Working in timber/lumber industries in the forest	4002	120	1.6	(1 - 3)
Working in a mine	4002	40	1.3	(0 - 5)
Collecting shellfish	4002	26	0.6	(0 - 3)

	N	n	%	95% CI
Sleeping outdoors overnight	4002	4	0.2	(0 - 1)
Producing charcoal	4002	0	0	(-)
Don't know	4002	5	0.2	(0 - 1)
Decline to respond	4002	4	0.1	(0 - 0)

Respondents were also asked what can be done to protect against malaria (Table 3.35), and what practices they follow in their own households (Table 3.36). 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 mosquito nets or other practices that protect against all mosquito vectors. Only 0.9% of households said they do not use any malaria prevention measures at home.

Table 3.35: Protective measures known by household

	N	n	%	95% CI
Methods known to protect against malaria				
Eliminate mosquito breeding areas (tires, bottles, or others)	715	535	74.1	(65 - 81)
Sleep under a mosquito net	715	449	59.2	(50 - 68)
Keep house surroundings clean	715	153	21.9	(18 - 26)
Clean water storage tanks with bleach	715	75	13.9	(8 - 22)
Use insect repellent	715	71	10.2	(6 - 16)
Avoid mosquito bites	715	54	10	(6 - 17)
Fumigate or spray house with insecticides	715	57	9.6	(6 - 15)
Add bleach temephos (Abate) to the water tank	715	45	9	(6 - 13)
Cut the grass around the house	715	44	7	(4 - 12)
Sleep under an insecticide-treated mosquito net	715	24	3.1	(2 - 6)
Fill in puddles (stagnant water)	715	20	3	(2 - 5)
Use mosquito coils	715	9	1.8	(1 - 5)
Take preventive medication	715	3	0.8	(0 - 4)
Put mosquito screens on the windows	715	9	0.6	(0 - 2)
Can't be prevented	715	5	0.4	(0 - 1)
Other	715	7	1.3	(0 - 4)
Don't know	715	10	2.4	(1 - 7)

Table 3.36: Protective measures used by household

	N	n	%	95% CI
Primary methods used in household to protect against malaria				
Eliminate mosquito breeding areas (tires, bottles, or others)	715	609	84.6	(77 - 90)
Sleep under a mosquito net	715	421	54.9	(43 - 66)
Keep house surroundings clean	715	166	25.2	(22 - 29)
Clean water storage tanks with bleach	715	100	17.8	(11 - 27)
Add bleach or temephos (Abate) to the water tank	715	67	12.9	(8 - 20)
Fumigate or spray house with insecticides	715	69	10.6	(7 - 16)
Avoid mosquito bites	715	72	10.4	(6 - 17)
Cut the grass around the house	715	56	8.3	(5 - 13)
Use insect repellent	715	65	7.2	(4 - 13)

	N	n	%	95% CI
Sleep under an insecticide-treated mosquito net	715	38	4.6	(2 - 8)
Fill in puddles (stagnant water)	715	21	3.2	(2 - 5)
Use mosquito coils	715	9	2.2	(1 - 5)
Organize community cleaning work days	715	10	1.3	(1 - 2)
Does nothing to protect from malaria	715	7	0.9	(0 - 3)
Put mosquito screens on the windows	715	6	0.8	(0 - 2)
Take preventive medication	715	3	0.5	(0 - 2)
Other	715	14	2.3	(1 - 5)
Don't know	715	2	0.7	(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-Nicaragua 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.

4.1 Vector control measures carried out in Nicaragua households

Vector control plans in Nicaragua included offering IRS and ITN measures to households in various communities in malaria-endemic areas. 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 new outbreak.

In Nicaragua, the community sample was designed to capture data from at least 28 communities with vector control measures implemented during 2019. Health facilities were listed for selection to the sample based on malaria stratum under the assumption that all health facilities in strata 4 and 5 had vector control interventions in the catchment area. After sample selection, some locality-level vector control data was received suggesting that interventions were carried out in many, but not all, communities in stratum 4. However, because the intervention data are organized by locality and not by health facility, and because the health service network received from the Ministry of Health did not include the names of the localities served by each health facility, we did not pair of the intervention data to corresponding health facilities in the service network.

According to data collected at the local-level health facilities via the Community Selection Module, only 19 of 32 communities surveyed had vector control interventions carried out. There are a few feasible explanations for the discrepancy in the nine communities in strata 4 and 5 (the other four communities surveyed were in malaria stratum 3, which are less likely to have vector control interventions) with no record of recent interventions: the assumption that every facility had communities in its catchment with vector control measures may have been inaccurate, and the selected facility may have served no communities with interventions; the intervention activity may have been planned in a selected community, but not yet carried out at the date of the survey; or the intervention activity may have been planned and carried out, but the health facility staff was not aware of it. We expect that each of these scenarios explains a portion of the discrepancies, as some of the nine communities had intervention measures observed at the household level, while others did not.

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.

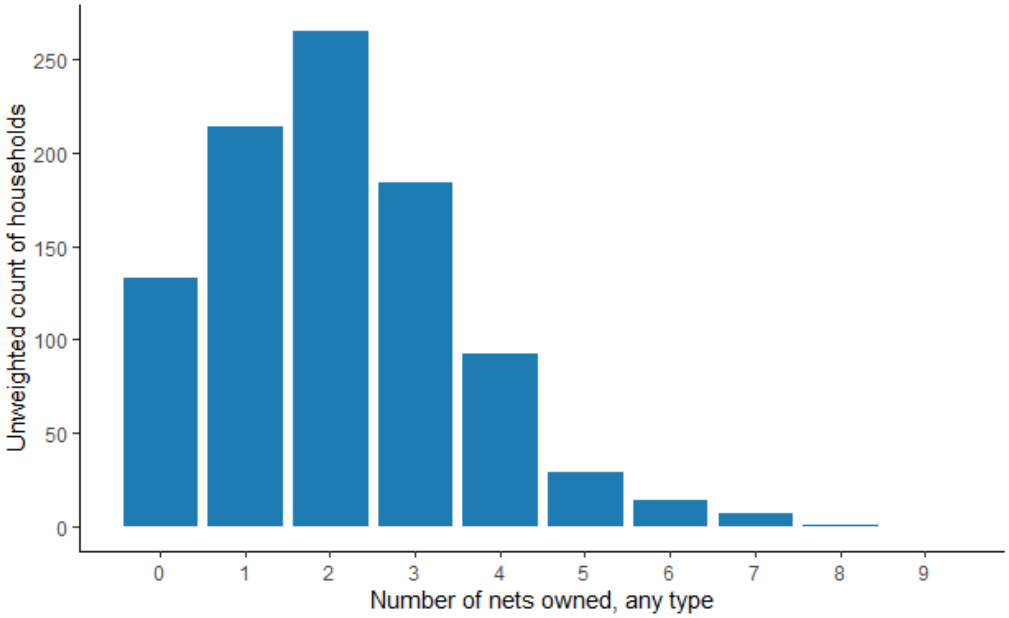
4.2.1 Ownership of nets by surveyed households

As Table 4.1 shows, 83.7% 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	949	815	83.7	(71 - 91)

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 (88.8%, in Table 4.3).

Table 4.2: Source of insecticide-treated nets

	N	n	%	95% CI
Source of net				
Government health facility	908	450	49.6	(46 - 53)
Vector control or malaria program or medicadora	908	276	30.4	(27 - 33)
Community health worker/promoter or Col-Vol	908	172	18.9	(17 - 22)
Shop/market	908	2	0.2	(0 - 1)
Religious institution	908	0	0	(-)
Pharmacy	908	0	0	(-)
Other	908	6	0.7	(0 - 1)
Don't know	908	2	0.2	(0 - 1)

Table 4.3: Source of untreated nets

	N	n	%	95% CI
Source of net				
Shop/market	1092	970	88.8	(87 - 91)
Religious institution	1092	1	0.1	(0 - 1)
Pharmacy	1092	1	0.1	(0 - 1)
Other	1092	112	10.3	(9 - 12)
Don't know	1092	7	0.6	(0 - 1)
Decline to respond	1092	1	0.1	(0 - 1)

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	1792	1466	81.8	(80 - 84)
Only thumb-sized holes	1792	278	15.5	(14 - 17)
At least one fist or head-sized hole	1792	40	2.2	(2 - 3)
Net never used	1792	8	0.4	(0 - 1)

Table 4.5: Reported condition of nets not observed

	N	n	%	95% CI
Condition of mosquito net as reported				
No holes	207	148	71.5	(65 - 77)
Only thumb-sized holes	207	28	13.5	(10 - 19)
Net never used	207	14	6.8	(4 - 11)
At least one fist or head-sized hole	207	2	1	(0 - 4)
Don't know	207	15	7.2	(4 - 12)

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)

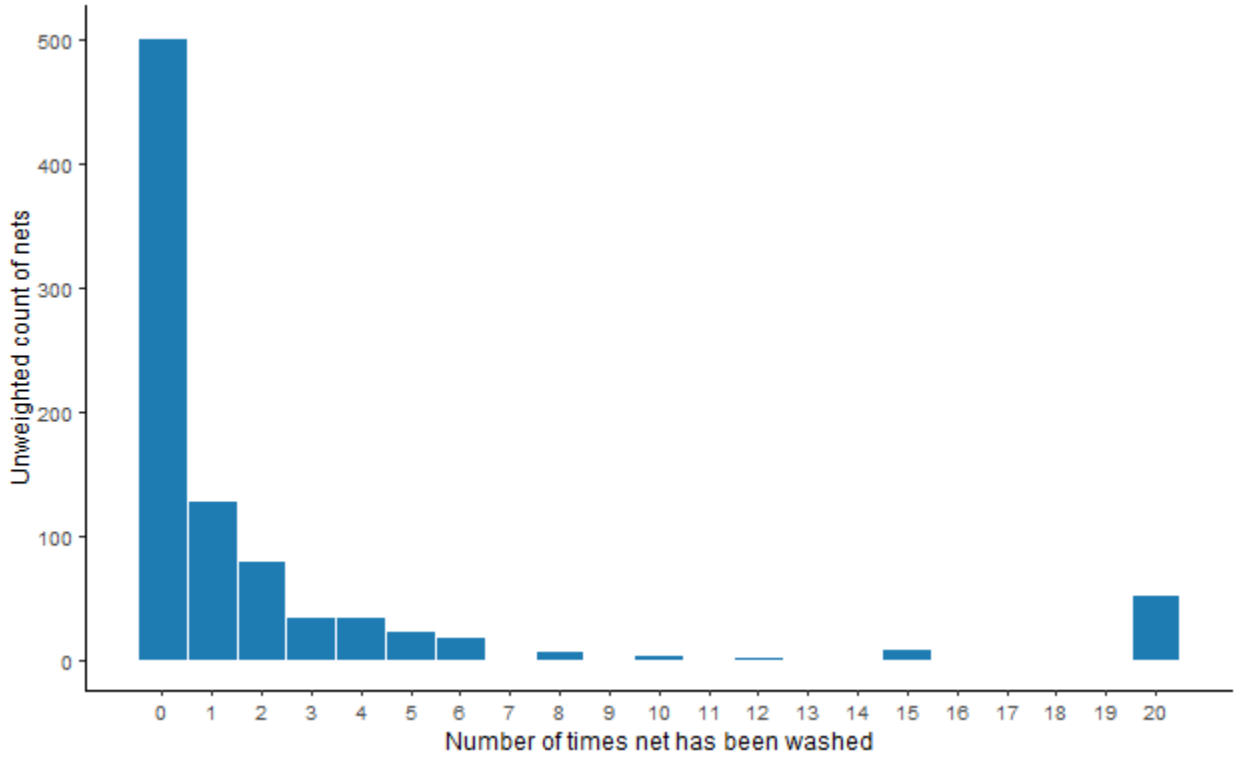


Table 4.6: Care of insecticide-treated nets - drying

	N	n	%	95% CI
Method of drying net				
In the shade	398	221	55.5	(51 - 60)
In the sun	398	177	44.5	(40 - 49)
Indoors	398	0	0	(-)
In a dryer	398	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, 30.8% 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, 37.6% 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	3900	1479	30.8	(18 - 47)
Slept under untreated net	3900	1584	45.2	(30 - 62)
Under 5				
Slept under treated net	422	177	37.6	(25 - 53)
Slept under untreated net	422	180	47.7	(35 - 61)
Pregnant				
Slept under treated net	35	13	22.4	(9 - 46)
Slept under untreated net	35	17	58.7	(30 - 82)
Reported usually sleeping under net during pregnancy	36	30	79.8	(58 - 92)

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 that it was too hot to sleep under a net. When respondents specified an “other” response, they often claimed it was due to price or economic reasons.

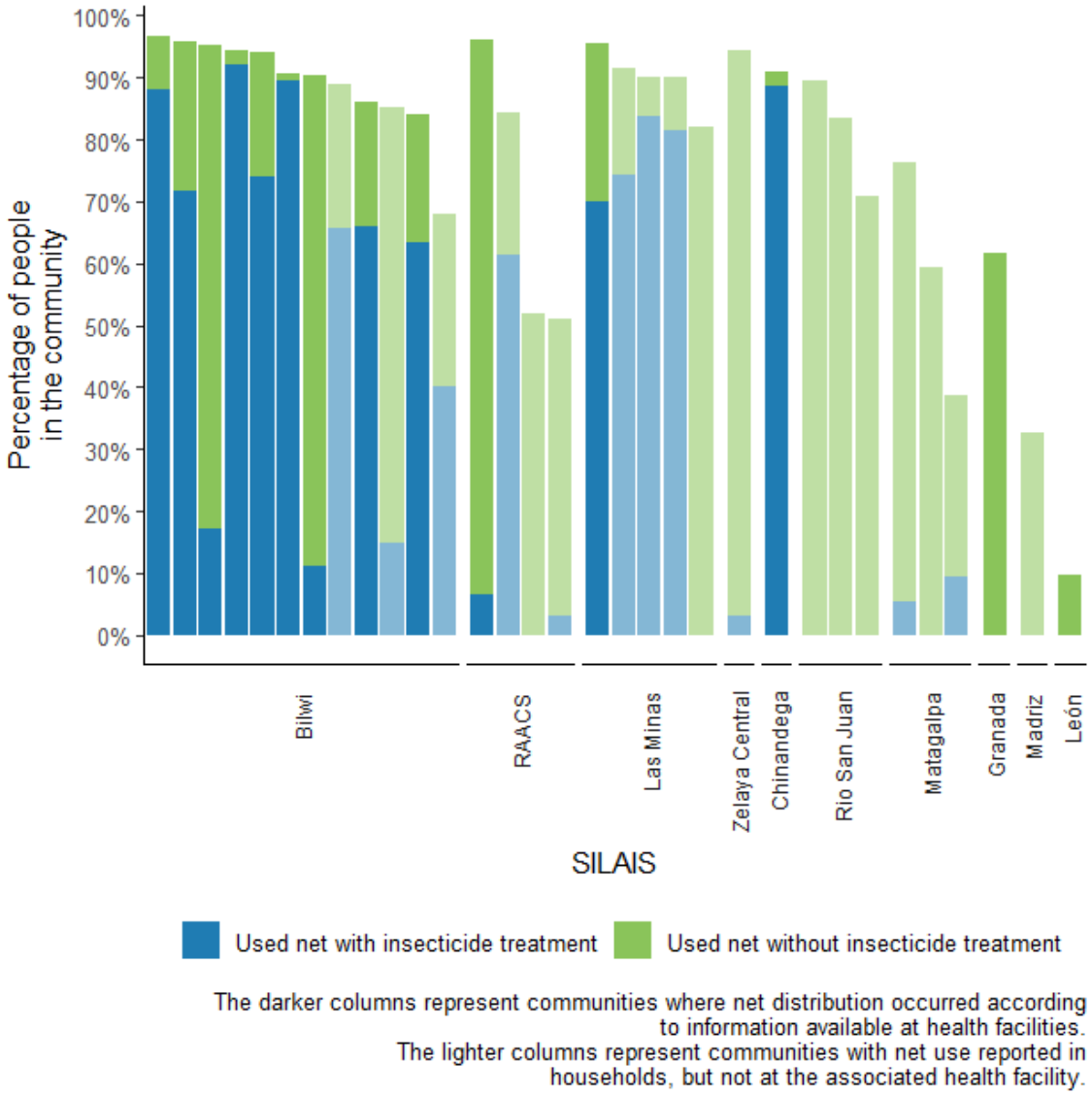
Table 4.8: Reasons for not using net

	N	n	%	95% CI
Reasons for not sleeping under mosquito net				
Too hot	182	43	26.9	(17 - 39)
Don't have enough nets	182	31	13	(8 - 22)
No mosquitoes	182	15	9.7	(4 - 23)
Not necessary, using fan instead	182	8	9.5	(3 - 25)
Saving net for later	182	17	8.4	(4 - 17)
Usual user(s) did not sleep here last night	182	14	7.2	(4 - 13)
Net too expensive	182	18	4.7	(2 - 10)
Extra net/more nets available than sleeping areas	182	10	3.3	(1 - 8)
Feel closed in/afraid	182	4	2.3	(0 - 12)

	N	n	%	95% CI
Sleep in a hammock and available mosquito nets do not work	182	5	2.1	(1 - 6)
Net too old/torn	182	3	2	(0 - 7)
Net not available last night/net being washed	182	3	2	(0 - 8)
Not necessary, using mosquito repellent instead	182	2	2	(0 - 9)
Don't like smell/insecticide is too strong	182	4	1.6	(0 - 7)
The insecticide is bad for your health	182	3	1.4	(0 - 6)
It is bad for the skin, it causes irritation	182	2	0.9	(0 - 4)
Net too small	182	1	0.7	(0 - 5)
Don't know where or how to get another net	182	1	0.5	(0 - 4)
No malaria now	182	1	0.5	(0 - 4)
Other	182	37	22.4	(14 - 34)
Don't know	182	2	1.4	(0 - 10)

Figure 4.3 shows by SILAIS/department 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 most cases in Nicaragua, 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. However, there is evidence that the corresponding health facility does not always have information about the intervention activity in communities in its catchment, which is particularly evident in the SILAIS of RAACS and Las Minas. Untreated net use is notable in some communities.

Figure 4.3: Net use by department and community



4.3 Indoor Residual Spraying

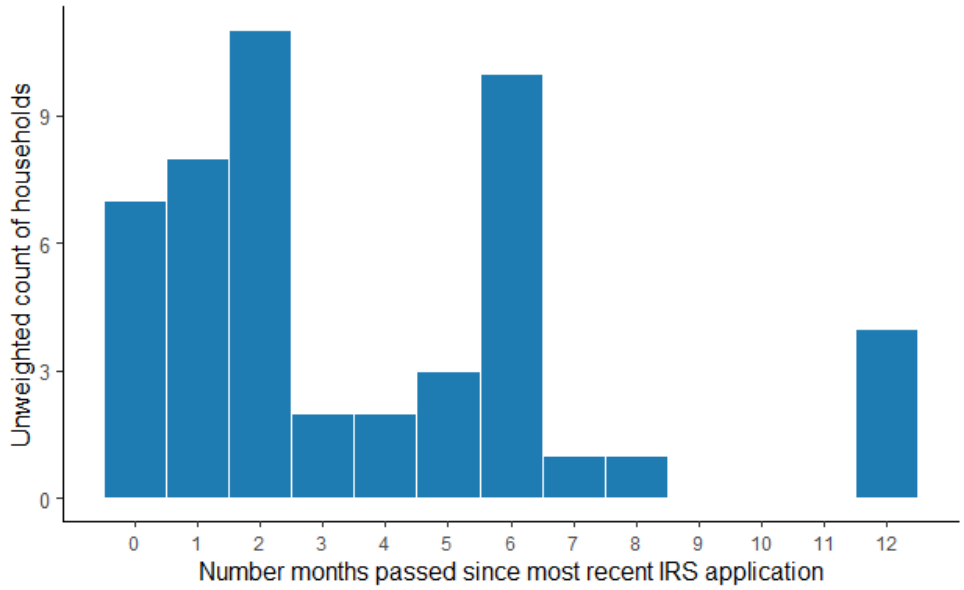
The other key vector control intervention of the Initiative is to offer to spray the interior walls of the dwelling against mosquitoes (usually with deltamethrin or a comparable insecticide). Insecticide application is usually carried out by staff or contractors of the vector control program every 4 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, 10.6% of households were offered IRS, and spraying was carried out in 86.2% 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 30.9% of households that received IRS. The response “don’t know” was given to the question about observing evidence of IRS completion in 3 households.

Table 4.9: Households offered and accepting spraying

	N	n	%	95% CI
Offered indoor residual spraying	942	64	10.6	(5 - 23)
Accepted indoor residual spraying	63	53	86.2	(68 - 95)
Evidence observed (card, sticker, mark)	50	13	30.9	(13 - 57)

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, were asked why the spraying was not carried out, an uncommon circumstance. 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				
No one was at home	10	4	29.7	(6 - 74)
Dangerous for children	10	1	18.9	(2 - 70)
Didn't have time/visit time was not convenient	10	2	15.1	(2 - 57)
Not effective to prevent mosquito bites	10	2	14.9	(4 - 41)
Don't know	10	2	25.3	(5 - 69)

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.

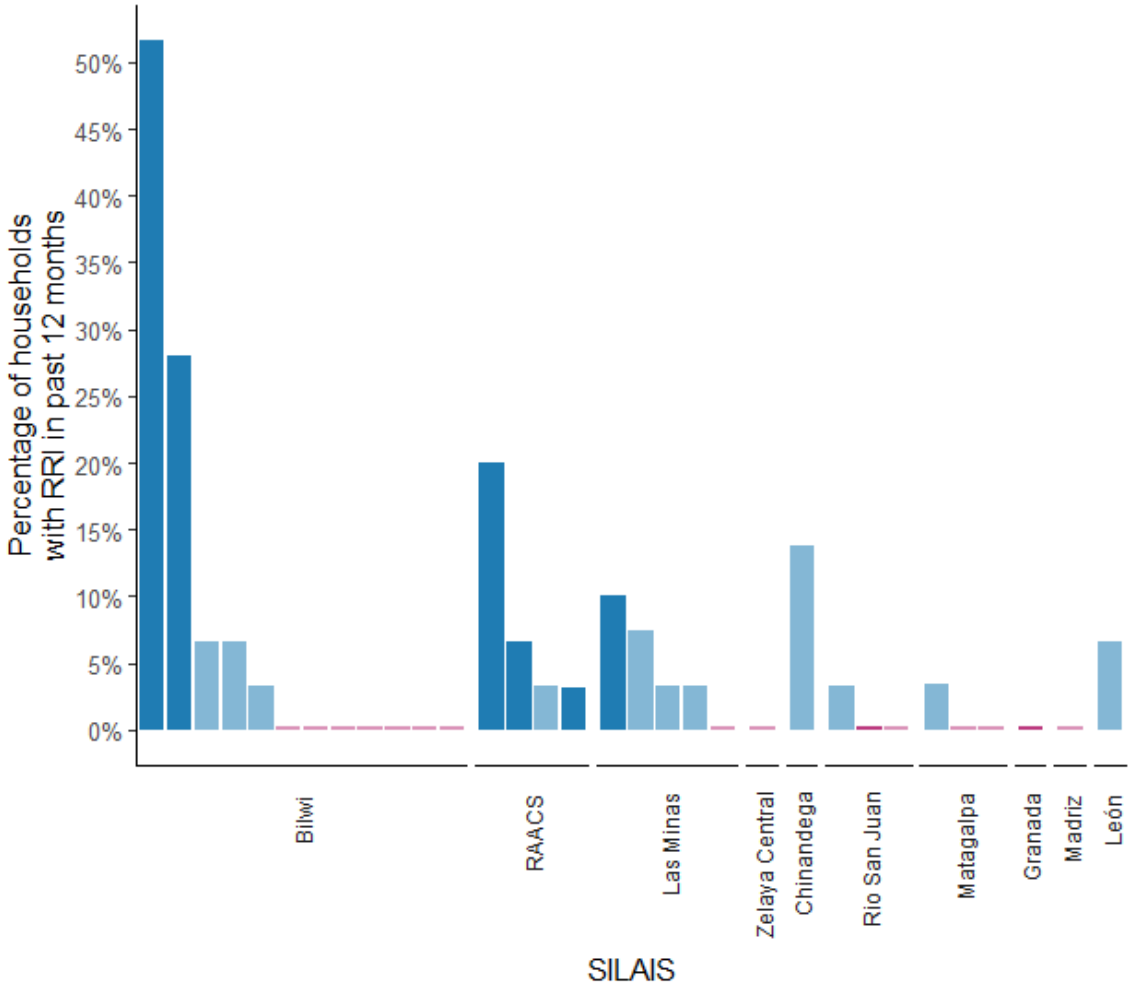
Table 4.11: Post-spraying practices

	N	n	%	95% CI
Walls painted since last IRS[1]	52	5	11.6	(6 - 23)
Walls washed since last IRS	53	15	32.1	(16 - 54)
Walls plastered since last IRS[1]	52	1	3.1	(1 - 9)

[1]One household responded 'do not know' to walls painted and walls plastered and is excluded.

Figure 4.5 shows by department the proportion of households that received IRS in each of the communities surveyed. The communities expected to receive the IRS intervention according to vector control staff at the corresponding health facility are highlighted in darker colors. Among the few communities expected to receive IRS, only one was found to have coverage above 50%, with the rest below 30%.

Figure 4.5: Indoor residual spraying by department and community



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 46.1% of individual usual household members in target communities covered by one of the two interventions.

Table 4.12: Vector control received by reported intervention

Vector control reported	Communities	Used treated net	House sprayed
Nets	11	56.4%	2.8%
Spray	5	32.8%	8.8%
Both	3	37.6%	28.1%
None	13	23.8%	1.7%

Table 4.13: Vector control indicator

	N	n	%	95% CI
Usual household members in vector control communities who slept in house last night	2412	2336	97	(95 - 98)
Slept under insecticide treated net	2336	1107	37.6	(21 - 58)
House sprayed with mosquito treatment past 12 months	2315	194	13.6	(5 - 31)
Omitted from household spraying calculations due to 'do not know' responses	2336	21	0.8	(0 - 3)
'DK' responses included in indicator because they slept under treated net	21	11	64.9	(18 - 94)
Received either vector control to standard	2326	1201	46.1	(29 - 65)

The variation in vector control coverage across malaria strata can be seen in Table 4.14, and across SILAIS health region in Table 4.15. Coverage was significantly higher in areas with higher malaria burden.

Table 4.14: Vector control indicator: result by facility stratification

	N	n	%	95% CI
Received either vector control to standard				
Stratum 5	1220	821	67.9	(53 - 80)
Stratum 4	865	373	43.8	(19 - 72)
Stratum 3	241	7	4.5	(2 - 8)
Total	2326	1201	46.1	(29 - 65)

Table 4.15: Vector control indicator: result by SILAIS health region

	N	n	%	95% CI
Received either vector control to standard				
Bilwi	1164	779	63.6	(51 - 75)
Chinandega	131	118	90.1	(90 - 90)
Granada	115	0	0	(-)
Las Minas	232	182	77.9	(67 - 86)
León	126	7	5.6	(6 - 6)
RAACS	450	115	31.7	(8 - 71)
Rio San Juan	108	0	0	(-)
Total	2326	1201	46.1	(29 - 65)

Chapter 5: Malaria Diagnostic Capacity

This chapter provides a descriptive summary of the health facilities surveyed for the RMEI-Nicaragua 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 included 60 facilities of various types as shown in Table 5.1. Thirty-two of the surveyed facilities provide primary level care, and 11 are secondary level services, though they may also provide primary attention as demanded and, in the case of health centers, to a local catchment population. The remaining facilities in the sample are administrative units: municipal headquarters (*sedes municipales*) which may be co-located with a health center or primary hospital, and were visited for review of confirmed malaria cases only (excluded from most tables in this chapter), and SILAIS headquarters that manage stock, reporting, and malaria programming for the entire department. The measurement included regional reference labs at the selected SILAIS as well as the national malaria reference lab.

Table 5.1: Health facility survey sample by facility type

	Facility Type	#
Primary care	Health post	32
Secondary care	Health center	7
	Primary hospital	4
Administrative unit/ National Lab	Municipal headquarters	11
	SILAIS headquarters	5
	National Reference Laboratory	1
Total		60

Table 5.2 shows the basic primary care services provided by 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
Health posts				
Child care	32	32	100	(-)
Child immunization services	32	30	93.7	(77 - 98)
Family planning services	32	32	100	(-)
Pregnancy testing	32	31	96.9	(80 - 100)
Antenatal care	32	32	100	(-)
Health centers & primary hospitals				
Child care	11	11	100	(-)
Child immunization services	11	11	100	(-)
Family planning services	11	11	100	(-)
Pregnancy testing	11	11	100	(-)
Antenatal care	11	11	100	(-)

All but one attention facilities in the sample provided services from Monday through Friday. A smaller number were open on the weekends (Table 5.3). Twenty-eight percent of primary care units and 72.7% of secondary care units had services open 24 hours (Table 5.4).

Table 5.3: Workweek of facility

	N	n	%	95% CI
Health posts: Days of the week service is provided				
Monday	32	32	100	(-)
Tuesday	32	32	100	(-)
Wednesday	32	32	100	(-)
Thursday	32	32	100	(-)
Friday	32	31	96.9	(80 - 100)
Saturday	32	7	21.9	(11 - 40)
Sunday	32	7	21.9	(11 - 40)
Health centers & primary hospitals: Days of the week service is provided				
Monday	11	11	100	(-)
Tuesday	11	11	100	(-)
Wednesday	11	11	100	(-)
Thursday	11	11	100	(-)
Friday	11	11	100	(-)
Saturday	11	9	81.8	(48 - 96)
Sunday	11	8	72.7	(40 - 91)

Table 5.4: Hours of operation

	N	n	%	95% CI
Health posts: Hours of operation				
Open less than 24 hours	32	23	71.9	(54 - 85)
Open 24 hours	32	9	28.1	(15 - 46)
Health centers & primary hospitals: Hours of operation				
Open 24 hours	11	8	72.7	(40 - 91)
Open less than 24 hours	11	3	27.3	(9 - 60)

Survey respondents indicated the type and number of personnel employed at the health facility. Table 5.5 shows the proportion of facilities that employ at least one of each personnel type. Physicians are employed at 50% of primary level facilities and at all secondary level facilities. In terms of laboratory diagnosis, microbiologists are employed at 54.5% and lab technicians at 81.8% of secondary care units, but not at any primary care units. Only 3.1% of primary level units employ epidemiology personnel, and 6.3% employ other statistics personnel, important functions for malaria notification and reporting.

Table 5.5: Facility personnel

	N	n	%	95% CI
Health posts				
General physician	32	16	50	(33 - 67)
Pediatrician	32	0	0	(-)
Nutritionist /dietician	32	0	0	(-)
Pharmacist	32	1	3.1	(0 - 20)
Auxiliary nurse	32	30	93.7	(77 - 98)
Practical nurse	32	8	25	(13 - 43)
Registered nurse	32	11	34.4	(20 - 53)
Professional midwife	32	7	21.9	(11 - 40)
Social worker	32	2	6.3	(2 - 23)
Microbiologist (laboratory)	32	0	0	(-)
Lab technician	32	0	0	(-)

	N	n	%	95% CI
Dispenser at pharmacy	32	2	6.3	(2 - 23)
Epidemiology personnel	32	1	3.1	(0 - 20)
Other personnel specific for statistics and reporting	32	2	6.3	(2 - 23)
Health centers & primary hospitals				
General physician	11	11	100	(-)
Pediatrician	11	10	90.9	(55 - 99)
Nutritionist /dietician	11	2	18.2	(4 - 52)
Pharmacist	11	5	45.5	(20 - 74)
Auxiliary nurse	11	11	100	(-)
Practical nurse	11	10	90.9	(55 - 99)
Registered nurse	11	10	90.9	(55 - 99)
Professional midwife	11	4	36.4	(14 - 67)
Social worker	11	0	0	(-)
Microbiologist (laboratory)	11	6	54.5	(26 - 80)
Lab technician	11	9	81.8	(48 - 96)
Dispenser at pharmacy	11	10	90.9	(55 - 99)
Epidemiology personnel	11	10	90.9	(55 - 99)
Other personnel specific for statistics and reporting	11	9	81.8	(48 - 96)
SILAIS headquarters				
Epidemiology personnel	5	5	100	(-)
Other personnel specific for statistics and reporting	5	4	80	(30 - 97)

5.2 Rapid diagnostic tests

Rapid diagnostic tests (RDT) are used in Nicaragua 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 Nicaragua 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.

5.2.1 Rapid diagnostic test practices

In Nicaragua, 34.4% of primary care facilities store RDTs, and 56.2% provide testing with RDTs (Table 5.6). In 62.5% of primary care facilities, personnel test with RDTs inside the facility, and personnel conduct testing in the community in 46.9% of facilities (Table 5.7). Testing in the community is most often conducted at least once per week (43.5% of facilities that conduct testing in the community), as shown in Table 5.8.

Table 5.6: Rapid diagnostic testing according to interview and observation

	N	n	%	95% CI
Health posts				
Unit stores RDTs	32	11	34.4	(20 - 53)
Unit conducts RDT testing	32	18	56.2	(39 - 73)
Health centers & primary hospitals				
Unit stores RDTs	11	3	27.3	(9 - 60)

	N	n	%	95% CI
Unit conducts RDT testing	11	3	27.3	(9 - 60)
SILAIS headquarters				
Unit stores RDTs	5	0	0	(-)
Unit conducts RDT testing	5	0	0	(-)

Table 5.7: Rapid diagnostic testing practices (interview)

	N	n	%	95% CI
Health posts				
Do health personnel perform rapid diagnostic testing for malaria in this facility?	32	20	62.5	(44 - 78)
Do health personnel in this facility perform rapid diagnostic testing for malaria in the community?	32	15	46.9	(30 - 64)
Health centers & primary hospitals				
Do health personnel perform rapid diagnostic testing for malaria in this facility?	11	2	18.2	(4 - 52)
Do health personnel in this facility perform rapid diagnostic testing for malaria in the community?	11	8	72.7	(40 - 91)
SILAIS headquarters				
Do health personnel perform rapid diagnostic testing for malaria in this facility?	5	0	0	(-)
Do health personnel in this facility perform rapid diagnostic testing for malaria in the community?	5	0	0	(-)

Table 5.8: Community rapid diagnostic testing frequency

	N	n	%	95% CI
Frequency of rapid diagnostic testing in the community				
At least once per week	23	10	43.5	(25 - 64)
Daily	23	5	21.7	(9 - 44)
At least once per month	23	4	17.4	(6 - 39)
Only in reaction to a positive malaria case	23	1	4.3	(1 - 26)
Other	23	3	13	(4 - 34)

Respondents at facilities that reported using both RDTs and microscopic diagnosis methods were asked which of the two methods are more commonly used. While 25% of facilities reported using both RDT and microscopy routinely for the same patient, 60.7% reported taking only a TBF sample routinely (Table 5.9).

Table 5.9: More commonly used testing method among facilities that report use of both RDTs and microscopy

	N	n	%	95% CI
For malaria diagnosis, is it most common to take a thick blood film only, use an RDT only, or take both samples (thick blood film and RDT) for diagnosis?				
Only thick blood film used more commonly	28	17	60.7	(41 - 77)
Both RDT and thick blood film: Samples are routinely taken for both tests at the same time	28	7	25	(12 - 45)
Only RDT used more commonly	28	4	14.3	(5 - 33)

Respondents at facilities that reported using both RDTs and microscopic diagnosis methods were asked if they must wait for confirmation with microscopic diagnosis before beginning malaria treatment. According to the norm, treatment can be initiated with a positive RDT diagnosis. However, 36.8% of

primary care facilities and 50% of secondary care facilities that used RDTs reported that they require confirmation by TBF examination in order to start treatment (Table 5.10).

Table 5.10: Microscopy confirmation of RDT results, attention units conducting RDT

	N	n	%	95% CI
Do you require a positive thick blood film test as confirmation after a positive RDT to start malaria treatment?				
Health posts	19	7	36.8	(18 - 60)
Health centers & primary hospitals	8	4	50	(19 - 81)

5.2.2 Rapid diagnostic testing as measured in medical record review

The health facility survey included a record review of confirmed cases of malaria to evaluate diagnosis and case management practices, and a review of suspected cases of malaria (patients presenting with fever). Chapters 6 and 7 discuss the results in detail. The review captured whether each case from the year 2018 included in the sample received a rapid diagnostic test based on case notification and investigation paperwork stored at the municipal headquarters (for confirmed cases) and based on patient charts, attention registries, and lab records at selected health facilities (for suspected cases). As seen in Table 5.11, 33.1% of confirmed cases reviewed had evidence of an RDT, and 7.2% of suspected cases reviewed had evidence of receiving an RDT.

Table 5.11: Rapid diagnostic testing observed in medical record review

	N	n	%	95% CI
RDT observed in record				
Confirmed cases	1025	339	33.1	(30 - 36)
Suspected cases	966	70	7.2	(6 - 9)

5.2.3 Stock of rapid diagnostic testing inputs

The health facility survey included an observation by field personnel of inputs and equipment for malaria diagnosis. The recommended *P. falciparum* + *P. vivax* card test was observed in 31.3% of primary care facilities. No rapid tests were observed the day of the survey in 65.6% of primary care facilities (Table 5.12).

Table 5.12: Rapid diagnostic test supply observed

	N	n	%	95% CI
Health posts				
P. falciparum rapid detection card equipment observed	32	2	6.3	(2 - 23)
P. falciparum + P. vivax rapid detection card equipment observed	32	10	31.3	(17 - 50)
None of these rapid detection cards observed	32	21	65.6	(47 - 80)
Health centers & primary hospitals				
P. falciparum rapid detection card equipment observed	11	1	9.1	(1 - 45)
P. falciparum + P. vivax rapid detection card equipment observed	11	3	27.3	(9 - 60)
None of these rapid detection cards observed	11	8	72.7	(40 - 91)
SILAIS headquarters				
None of these rapid detection cards observed	5	5	100	(-)

As shown in Table 5.13, 53.1% of primary care facilities, 54.5% of secondary care facilities, and 0% of SILAIS headquarters routinely store RDTs.

Table 5.13: Rapid diagnostic test routine storage (questionnaire)

	N	n	%	95% CI
Health posts: Does this facility routinely store any malaria rapid diagnostic tests (RDTs)?				
No, delivered when services are being provided	32	1	3.1	(0 - 20)
No, picked up from another facility	32	2	6.3	(2 - 23)
Yes, stores malaria rapid diagnostic tests (RDTs)	32	17	53.1	(36 - 70)
None of the above	32	12	37.5	(22 - 56)
Health centers & primary hospitals: Does this facility routinely store any malaria rapid diagnostic tests (RDTs)?				
No, delivered when services are being provided	11	0	0	(-)
No, picked up from another facility	11	0	0	(-)
Yes, stores malaria rapid diagnostic tests (RDTs)	11	6	54.5	(26 - 80)
None of the above	11	5	45.5	(20 - 74)
SILAIS headquarters: Does this facility routinely store any malaria rapid diagnostic tests (RDTs)?				
No, delivered when services are being provided	5	1	20	(3 - 70)
No, picked up from another facility	5	1	20	(3 - 70)
Yes, stores malaria rapid diagnostic tests (RDTs)	5	0	0	(-)
None of the above	5	3	60	(19 - 90)

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 Nicaragua, all facilities providing primary care to patients are expected to have the capacity to prepare TBF slides. In the health facility interview and observation, 87.5% of primary care facilities were found to take TBF samples. Administrative units sometimes have this capacity as well, when the unit has vector control technicians affiliated (20% of SILAIS headquarters, as in Table 5.14). The health facility survey (interview and observation) determined microscopic diagnostic capacity at 0% of primary care facilities, 90.9% of secondary care facilities, and 60% of SILAIS headquarters.

Table 5.14: Microscopy and thick blood film sampling according to interview + observation

	N	n	%	95% CI
Health posts				
Unit takes thick blood film samples	32	28	87.5	(70 - 95)
Unit has microscopy capacity	32	0	0	(-)
Health centers & primary hospitals				
Unit takes thick blood film samples	11	11	100	(-)
Unit has microscopy capacity	11	10	90.9	(55 - 99)
SILAIS headquarters				
Unit takes thick blood film samples	5	1	20	(3 - 70)

	N	n	%	95% CI
Unit has microscopy capacity	5	3	60	(19 - 90)

According to the interview alone and as seen in Table 5.15, 85.4% of all facilities (regardless of type) have personnel that take TBF samples in-facility, and 75% have personnel that take TBF samples in the community.

Table 5.15: Thick blood film sampling according to interview

	N	n	%	95% CI
Health personnel in this facility take thick blood film samples in-facility	48	41	85.4	(72 - 93)
Health personnel take thick blood film samples in the community	48	36	75	(60 - 85)

As shown in Table 5.16 and regardless of facility type, 24.4% of facilities conduct initial diagnosis of malaria according to the interview. Facilities that do not conduct initial diagnosis either do not have microscopic diagnostic capacity, or they exclusively examine already-diagnosed slides for quality control (such as some SILAIS regional laboratories and at the national laboratory). Of those 10 facilities that report conducting initial diagnosis, 90% also examine samples taken by community health workers or volunteer collaborators, and 20% sometimes send slides elsewhere for initial diagnosis (for example, when the sole laboratorist is on leave). Among the 31 facilities that do not conduct initial diagnosis, 100% send samples to another facility for initial diagnosis.

Among all 33 facilities that send samples to another facility (sometimes or always), 69.7% report sending them to another health care facility, while 18.2% report sending them directly to the regional laboratory for initial diagnosis (Table 5.17).

Table 5.16: Microscopy capacity in facility according to interview

	N	n	%	95% CI
Thick blood film samples examined for initial diagnosis of malaria in-facility	41	10	24.4	(13 - 40)
Thick blood film samples taken by community health workers (health promotors/volunteer collaborators) examined for malaria in-facility	10	9	90	(52 - 99)
Samples sometimes sent elsewhere for initial diagnosis of malaria, among facilities with capacity	10	2	20	(5 - 55)
Samples sent elsewhere for initial diagnosis of malaria, among facilities without capacity	31	31	100	(-)

Table 5.17: Samples sent elsewhere: location

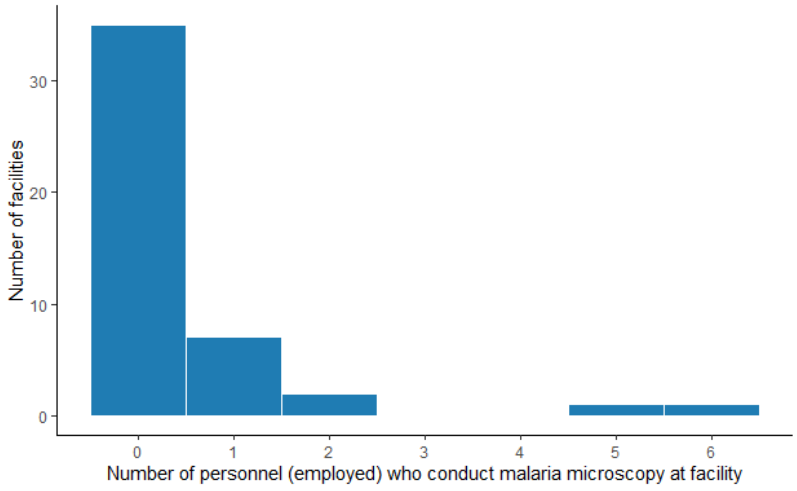
	N	n	%	95% CI
Location of initial diagnosis				
Municipal laboratory	33	23	69.7	(52 - 83)
Another health facility	33	6	18.2	(8 - 36)
Regional laboratory	33	1	3	(0 - 20)
Other	33	3	9.1	(3 - 25)

Facilities that reported conducting initial diagnosis (regardless of facility type) were asked about the personnel responsible for examining slides, and respondents could indicate more than one type. In 50% of facilities there is at least one malaria microscopist, 50% of facilities have at least one microbiologist who conducts malaria diagnosis, and 70% have other lab personnel that read malaria slides (Table 5.18). Figure 5.2 shows the number of employed personnel of all personnel types who conduct malaria diagnosis at each facility in the sample.

Table 5.18: Personnel responsible for malaria microscopy testing

	N	n	%	95% CI
Personnel responsible for TBF examination				
Other lab technician	10	7	70	(37 - 90)
Malaria microscopist	10	5	50	(22 - 78)
Microbiologist (laboratory)	10	5	50	(22 - 78)

Figure 5.2: Diagnostic personnel employed by facilities

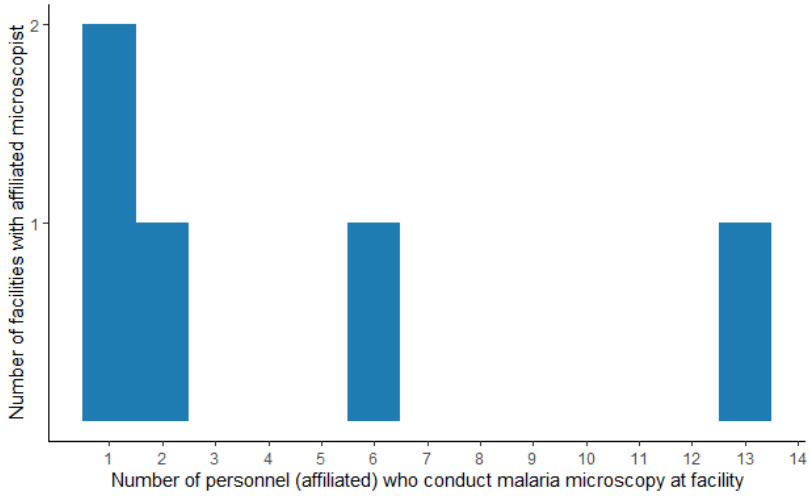


The health facility survey also asked about any affiliated personnel (employed by another institution rather than by the facility directly) who conduct malaria diagnosis. Only 10.6% of facilities had affiliated personnel involved in diagnosis (Table 5.19). Figure 5.3 shows the number of affiliated diagnostic personnel at each of the 5 facilities reporting affiliates.

Table 5.19: Diagnostic personnel not employed but working in facility

	N	n	%	95% CI
Affiliated microscopists work at but are not employed by facility	47	5	10.6	(4 - 24)

Figure 5.3: Diagnostic personnel affiliated to facilities



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 5.20. Supplies and equipment inputs are not evaluated at municipal headquarters or the national reference laboratory in Nicaragua.

Table 5.20: Indicator 7.01: Required components by facility type

Component	Health Posts (32)	Health Centers (7)	Primary Hospitals (4)	SILAIS headquarters (5)
Medications (basic)	Strata 3+ (all)	Strata 3+ (all)	Strata 3+ (all)	
Medications (severe malaria)			Strata 3+ (all)	
Sampling equipment	Strata 3+ (all)	Strata 3+ (all)	Strata 3+ (all)	
Forms for sending samples	Strata 3+ (all)	Strata 3+ (all)	Strata 3+ (all)	
Equipment for on-site diagnosis (RDT)	Strata 3+ (all)		Strata 3+ (all)	
Microscopy equipment		Strata 3+ if reported microscopy capacity	Strata 3+ if reported microscopy capacity	If reported microscopy capacity
Staining and sample reading equipment		Strata 3+ if reported microscopy capacity	Strata 3+ if reported microscopy capacity	If reported microscopy capacity
Staining reagents		Strata 3+ if reported microscopy capacity	Strata 3+ if reported microscopy capacity	If reported microscopy capacity

The indicator results are shown in Table 5.21. Only 15.2% of all the facilities in the sample had all of the inputs required for the corresponding facility type. Table 5.22 shows, for comparison, the results by malaria stratum.

Table 5.21: Indicator 7.01: Equipment and medications

	N	n	%	95% CI
Antimalarial medications	43	25	58.1	(43 - 72)
Medications for basic treatment: Chloroquine	43	29	67.4	(52 - 80)
Medications for basic treatment: Primaquine (5 or 15 mg tablets)	43	30	69.8	(54 - 82)
Medication for treatment of severe malaria: Quinine / Artesunate	4	2	50	(12 - 88)
No stockout of chloroquine or primaquine in past 3 months	43	27	62.8	(47 - 76)
Sampling and biosafety equipment[1]	32	25	78.1	(60 - 89)
Disposable gloves	32	30	93.7	(77 - 98)
Lancets	32	28	87.5	(70 - 95)
Microscope slides (frosted or non-frosted)	32	26	81.2	(63 - 92)
Sample submission forms[2]	12	10	83.3	(51 - 96)
Rapid diagnostic tests (RDTs) for onsite testing	36	13	36.1	(22 - 53)
Microscopy equipment	13	12	92.3	(59 - 99)
Binocular microscope (with 100x retractable lens)	13	13	100	(-)
Cell counter (manual or automatic)	13	12	92.3	(59 - 99)

	N	n	%	95% CI
Equipment for staining and testing	13	11	84.6	(54 - 96)
Immersion oil	13	13	100	(-)
Staining tray/ container	13	12	92.3	(59 - 99)
Laboratory stopwatch	13	12	92.3	(59 - 99)
Container for mixing dye/ stain	13	12	92.3	(59 - 99)
Pipettes/ droppers/ syringes	13	11	84.6	(54 - 96)
Reagents for staining	13	2	15.4	(4 - 46)
GIEMSA solution (or alternative: Methylene blue + Solution A + Solution B + Methanol)	13	12	92.3	(59 - 99)
Buffer solution or buffered water	13	3	23.1	(7 - 53)
No stockout of reagents in past 3 months	13	2	15.4	(4 - 46)
Units with all required equipment and medications	46	7	15.2	(7 - 29)

[1]Sampling inputs were collected in only 32/43 establishments
[2]Sample submission forms were collected in only 12/43 establishments

Table 5.22: Comparison: result by facility stratification

	N	n	%	95% CI
P7.01 Equipment Indicator				
Stratum 5	16	3	18.8	(6 - 46)
Stratum 4	19	4	21.1	(8 - 45)
Stratum 3	11	0	0	(-)
Total	46	7	15.2	(7 - 29)

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 5.23 and Table 5.24 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), Microcuvettes, Needles, Vacutainer-type needles, Capillary tubes) were sought for observation only in facilities with a microscopy post or laboratory.

Table 5.23: Sample-taking supplies observed

	N	n	%	95% CI
Disposable gloves	35	32	91.4	(76 - 97)
Alcohol swabs	35	11	31.4	(18 - 49)
Cotton-wool swabs	35	27	77.1	(60 - 88)
Acetone or Acetone alcohol (antiseptic)	35	25	71.4	(54 - 84)
Lancets	35	30	85.7	(69 - 94)
Syringes (for taking blood)	35	11	31.4	(18 - 49)
Needles	35	11	31.4	(18 - 49)
Vacutainer-type needles	35	12	34.3	(20 - 52)
Capillary tubes	35	15	42.9	(27 - 60)
Sharps box	35	22	62.9	(46 - 77)
Microscope slides (not frosted)	35	22	62.9	(46 - 77)
Frosted microscope slides	35	13	37.1	(23 - 54)

Table 5.24: Microscopy equipment and supplies observed, among all facilities reporting microscopy capacity (excluding national lab and municipal headquarters)

	N	n	%	95% CI
Lens-cleaning tissues	13	13	100	(-)
Spare bulbs (for microscopes)	13	7	53.8	(28 - 78)
Spare fuses (for microscopes)	13	5	38.5	(17 - 66)
Immersion oil	13	13	100	(-)
Oil immersion lens-cleaning solution	13	4	30.8	(12 - 60)
Staining rack	13	11	84.6	(54 - 96)
Drying rack (or sheet)	13	11	84.6	(54 - 96)
Measuring cylinder/disposable graduated cylinder	13	9	69.2	(40 - 88)
Glass or plastic bottles with a lid, that do not allow the passage of light	13	9	69.2	(40 - 88)
Filter paper (or other input to act as filter paper)	13	11	84.6	(54 - 96)
Slide holders or wooden dowels	13	11	84.6	(54 - 96)
Containers for mixing dye or stain	13	10	76.9	(47 - 93)
Concave staining surface	13	4	30.8	(12 - 60)
Glass or plastic petri dishes	13	8	61.5	(34 - 83)
Syringes	13	2	15.4	(4 - 46)
Disposable droppers	13	8	61.5	(34 - 83)
Test tubes	13	9	69.2	(40 - 88)
Safety glasses (including the over-spectacle type)	13	10	76.9	(47 - 93)
Gowns	13	11	84.6	(54 - 96)
Markers	13	11	84.6	(54 - 96)
Detergents	13	11	84.6	(54 - 96)
Timer in laboratory	13	7	53.8	(28 - 78)

Each microscope present at facilities in the sample was observed separately for characteristics. The number of microscopes at each facility is detailed in Figure 5.4. The observed characteristics, by microscope, are shown in Table 5.26.

Figure 5.4: Functional microscopes per facility

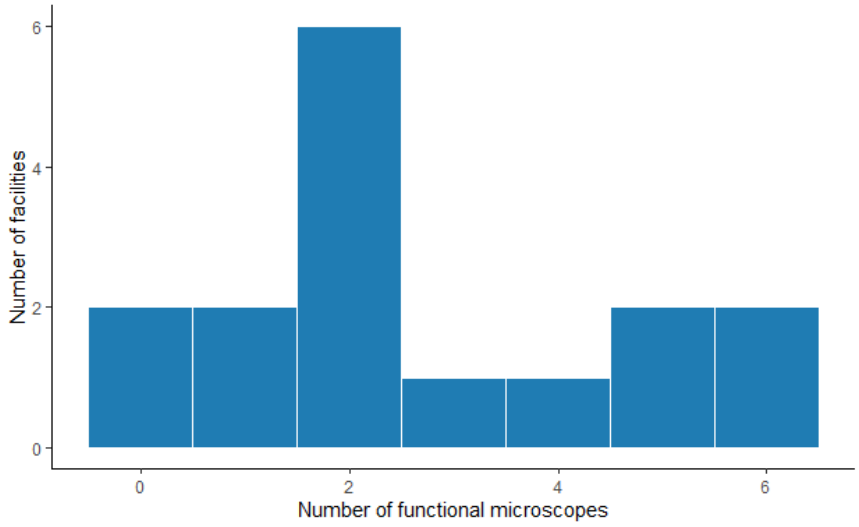


Table 5.26: Microscope characteristics among all observed microscopes

	N	n	%	95% CI
Is this a binocular microscope?	64	62	96.9	(88 - 99)
Is this a light microscope?	64	61	95.3	(86 - 99)
Is this a fluorescence microscope?	64	11	17.2	(10 - 29)
Is this a dark field microscope?	64	12	18.8	(11 - 31)
Is this a solar power microscope?	64	2	3.1	(1 - 12)
Lens observed: 4x	64	36	56.2	(44 - 68)
Lens observed: 10x	64	62	96.9	(88 - 99)
Lens observed: 20x	64	9	14.1	(7 - 25)
Lens observed: 40x	64	61	95.3	(86 - 99)
Lens observed: 100x	64	62	96.9	(88 - 99)
Lens observed: 1000x	64	0	0	(-)
Does the binocular microscope have an oil immersion lens?	62	59	95.2	(86 - 98)

Chapter 6: Malaria Case Detection

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 Nicaragua, 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 Nicaragua, clinical and community health personnel are trained to suspect and test for malaria in patients with high fever in zones with local transmission or among patients who have traveled to those zones. 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 (*colaboradores voluntarios*, or “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 Community case detection and malaria prevention activities

As a part of the health facility interview, respondents were asked about vector control personnel and community health workers affiliated with the facility. Many primary care facilities had at least one vector control technician or community health worker affiliated, all of whom were involved in malaria service provision. Vector control personnel and volunteer collaborators were also usually affiliated to SILAIS headquarters (Table 6.1).

Table 6.1: Affiliated malaria personnel

	N	n	%	95% CI
Health posts				
Vector control personnel	32	11	34.4	(20 - 53)
Community health workers/volunteer collaborators	32	26	81.2	(63 - 92)
Community health workers/volunteer collaborators involved in malaria activities (such as vector control, diagnosis, case detection, or treatment)	26	26	100	(-)
Other personnel involved in malaria diagnosis or treatment	32	3	9.4	(3 - 26)
Health centers & primary hospitals				
Vector control personnel	11	11	100	(-)
Community health workers/volunteer collaborators	11	9	81.8	(48 - 96)
Community health workers/volunteer collaborators involved in malaria activities (such as vector control, diagnosis, case detection, or treatment)	9	9	100	(-)
Other personnel involved in malaria diagnosis or treatment	11	2	18.2	(4 - 52)
SILAIS headquarters				
Vector control personnel	5	4	80	(30 - 97)
Community health workers/volunteer collaborators	5	0	0	(-)

	N	n	%	95% CI
Community health workers/volunteer collaborators involved in malaria activities (such as vector control, diagnosis, case detection, or treatment)	0	0		-
Other personnel involved in malaria diagnosis or treatment	5	1	20	(3 - 70)

As shown in Table 6.2, 87.5% of primary care facilities and 60% of administrative units reported that facility personnel participate in active searches for malaria. Some administrative units also reported storing mosquito nets for distribution (20%) and employing personnel involved with indoor residual spraying (0%). Educational campaigns about malaria were conducted by 60% of SILAIS headquarters and 56.2% of health posts.

The breakdown of health facilities that complete active case detection after there is a case of malaria in the catchment area and health facilities that schedule active case detection on a periodic bases are shown by department in Figure 6.1 and Figure 6.2.

Table 6.2: Active case detection and community activities

	N	n	%	95% CI
Health posts				
Conducts active search for malaria cases	32	28	87.5	(70 - 95)
Stores insecticide-treated mosquito nets for distribution in the community	32	1	3.1	(0 - 20)
Performs indoor residual spraying	32	1	3.1	(0 - 20)
Conducts educational campaigns about malaria in the community	32	30	93.7	(77 - 98)
Other malaria outreach activities	32	18	56.2	(39 - 73)
Health centers & primary hospitals				
Conducts active search for malaria cases	11	10	90.9	(55 - 99)
Stores insecticide-treated mosquito nets for distribution in the community[1]	10	6	60	(29 - 85)
Performs indoor residual spraying	11	10	90.9	(55 - 99)
Conducts educational campaigns about malaria in the community	11	10	90.9	(55 - 99)
Other malaria outreach activities	11	7	63.6	(33 - 86)
SILAIS headquarters				
Conducts active search for malaria cases	5	3	60	(19 - 90)
Stores insecticide-treated mosquito nets for distribution in the community	5	1	20	(3 - 70)
Performs indoor residual spraying	5	0	0	(-)
Conducts educational campaigns about malaria in the community	5	3	60	(19 - 90)
Other malaria outreach activities	5	4	80	(30 - 97)

[1]One health center representative responded 'do not know' to net storage and is excluded.

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, many facilities (regardless of facility type) reported they do active case detection after there is a case of malaria in the catchment area (39% of facilities). Among the 7.3% of facilities that reported doing active search according to direction from health authorities, 66.7% said the direction came from the municipal level (Table 6.4).

Table 6.3: Determinants of active case detection

	N	n	%	95% CI
When do you search for suspected malaria cases in your catchment area?				
After there is a case of malaria in the catchment area	41	16	39	(25 - 55)
On a scheduled periodic basis	41	15	36.6	(23 - 53)
When events (market, celebrations, vacations) are happening in the community	41	9	22	(12 - 38)
Daily	41	4	9.8	(4 - 24)
When directed from health authorities	41	3	7.3	(2 - 21)
Based on seasonality	41	2	4.9	(1 - 18)
Other	41	8	19.5	(10 - 35)

Table 6.4: Active case detection direction from health authorities

	N	n	%	95% CI
Agency/level that orders the active search				
Municipal level	3	2	66.7	(14 - 96)
Regional level	3	1	33.3	(4 - 86)

Figure 6.3: Active case detection completed after there is a case of malaria in the catchment area of the health facility, by department

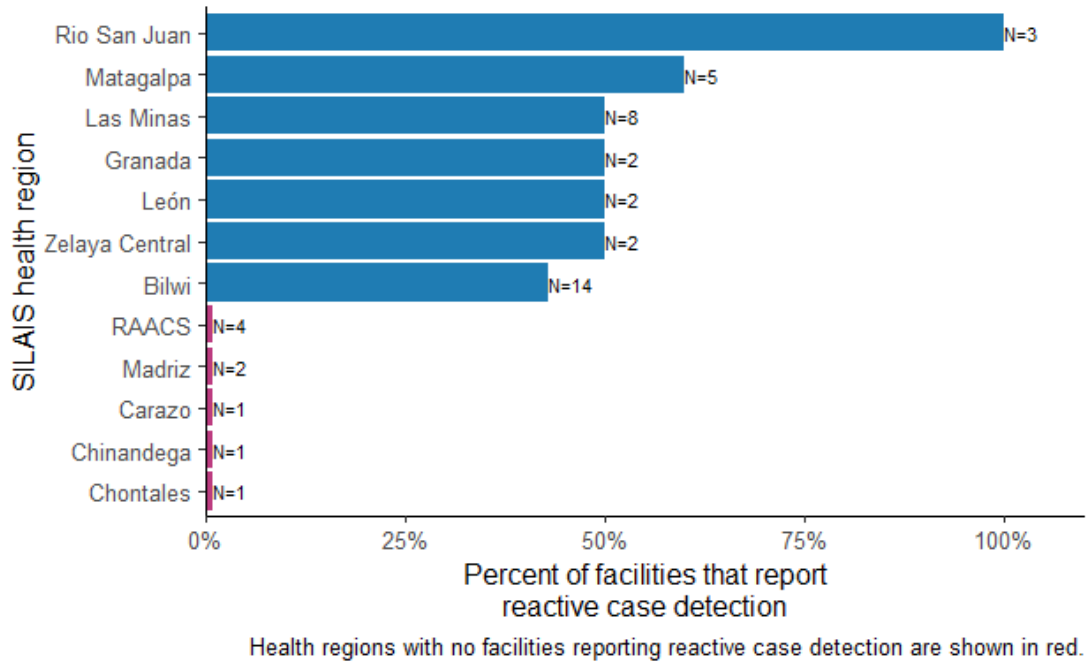
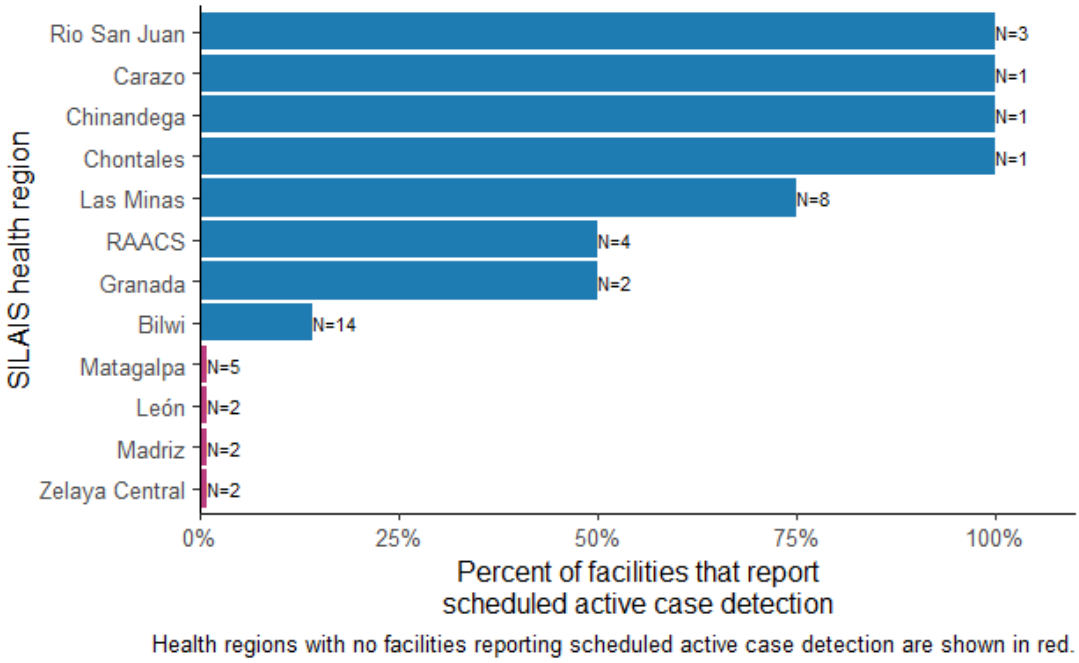


Figure 6.4: Active case detection scheduled on a periodic basis, by department



The facilities 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 6.5.

Table 6.5: Community net distribution

	N	n	%	95% CI
Mode of treated net distribution				
Vector control personnel distributes the nets in the community	8	6	75	(37 - 94)
Personnel from this health facility distributes the nets in the community	8	3	37.5	(12 - 72)
Other	8	1	12.5	(2 - 55)

Respondents were also asked a series of questions about malaria detection activities in the community and referrals from community health workers. Among facilities that administer malaria treatment, 50% of primary care units and 72.7% of secondary care units received referrals from col-vols or other community health workers to treat malaria. Diagnosis activities were common, with 62.5% of primary care facilities receiving referrals for malaria testing, 78.1% of primary care units taking TBF samples in the community, and 46.9% of primary care units taking RDTs in the community.

Table 6.6: Community malaria activities - questionnaire

	N	n	%	95% CI
Health posts				
Do you receive referred patients from community health workers or volunteer collaborators for malaria testing?	32	20	62.5	(44 - 78)
Do you receive referred patients from community health workers or volunteer collaborators for malaria treatment?	32	16	50	(33 - 67)
Do health personnel take thick blood film samples in the community?	32	25	78.1	(60 - 89)

	N	n	%	95% CI
Do health personnel in this facility perform rapid diagnostic testing for malaria in the community?	32	15	46.9	(30 - 64)
Do community health workers or volunteer collaborators receive malaria rapid tests from this facility for use in the community?	32	5	15.6	(6 - 33)
Health centers & primary hospitals				
Do you receive referred patients from community health workers or volunteer collaborators for malaria testing?	11	10	90.9	(55 - 99)
Do you receive referred patients from community health workers or volunteer collaborators for malaria treatment?	11	8	72.7	(40 - 91)
Do health personnel take thick blood film samples in the community?	11	11	100	(-)
Do health personnel in this facility perform rapid diagnostic testing for malaria in the community?	11	8	72.7	(40 - 91)
Do community health workers or volunteer collaborators receive malaria rapid tests from this facility for use in the community?	11	6	54.5	(26 - 80)

6.2 Passive case detection practices as measured in 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 suspicious symptoms will have a sample taken, usually of capillary blood, to prepare a TBF slide and sometimes to perform a rapid diagnostic test as well. If the *Plasmodium* parasite is detected via rapid test or microscopy, treatment with the first-line regimen corresponding to the parasite species begins and the case is notified to local vector control personnel and to the SILAIS. 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 blood sample information form (E-2) filled by the provider who took the sample, to a nearby lab 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 are notified so that they can 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 6.7 shows that doctors order the test in 63.3% of primary care facilities and 90.9% of secondary care facilities, and nurses order the test or take the sample at triage in 80% of primary care facilities and 45.5% of secondary care facilities. Text responses entered for “other” in primary care units include: nurse during consult, other technical or auxiliary staff, and all febrile patients automatically receive test.

Table 6.7: Malaria testing by facility personnel among facilities conducting testing

	N	n	%	95% CI
Health posts: Who decides whether a patient presenting at this facility will receive a malaria test?				
Nurse at triage or pre-clinic	30	24	80	(61 - 91)
Doctor during consult	30	19	63.3	(45 - 79)
Lab staff or microscopy staff	30	0	0	(-)
Other	30	2	6.7	(2 - 24)
Health centers & primary hospitals: Who decides whether a patient presenting at this facility will receive a malaria test?				
Nurse at triage or pre-clinic	11	5	45.5	(20 - 74)

	N	n	%	95% CI
Doctor during consult	11	10	90.9	(55 - 99)
Lab staff or microscopy staff	11	1	9.1	(1 - 45)
Other	11	1	9.1	(1 - 45)

Next, respondents were asked to mention what criteria are used to determine whether a patient gets a malaria test, at triage (Table 6.8) and at consult (Table 6.9). 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 (91.7, 80% and 94.7, 100% respectively) and chills was also frequently mentioned (in 54.2, 40% of facilities at triage). Few respondents mentioned travel history as a determining factor for malaria testing.

Table 6.8: Malaria testing criteria at triage

	N	n	%	95% CI
Health posts: 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	22	91.7	(71 - 98)
Chills	24	13	54.2	(34 - 73)
History of recent fever	24	8	33.3	(17 - 55)
Fever for more than 3 days	24	7	29.2	(14 - 50)
General malaise	24	7	29.2	(14 - 50)
Sweating	24	5	20.8	(9 - 42)
History of recent travel to areas with endemic malaria	24	5	20.8	(9 - 42)
Fever without nonspecific digestive symptoms (vomiting, abdominal pain, loss of appetite)	24	4	16.7	(6 - 38)
Profuse sweating	24	3	12.5	(4 - 33)
Weakness (asthenia or adynamia)	24	2	8.3	(2 - 29)
Prior history of malaria	24	1	4.2	(1 - 25)
Other	24	3	12.5	(4 - 33)
Health centers & primary hospitals: What criteria must a patient meet in order to get a blood sample taken for malaria test during triage or pre-clinic?				
High fever	5	4	80	(30 - 97)
General malaise	5	3	60	(19 - 90)
History of recent travel to areas with endemic malaria	5	3	60	(19 - 90)
Fever for more than 3 days	5	2	40	(10 - 81)
Chills	5	2	40	(10 - 81)
History of recent fever	5	1	20	(3 - 70)
Sweating	5	1	20	(3 - 70)
Profuse sweating	5	1	20	(3 - 70)
Fever without nonspecific digestive symptoms (vomiting, abdominal pain, loss of appetite)	5	1	20	(3 - 70)
Prior history of malaria	5	1	20	(3 - 70)

Table 6.9: Malaria testing criteria at consultation

	N	n	%	95% CI
Health posts: What criteria must a patient meet in order for the doctor to order a malaria test during the consultation?				
High fever	19	18	94.7	(69 - 99)
Chills	19	11	57.9	(35 - 78)
History of recent fever	19	7	36.8	(18 - 60)
General malaise	19	7	36.8	(18 - 60)
History of recent travel to areas with endemic malaria	19	7	36.8	(18 - 60)
Sweating	19	5	26.3	(11 - 51)
Profuse sweating	19	2	10.5	(3 - 35)
Fever without nonspecific digestive symptoms (vomiting, abdominal pain, loss of appetite)	19	2	10.5	(3 - 35)
Weakness (asthenia or adynamia)	19	1	5.3	(1 - 31)
Prior history of malaria	19	1	5.3	(1 - 31)
Health centers & primary hospitals: What criteria must a patient meet in order for the doctor to order a malaria test during the consultation?				
High fever	10	10	100	(-)
Chills	10	6	60	(29 - 85)
General malaise	10	6	60	(29 - 85)
History of recent travel to areas with endemic malaria	10	5	50	(22 - 78)
Prior history of malaria	10	5	50	(22 - 78)
History of recent fever	10	3	30	(10 - 63)
Sweating	10	3	30	(10 - 63)
Profuse sweating	10	3	30	(10 - 63)
Fever without nonspecific digestive symptoms (vomiting, abdominal pain, loss of appetite)	10	2	20	(5 - 55)
Weakness (asthenia or adynamia)	10	1	10	(1 - 48)
Fever without rash	10	1	10	(1 - 48)
Fever without respiratory symptoms	10	1	10	(1 - 48)
Other	10	1	10	(1 - 48)

6.3 Suspected malaria cases with test as measured in households

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.

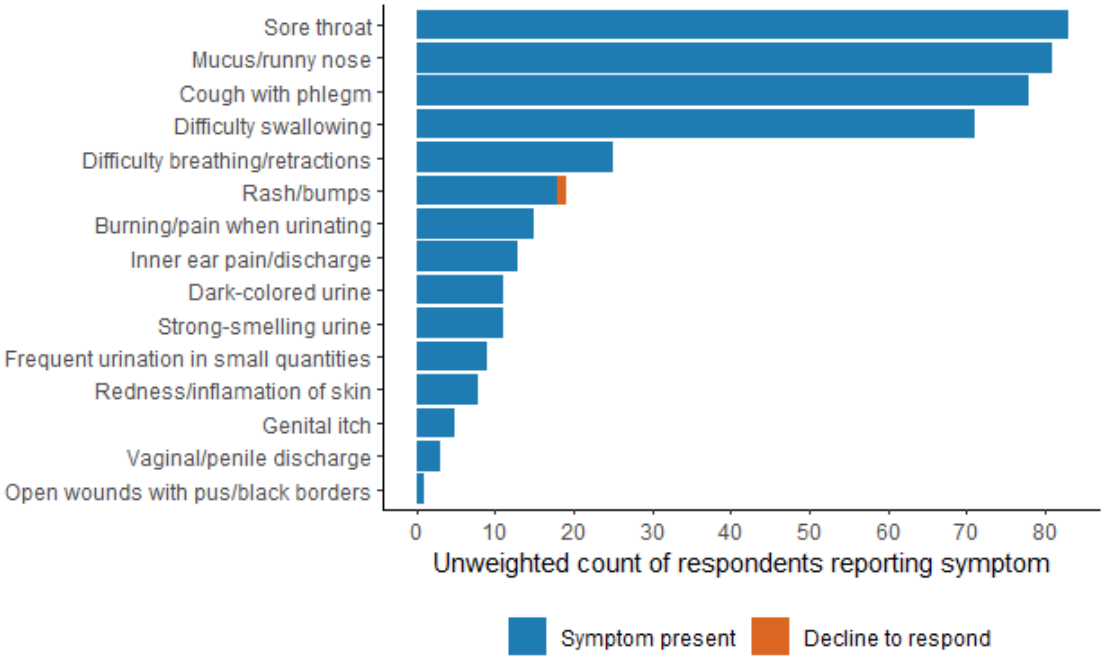
If the primary interview respondent reported that a household member had a recent fever, the interviewer asked to speak to the person who had the fever, or in the case that a child or adolescent had a fever, with the child's primary caregiver. If the person with the fever was not available and the primary 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 6.10, 4.9% 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 197 respondents who reported experiencing fever, the majority experienced other symptoms that suggested a condition other than malaria. Only 64 people, or 32.5% 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 6.5.

Table 6.10: Eligible fever cases reported in LQAS household survey

	N	n	%	95% CI
LQAS respondents	4037	4037	100	(-)
Fever cases	3996	197	4.9	(4 - 6)
Fever without exclusion symptoms	197	64	32.5	(23 - 43)

Figure 6.5: Exclusion symptoms experienced by respondents reporting fever



6.3.1 Indicator 2.02: Suspected malaria cases with test (household)

In Nicaragua, case detection is measured as an indicator for RMEI in the LQAS survey. 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 6.11, 43.5% of respondents with an eligible fever (with no exclusion symptoms) had a blood sample taken. The indicator result by malaria stratum is shown in Table 6.12, and by SILAIS health region in Table 6.13.

Table 6.11: Indicator 2.02: Fevers with blood sample

	N	n	%	95% CI
Fever cases in past two weeks	3996	197	4.9	(4 - 6)
Fevers with no exclusion symptoms	197	64	32.5	(23 - 43)
Omitted due to 'do not know' responses	64	2	3.1	(0 - 21)
Fevers with any blood sample	62	27	43.5	(26 - 63)
Capillary blood test	62	22	35.5	(19 - 56)
Venal blood test	62	9	14.5	(7 - 29)

Table 6.12: Indicator 2.02: result by facility stratification

	N	n	%	95% CI
Fevers with any blood sample				
Stratum 5	19	14	73.7	(37 - 93)
Stratum 4	35	9	25.7	(11 - 50)
Stratum 3	8	4	50	(30 - 70)
Total	62	27	43.5	(26 - 63)

Table 6.13: Indicator 2.02: result by SILAIS health region

	N	n	%	95% CI
Fevers with any blood sample				
Bilwi	18	15	83.3	(47 - 97)
Granada	1	0	0	(-)
Las Minas	10	3	30	(8 - 69)
León	1	1	100	(-)
Madriz	4	2	50	(50 - 50)
Matagalpa	8	2	25	(11 - 47)
RAACS	2	1	50	(50 - 50)
Rio San Juan	10	2	20	(3 - 71)
Zelaya Central	8	1	12.5	(12 - 13)
Total	62	27	43.5	(26 - 63)

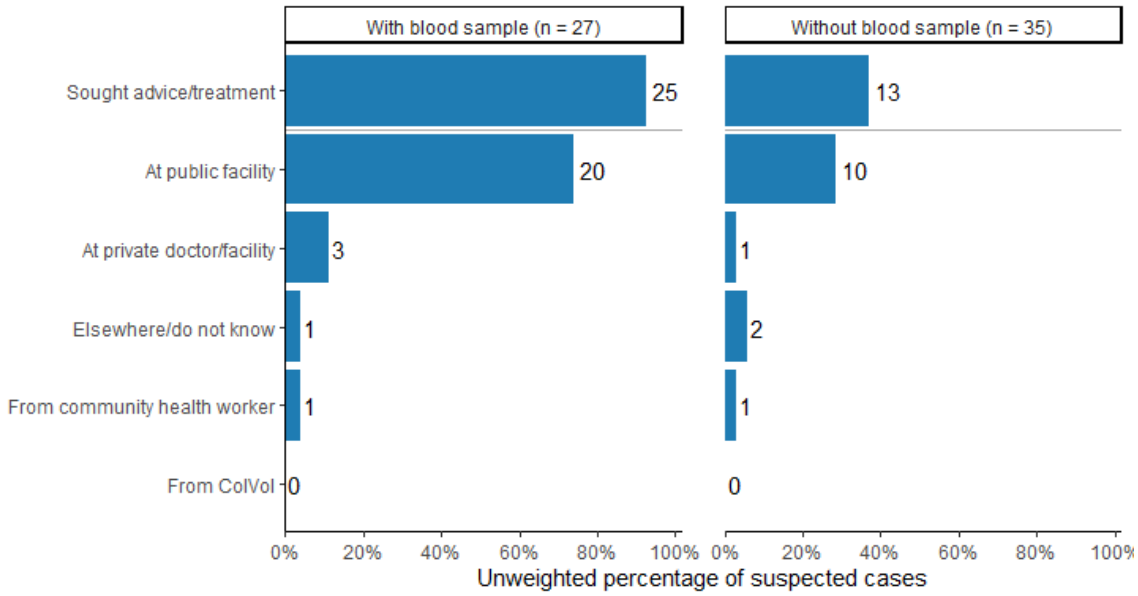
Respondents who reported a blood sample draw were asked whether their blood was tested for malaria, and if so, the result of the test. As seen in Table 6.14, 74.1% of respondents with a blood sample reported a malaria test, and 70% of those who had the malaria test reported a positive result.

Table 6.14: Result of blood tests, LQAS fevers

	N	n	%	95% CI
Blood tested for malaria	27	20	74.1	(51 - 89)
Result of malaria test				
Positive malaria	20	14	70	(42 - 88)
Negative malaria	20	3	15	(4 - 40)
Other result	20	1	5	(1 - 32)
Don't know	20	2	10	(2 - 36)

Figure 6.6 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 6.6: Treatment sought by respondents with fever cases



The calculation for Indicator 2.02 is presented in Table 6.15 both excluding cases with symptoms suggesting an illness other than malaria (43.5%) and including all fever cases reported from the past two weeks (34.4%).

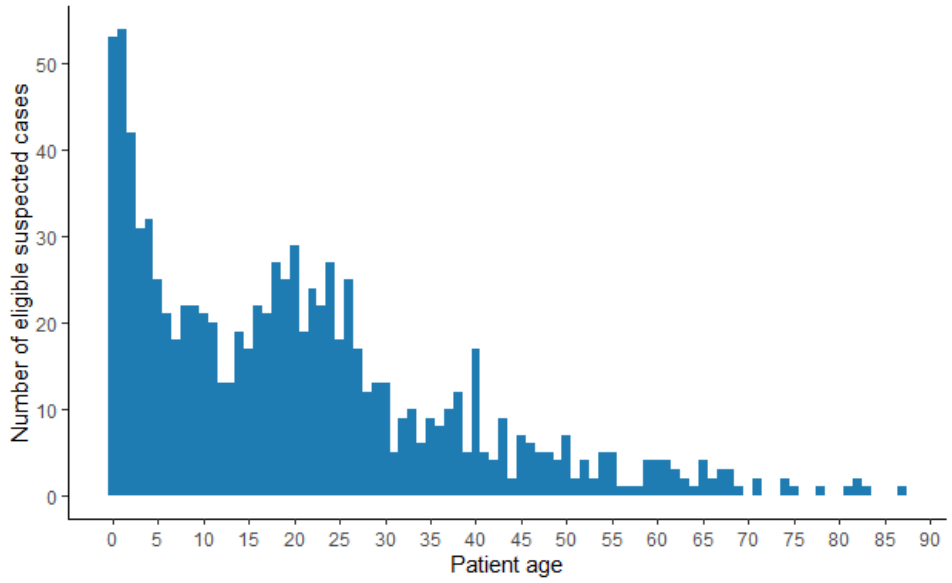
Table 6.15: Indicator 2.02: Fevers with blood sample, with and without exclusion symptoms

	N	n	%	95% CI
Fevers (with no exclusion symptoms) with any blood sample	62	27	43.5	(26 - 63)
All fevers with any blood sample	195	67	34.4	(25 - 45)

6.4 Suspected malaria cases with test as measured in medical record review

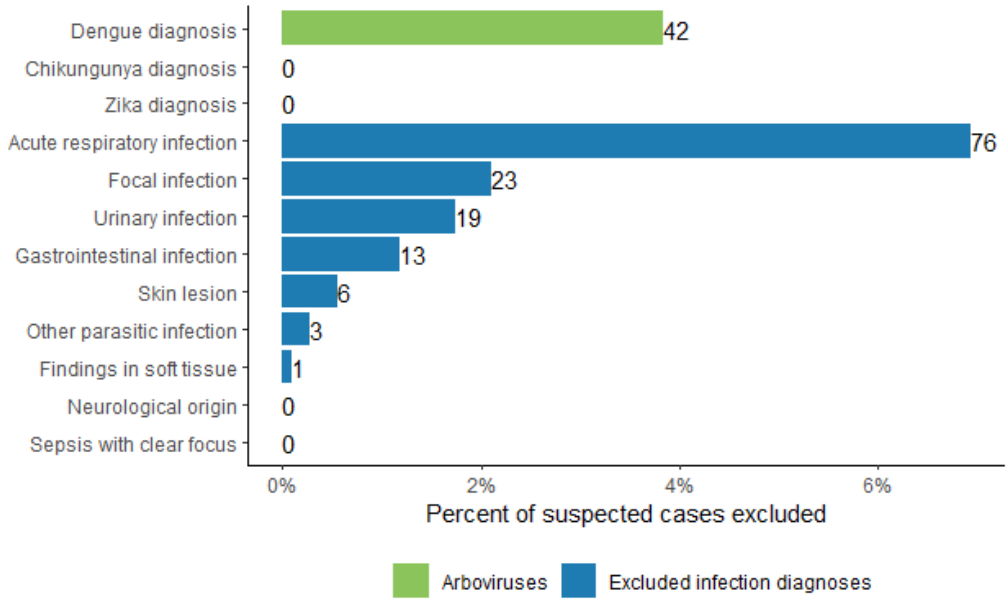
For a clinical comparison to the indicator measured in the LQAS survey, the health facility survey included a review of medical records of patients with fever or other malaria symptoms (suspected cases of malaria). In each facility that provided care to patients, field personnel selected eligible patient visits based on fever lists, attention registries or diagnosis databases according to the process described in 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 as available and entered information related to the diagnosis, symptoms, and lab tests to the electronic survey module. The patient age distribution of eligible suspected cases can be seen in Figure 6.7. 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 6.7: Suspected cases patient age



Some of the sampled records were eligible to be selected from a list of all febrile patients or 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 6.8. 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.

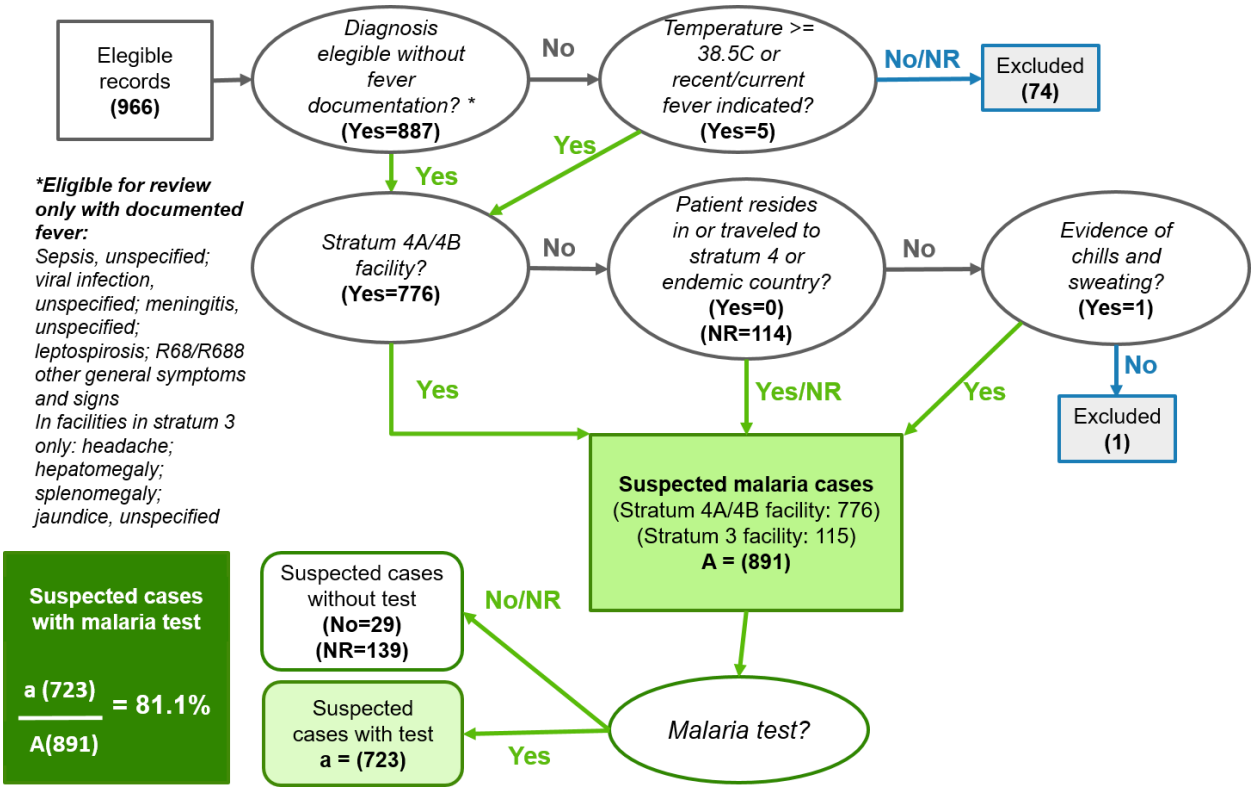
Figure 6.8: Exclusion diagnoses for review of suspected malaria cases



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

In Nicaragua, indicator 2.01 is measured for monitoring purposes from medical record review (suspected cases with malaria test is measured for performance in households in indicator 2.02). 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 6.9. Facilities in malaria strata 4 and 5 are subject to a different suspected malaria case definition than facilities in malaria stratum 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 6.9: Eligibility of suspected cases reviewed for Indicator 2.01



In total in Nicaragua, 891 of the 966 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 6.17, 81.1% of patients with suspected malaria had evidence that a malaria test was received. Of these 723 patients with evidence of a test, 9.7% received an RDT and 98.9% a TBF. Table 6.18 shows the results by malaria stratum for comparison.

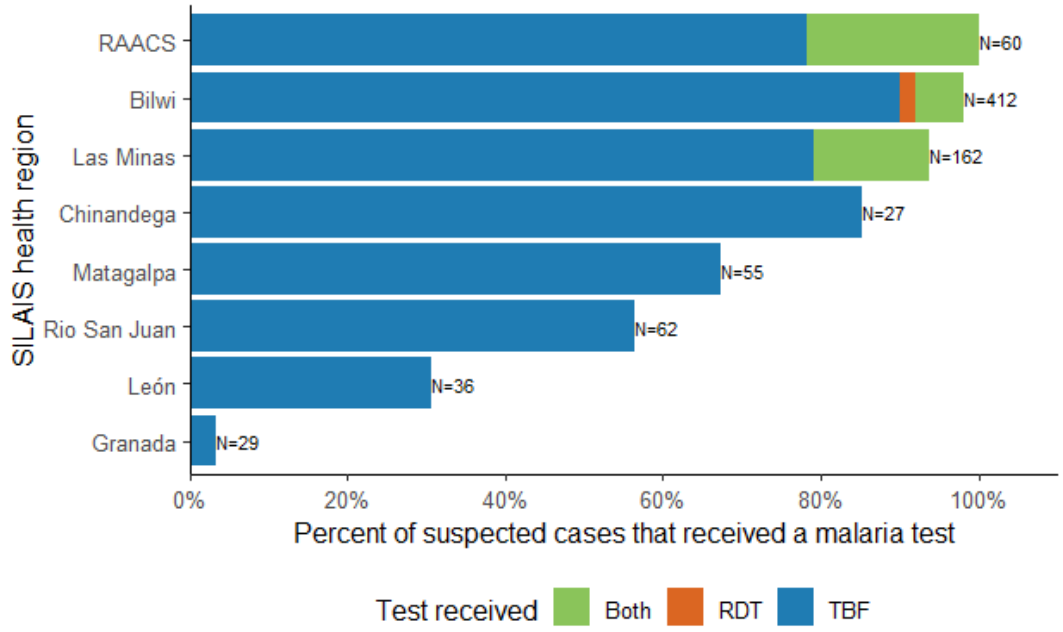
Table 6.17: Indicator 2.01: Suspected cases with malaria test

	N	n	%	95% CI
Suspected case with malaria test	891	723	81.1	(78 - 84)
Rapid diagnostic test	723	70	9.7	(8 - 12)
Thick blood film	723	715	98.9	(98 - 99)

Table 6.19: Indicator 2.01: result by facility stratification

	N	n	%	95% CI
Suspected cases with malaria test				
Stratum 5	441	433	98.2	(96 - 99)
Stratum 4	335	278	83	(79 - 87)
Stratum 3	115	12	10.4	(6 - 17)
Total	891	723	81.1	(78 - 84)

Figure 6.10: Indicator 2.01: result by SILAIS health region



6.5 Timely diagnosis of confirmed malaria cases as measured in 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. At municipal headquarters selected to the sample, field personnel reviewed all paper records of confirmed malaria cases from the year 2018 stored at those units. Case records sampled (see Chapter 2 for selection methods) were reviewed from all available sources, including case notification forms, case investigation forms, and any patient charts, laboratory records, or treatment forms filed at the municipal (and in one case SILAIS) headquarters. Figure 6.11 shows that nearly all confirmed malaria case reviews used both the E-2 blood sample form and the M-10 case investigation form. Examples of these forms are shown in Figure 6.12 and Figure 6.13 for reference of the content included from these data sources.

Figure 6.11: Sources of confirmed case medical record review

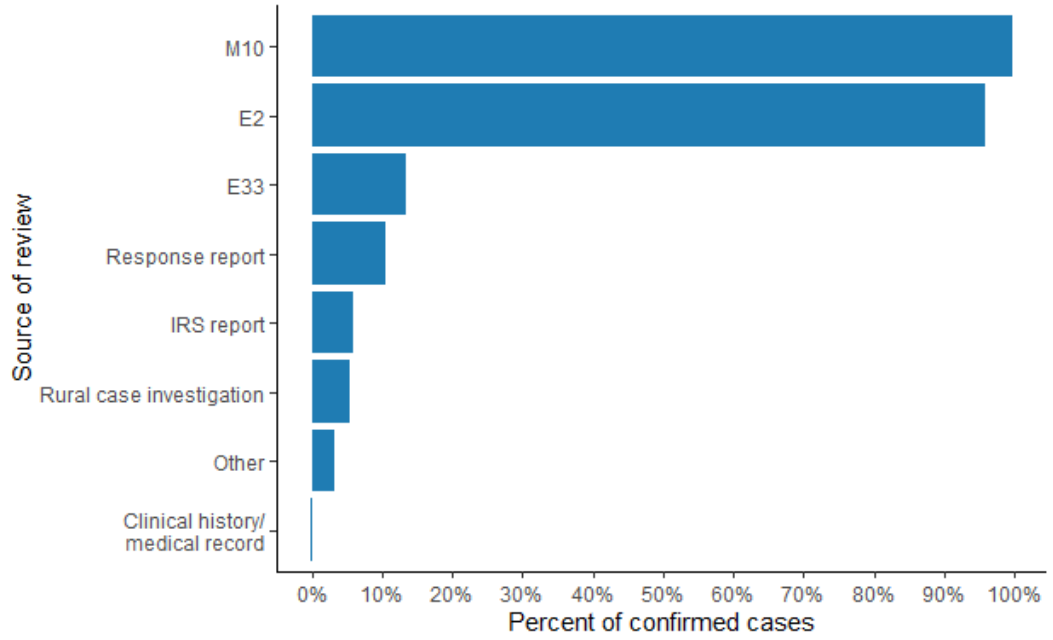


Figure 6.12: M-10 blank case investigation form

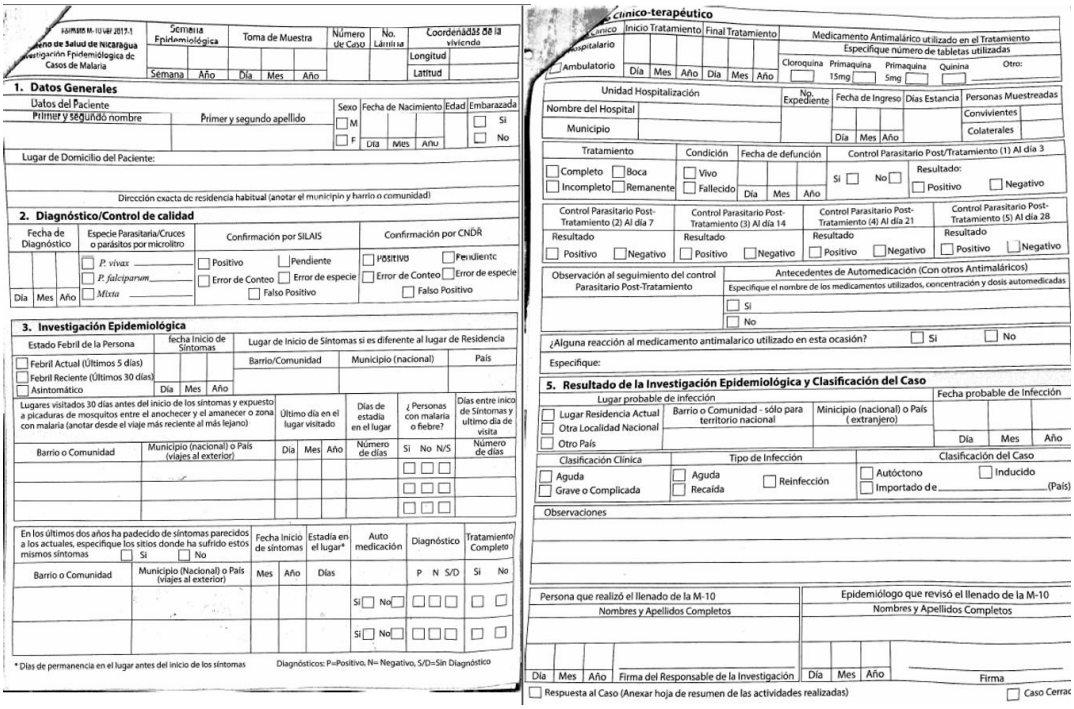
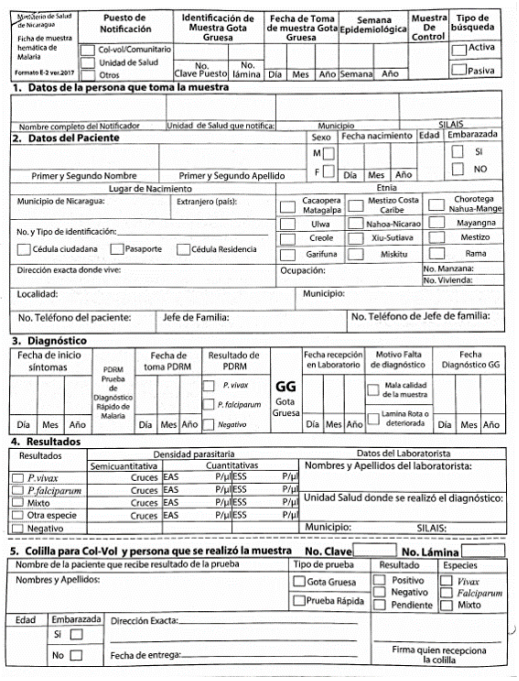


Figure 6.13: E-2 blank case investigation forms



Ficha de muestra hemática de Malaria — Formato E-2 ver.2017

Puesto de Notificación: Col-vol/Comunitario; Unidad de Salud; Otros
Identificación de Muestra Gota Gruesa: No. Clave Puesto; No. lámina
Fecha de Toma de muestra Gota Gruesa: Día Mes Año
Semana Epidemiológica: Semana Año
Muestra De Control
Tipo de búsqueda: Activa; Pasiva

1. Datos de la persona que toma la muestra

Nombre completo del Notificador; Unidad de Salud que notifica; Municipio; SILAIS

2. Datos del Paciente

Primer y Segundo Nombre; Primer y Segundo Apellido; Sexo M F; Fecha nacimiento Día Mes Año; Edad; Embarazada SI NO

Lugar de Nacimiento: Municipio de Nicaragua; Extranjero (país)
Etnia: Cacaopera Matagalpa; Mestizo Costa Caribe; Chorotega Nahua-Mange; Ulwa; Nahoa-Nicarao; Mayangna; Creole; Xiu-Sutiava; Mestizo; Garifuna; Miskitu; Rama
No. y Tipo de identificación: Cédula ciudadana; Pasaporte; Cédula Residencia
Dirección exacta donde vive:
Ocupación:
No. Manzana:
No. Vivienda:
Localidad:
Municipio:
No. Teléfono del paciente:
Jefe de Familia:
No. Teléfono de Jefe de familia:

3. Diagnóstico

Fecha de inicio síntomas Día Mes Año
PDRM Prueba de Diagnóstico Rápido de Malaria
Fecha de toma PDRM Día Mes Año
Resultado de PDRM: *P. vivax*; *P. falciparum*; *Negativo*
GG Gota Gruesa
Fecha recepción en Laboratorio Día Mes Año
Motivo Falta de diagnóstico: Mala calidad de la muestra; Lamina Rota o deteriorada
Fecha Diagnóstico GG Día Mes Año

4. Resultados

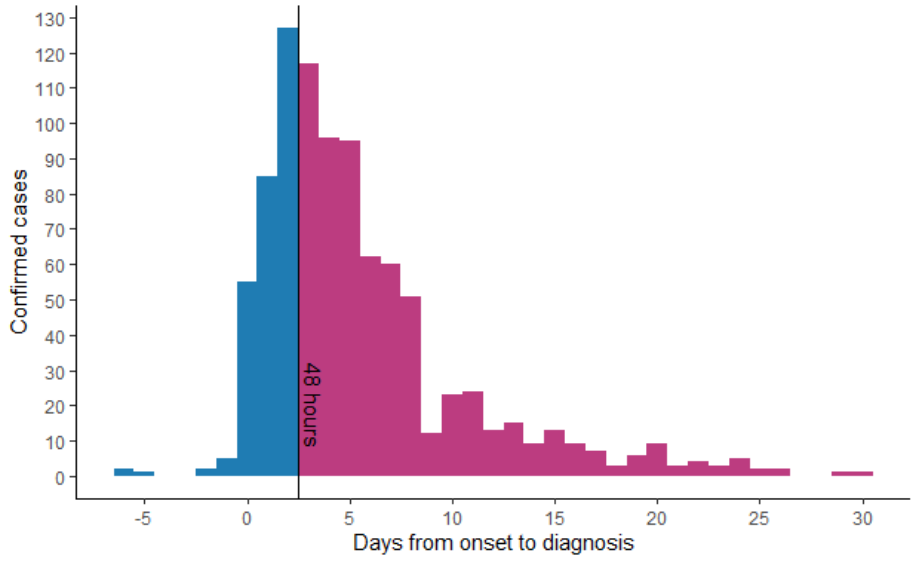
Resultados: *P. vivax*; *P. falciparum*; Mixto; Otra especie; Negativo
Densidad parasitaria: Semicuantitativa; Cuantitativas: Cruces EAS P/µl ESS P/µl
Datos del Laboratorista: Nombres y Apellidos del laboratorista:
Unidad Salud donde se realizó el diagnóstico:
Municipio: SILAIS:

5. Colilla para Col-Vol y persona que se realizó la muestra No. Clave No. Lámina

Nombre de la paciente que recibe resultado de la prueba
Nombres y Apellidos:
Tipo de prueba: Gota Gruesa; Prueba Rápida
Resultado: Positivo; Negativo; Pendiente
Especies: *Vivax*; *Falciparum*; Mixto
Edad
Embarazada SI No
Dirección Exacta:
Fecha de entrega:
Firma quien recepciona la colilla

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 M-10 and E-2 forms. Figure 6.14 shows the number of days from fever onset (or onset of other malaria symptoms, if date of fever onset was not recorded) to the date of diagnosis. 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 28 cases which are excluded from the figure. In 10 cases, diagnosis was recorded before symptom onset which is a plausible scenario for cases tested through active case detection or for other reasons where testing was recommended before symptoms presented.

Figure 6.14: Time from symptom onset to diagnosis



The personnel who performed the diagnosis of these confirmed malaria cases are reported in Table 6.20 (diagnosis by RDT) and Table 6.21 (diagnosis by TBF). Some records did not have the personnel recorded (8.8% for records with RDT diagnosis and 9.6% for records with TBF diagnosis). The personnel most commonly recorded as collecting RDTs were lab technicians/microbiologists (24.5%) and community health workers (18%). The personnel most commonly recorded as preparing TBFs were lab technicians/microbiologists (49.4%) and microscopists (12.6%).

Table 6.20: Personnel who performed diagnosis of confirmed cases, RDT

	N	n	%	95% CI
RDT taken by:				
Lab tech/ microbiologist	339	83	24.5	(20 - 29)
Community Health Worker (CHW)	339	61	18	(14 - 22)
Vector Control staff (VC)	339	50	14.7	(11 - 19)
Nurse	339	37	10.9	(8 - 15)
Not registered	339	30	8.8	(6 - 12)
Microscopist	339	27	8	(6 - 11)
Doctor	339	18	5.3	(3 - 8)
Other	339	33	9.7	(7 - 13)

Table 6.21: Personnel who performed diagnosis of confirmed cases, TBF

	N	n	%	95% CI
Thick blood film sample taken by:				
Lab tech/ microbiologist	984	486	49.4	(46 - 53)
Microscopist	984	124	12.6	(11 - 15)
Not registered	984	94	9.6	(8 - 12)
Nurse	984	94	9.6	(8 - 12)
Community Health Worker (CHW)	984	69	7	(6 - 9)
Vector Control staff (VC)	984	58	5.9	(5 - 8)
Doctor	984	28	2.8	(2 - 4)
Other	984	31	3.2	(2 - 4)

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

Diagnosis within two days (48 hours) of symptom onset was negotiated as an indicator for RMEI. As shown in Table 6.22, 92.5% of confirmed case records in Nicaragua had both fever/symptom onset and diagnosis dates registered. Only 27.8% were diagnosed within 48 hours of fever/symptom onset, and 21.6% were diagnosed more than a week after fever/symptom onset.

Table 6.22: Indicator 4.02: Fever/symptom onset to diagnosis within 48 hours

	N	n	%	95% CI
Total confirmed malaria cases	1025	1025	100	(-)
Excluded due to suspected inscription/data entry error (<-7 day or >30 day window)	1025	28	2.7	(2 - 4)
Denominator: Confirmed cases with valid dates	997	997	100	(-)
Fever/symptom onset date registered	997	960	96.3	(95 - 97)
Diagnosis date registered	997	959	96.2	(95 - 97)
Both dates registered	997	922	92.5	(91 - 94)
Diagnosis before onset (presumptive)	997	10	1	(1 - 2)
Cases diagnosed within 48 hours of onset	997	277	27.8	(25 - 31)
3 days	997	117	11.7	(10 - 14)
4-5 days	997	191	19.2	(17 - 22)

	N	n	%	95% CI
6-7 days	997	122	12.2	(10 - 14)
Over 7 days	997	215	21.6	(19 - 24)
Indicator result: Cases diagnosed within 48 hours of onset	997	277	27.8	(25 - 31)

Figure 6.15 shows the same indicator results in a graphic format.

Figure 6.15: Indictor 4.02: Cases categorized

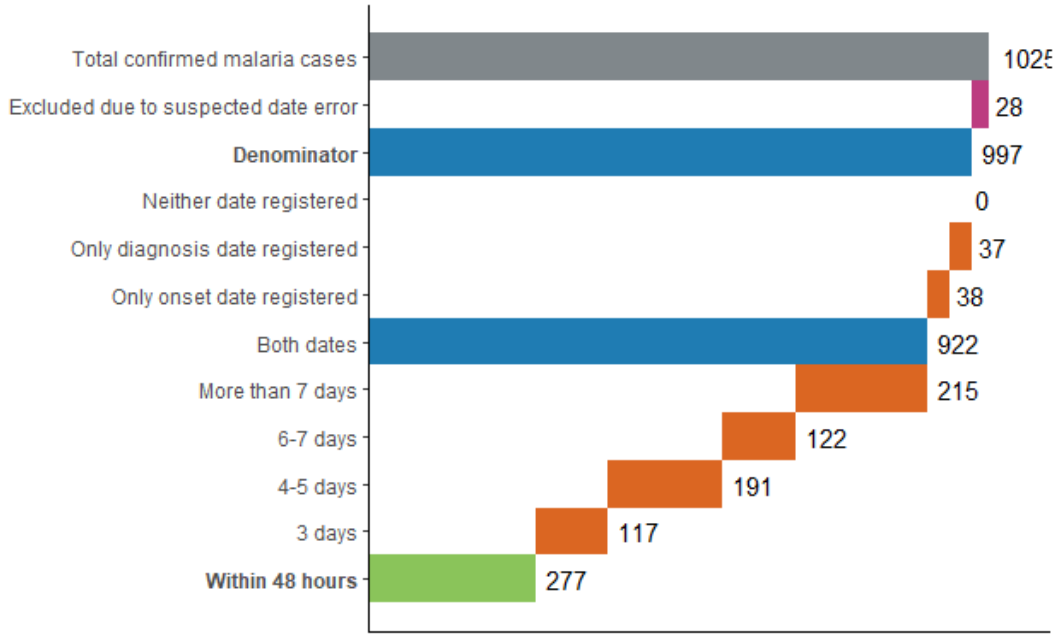


Table 6.23 shows the indicator performance in each malaria stratum. Diagnosis timeliness did not vary significantly between strata. Table 6.24 and Table 6.25 show the indicator performance by SILAIS health region and type of diagnosis, respectively.

Table 6.23: Indicator 4.02: result by facility stratification

	N	n	%	95% CI
Diagnosis within 48 hours of symptom onset				
Stratum 4	409	107	26.2	(22 - 31)
Stratum 5	588	170	28.9	(25 - 33)
Total	997	277	27.8	(25 - 31)

Table 6.24: Indicator 4.02: result by SILAIS health region

	N	n	%	95% CI
Diagnosis within 48 hours of symptom onset				
Bilwi	730	227	31.1	(28 - 35)
Chinandega	23	1	4.3	(1 - 25)
Las Minas	204	42	20.6	(16 - 27)
Matagalpa	3	0	0	(-)
RAACS	21	4	19	(7 - 41)
Rio San Juan	16	3	18.8	(6 - 45)
Total	997	277	27.8	(25 - 31)

Table 6.25: Indicator 4.02: result by diagnosis test

	N	n	%	95% CI
Diagnosis within 48 hours of symptom onset				
RDT	198	72	36.4	(30 - 43)
TBF	761	205	26.9	(24 - 30)
No test date registered	38	0	0	(-)
Total	997	277	27.8	(25 - 31)

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. All confirmed cases of malaria were expected to have a notification report, but as shown in Figure 6.16 not all collected cases had a reviewed notification form and not all notification forms had a date recorded for when notification occurred. As shown in Table 6.26, 30.2% of confirmed case records in Nicaragua had both diagnosis and notification dates registered. Only 23.7% were notified within 24 hours of diagnosis.

Figure 6.16: Confirmed cases: source of notification information

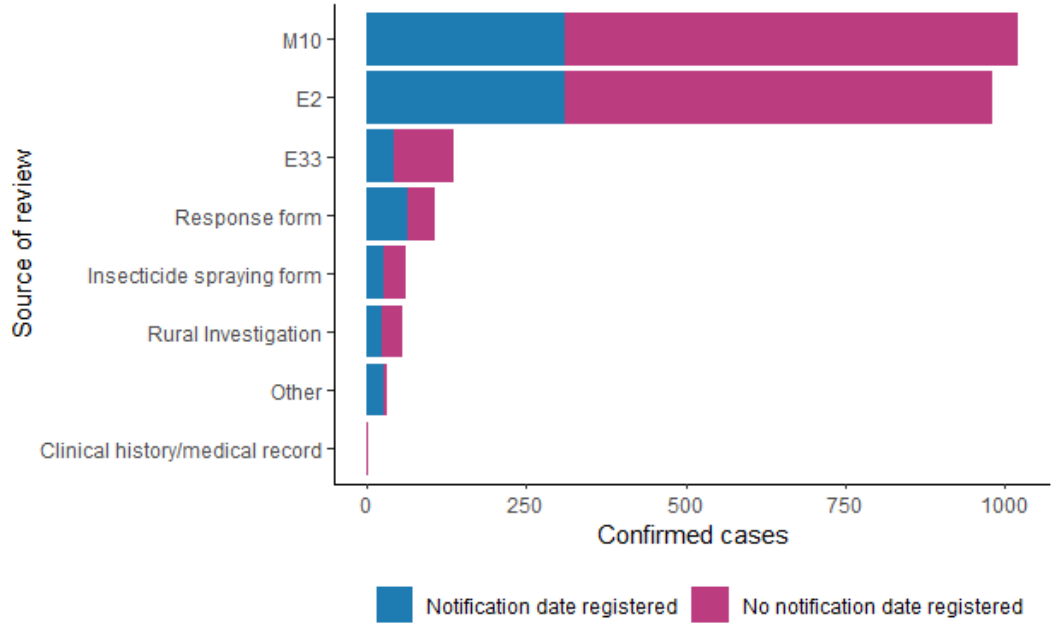


Table 6.26: Indicator E2.04: Notification within 24 hours of diagnosis

	N	n	%	95% CI
Diagnosis date registered	1025	987	96.3	(95 - 97)
Notification date registered	1025	312	30.4	(28 - 33)
Both dates registered	1025	310	30.2	(28 - 33)
Excluded due to suspected inscription/data entry error (<-7 day or >30 day window)	1025	24	2.3	(2 - 3)
Notification within 24 hours of diagnosis	1001	237	23.7	(21 - 26)

Chapter 7: Malaria treatment

In Nicaragua, routine malaria treatment is managed by health facility personnel and community health workers. Supervision of ingestion of all doses is the norm in much of Nicaragua in order to ensure each patient completes the radical cure. The survey results in the following sections align to some extent with these expectations, though they suggest substantial variation in administration and supervision practices by facilities (or at least in knowledge of standard practices by personnel in health facilities that may diagnose malaria cases infrequently).

7.1 Treatment administration practices

The health facility interview includes questions about malaria service provision (in all health facilities and SILAIS). 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). Many facilities report that they prescribe treatment via their own pharmacies (53.1% of primary care facilities), supervise treatment at the facility (59.4% of primary care facilities), and that facility personnel supervise treatment in the community, as in home visits (37.5% of primary care facilities).

Table 7.1: Services provided by facilities for malaria treatment

	N	n	%	95% CI
Health posts: Services provided for malaria treatment				
Prescribe treatment to pharmacy at this facility	32	17	53.1	(36 - 70)
Provide prescription to external pharmacy	32	3	9.4	(3 - 26)
Give medication to take at home (unsupervised)	32	1	3.1	(0 - 20)
Supervise ingestion (in the facility)	32	19	59.4	(41 - 75)
Supervise ingestion (in the community)	32	12	37.5	(22 - 56)
Call or visit the home to ask if treatment was taken (without supervising ingestion)	32	1	3.1	(0 - 20)
None of the above	32	2	6.3	(2 - 23)
Other	32	2	6.3	(2 - 23)
Health centers & primary hospitals: Services provided for malaria treatment				
Prescribe treatment to pharmacy at this facility	11	6	54.5	(26 - 80)
Give medication to take at home (unsupervised)	11	1	9.1	(1 - 45)
Supervise ingestion (in the facility)	11	7	63.6	(33 - 86)
Supervise ingestion (in the community)	11	8	72.7	(40 - 91)
Other	11	1	9.1	(1 - 45)
SILAIS headquarters: Services provided for malaria treatment				
Supervise ingestion (in the facility)	5	2	40	(10 - 81)
Supervise ingestion (in the community)	5	1	20	(3 - 70)
None of the above	5	2	40	(10 - 81)
Other	5	2	40	(10 - 81)

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 89.3% of facilities that supervise treatment regardless of type, all doses are supervised at the facility, and at 7.1% of these facilities only some doses are 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).

Table 7.2: Doses supervised in-facility

	N	n	%	95% CI
Doses supervised in-facility				
Only some doses	28	2	7.1	(2 - 25)
All doses	28	25	89.3	(71 - 97)
Don't know	28	1	3.6	(0 - 22)

Table 7.3: Personnel responsible for subsequent administrations

	N	n	%	95% CI
Administration of subsequent doses				
Treatment is supervised at the patient's home by health facility personnel	2	2	100	(-)
Patient was prescribed medication to take at home	2	1	50	(5 - 95)
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)
Other	2	0	0	(-)

All facilities that provide malaria care were asked if personnel ever administer malaria treatment before a positive test result, and only 15.9% replied that they do. Respondents reported that community personnel administer presumptive treatment in only 14.9% of facilities.

Table 7.4: Presumptive treatment

	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)	44	7	15.9	(8 - 30)
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)	47	7	14.9	(7 - 29)

7.2 Storage and stock of antimalarial medications

The health facility survey included an observation of antimalarial medications in stock on the day of the survey and of stock records for the three months prior (in all health facilities and administrative units except the national reference laboratory). First, the respondent (typically the pharmacist or pharmacy technician) was asked if the facility routinely stocks any antimalarial medications. As shown in Table 7.5, 75% of primary care facilities, 81.8% of secondary care facilities, and 75% of SILAIS and municipal headquarters reported stock of antimalarials.

Table 7.5: Facility types reporting stock of antimalarials

	N	n	%	95% CI
Facilities reporting antimalarial stock in past 3 months				
Health posts	32	24	75	(57 - 87)
Health centers & primary hospitals	11	9	81.8	(48 - 96)
SILAIS headquarters	4	3	75	(23 - 97)

Next, the respondent was asked to respond whether or not the facility stocks each of a list of antimalarial medications including those shown in Table 7.6. Among the facilities that reported stocking any antimalarials, the most common pharmaceuticals were chloroquine (100% primary care facilities, 81.8% of secondary care facilities, and 75% of administrative units with any antimalarials) and primaquine (100% of primary care facilities, 100% of secondary care facilities, and 100% of administrative units with any antimalarials). Any drugs that were reported to be stocked were then sought for observation by survey personnel. The drug presentation was registered and the surveyor checked the expiration date to see if at least one dose of the medication was valid on the day of the survey. As seen in Table 7.7, no doses or only expired doses of chloroquine were observed in 11.1% of primary care facilities that stock chloroquine, and no doses or only expired doses of primaquine were observed in 5.7% of primary care facilities that stock primaquine, suggesting facilities in Nicaragua are fairly well supplied for malaria treatment and succeed in maintaining stock of valid doses.

Table 7.6: Reported stock of antimalarials

	N	n	%	95% CI
Health posts				
Has this facility stocked any antimalarials for at least one day over the past three months?	32	24	75	(57 - 87)
Chloroquine	24	24	100	(-)
Primaquine	24	24	100	(-)
Sulfadoxine	24	1	4.2	(1 - 25)
Health centers & primary hospitals				
Has this facility stocked any antimalarials for at least one day over the past three months?	11	9	81.8	(48 - 96)
Chloroquine	9	9	100	(-)
Primaquine	9	8	88.9	(48 - 99)
Artesunate[1]	8	2	25	(6 - 63)
SILAIS headquarters				
Has this facility stocked any antimalarials for at least one day over the past three months?	4	3	75	(23 - 97)
Chloroquine	3	3	100	(-)
Primaquine	3	3	100	(-)
Artesunate	3	2	66.7	(14 - 96)
Artemisinin (Artemether + Lumefantrine tablets (ex. Coartem))	3	1	33.3	(4 - 86)

[1]One primary hospital responded 'do not know' to artesunate stock and is excluded.

Table 7.7: Antimalarials observed in facility, among those reporting stock

	N	n	%	95% CI
Chloroquine tablets observed				
At least one observed and valid	36	32	88.9	(73 - 96)
Not observed	36	3	8.3	(3 - 23)
At least one observed, but none valid	36	1	2.8	(0 - 18)
Primaquine tablets observed[1]				
At least one observed and valid	35	33	94.3	(79 - 99)
Not observed	35	1	2.9	(0 - 19)
At least one observed, but none valid	35	1	2.9	(0 - 19)
Artesunate tablets observed				
Not observed	4	4	100	(-)
Artesunate suppositories observed				
Not observed	4	4	100	(-)

	N	n	%	95% CI
Injectable artesunate observed				
At least one observed and valid	4	4	100	(-)

[1]One health center had chloroquine stock but not primaquine stock.

Because most health facilities do not store medications to treat severe malaria or chloroquine-resistant malaria, the interview asked how a patient with severe or resistant malaria receives treatment (Table 7.9). Most facilities (regardless of type) informed that the patient is referred to a location that stores medication (72.9% of facilities).

Table 7.9: 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?				
Patient is referred to a location that stores medication	48	35	72.9	(58 - 84)
Treatment is delivered to this health facility by vector control or malaria program staff	48	5	10.4	(4 - 23)
Treatment is delivered to the patient's home by vector control or malaria program staff	48	1	2.1	(0 - 14)
Other	48	4	8.3	(3 - 21)
Don't know	48	2	4.2	(1 - 16)

The interview also asked about how antimalarial supplies are managed. As seen in Table 7.10, 84% of primary care facilities generally order their own antimalarials. Among those primary care facilities that do not determine their own antimalarial supplies, most frequently the supply is determined by the municipal supply or logistics management office (Table 7.11).

Table 7.10: Determination of malaria medication needs

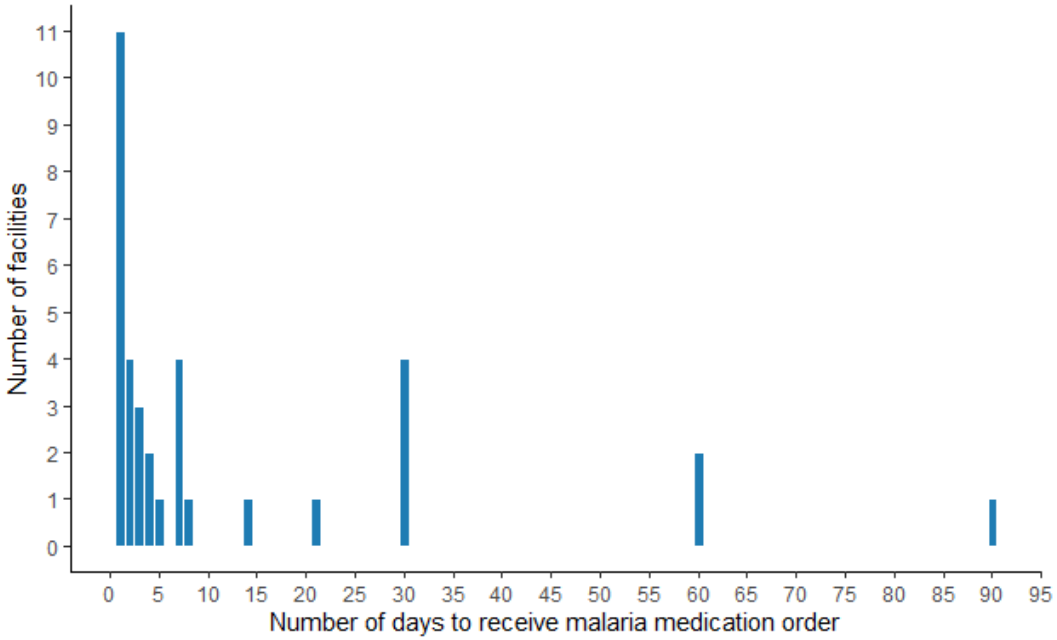
	N	n	%	95% CI
Health posts: How is the quantity of malaria medication needed by this facility determined?				
Facility determines quantity and orders	25	21	84	(64 - 94)
Quantity determined elsewhere	25	4	16	(6 - 36)
Health centers & primary hospitals: How is the quantity of malaria medication needed by this facility determined?				
Facility determines quantity and orders	11	11	100	(-)
Quantity determined elsewhere	11	0	0	(-)
SILAIS headquarters: How is the quantity of malaria medication needed by this facility determined?				
Facility determines quantity and orders	3	3	100	(-)
Quantity determined elsewhere	3	0	0	(-)

Table 7.11: Determination of malaria medication needs: authority

	N	n	%	95% CI
Health posts: Who determines the quantity of malaria medication that are given to this facility?				
Municipal supply or logistics management office	4	3	75	(23 - 97)
Don't know	4	1	25	(3 - 77)

Figure 7.1 shows the usual number of days between ordering and receiving antimalarials as reported at facilities that order their own antimalarial medications.

Figure 7.1: Days to receive ordered malaria medication



The interview also asked about recent shortages of antimalarial medication and how they are handled. Most facilities that stock antimalarials reported that they always or almost always receive the expected quantities of antimalarial medications (Table 7.12). As seen in Table 7.13, if there is a shortage, many facilities reported that it is handled through a special order (68% of primary care facilities that stock antimalarials).

Table 7.12: Medication order reliability

	N	n	%	95% CI
Health posts: 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	25	18	72	(51 - 86)
Almost always	25	5	20	(8 - 41)
Almost never	25	2	8	(2 - 28)
Health centers & primary hospitals: 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	11	9	81.8	(48 - 96)
Almost always	11	2	18.2	(4 - 52)
Almost never	11	0	0	(-)
SILAIS headquarters: 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	3	3	100	(-)
Almost never	3	0	0	(-)
Almost always	3	0	0	(-)

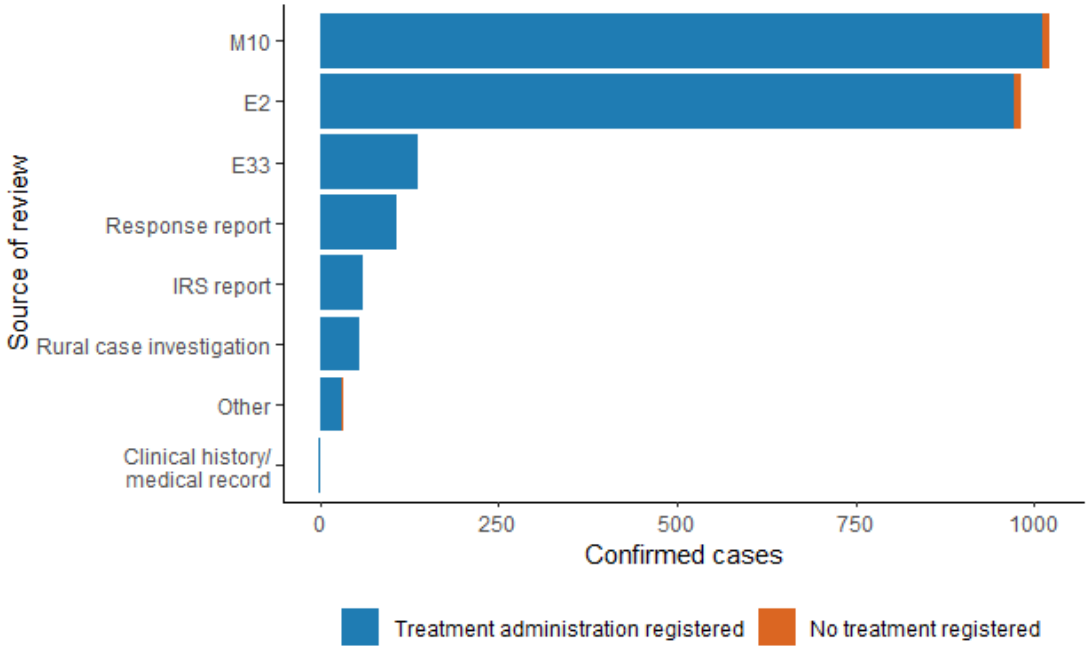
Table 7.13: Malaria medication shortages

	N	n	%	95% CI
Health posts: 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	25	17	68	(47 - 83)
Borrow from another health facility	25	9	36	(20 - 57)
Don't know	25	1	4	(1 - 25)
Health centers & primary hospitals: 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	11	7	63.6	(33 - 86)
Borrow from another health facility	11	5	45.5	(20 - 74)
SILAIS headquarters: 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	3	2	66.7	(14 - 96)
Borrow from another health facility	3	1	33.3	(4 - 86)
Don't know	3	1	33.3	(4 - 86)

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 the dates of diagnosis and of treatment initiation and completion, as well as the medications administered, dosage, and the number of doses provided. Figure 7.2 shows that both the E-2 blood sample information form and the M-10 case investigation form were observed in most confirmed case reviews, and the majority of the reviews had some treatment information registered. Both forms have space to register diagnosis date, and the M-10 has a space to register the treatment initiation date. The E-33 treatment administration form also has space for treatment dates. Where dates are registered for both a rapid diagnostic test and a microscopic diagnosis, the earlier date is considered.

Figure 7.2: Confirmed cases: source of treatment information



Antimalarial treatment is prescribed according to the test result. In Nicaragua, 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 artemisin-based regimen is used. As seen in Table 7.14, 94.6% of *P. vivax* cases had the correct regimen registered, and 93.3% of *P. falciparum* cases had the correct regimen registered. 40 of the cases reviewed did not have parasite species registered on any of the forms reviewed, and thus the corresponding regimen could not be identified. These cases are not considered to have had the correct treatment regimen administered, because of the failure to register the species.

Table 7.14: Confirmed cases: Appropriate treatment by parasite species

	N	n	%	95% CI
Total cases with adequate treatment for species	1025	929	90.6	(89 - 92)
P. vivax with adequate treatment for species	783	741	94.6	(93 - 96)
P. falciparum (non-resistant) with adequate treatment for species	195	182	93.3	(89 - 96)
Mixed cases (non-resistant) with adequate treatment for species	6	5	83.3	(37 - 98)
Chloroquine-resistant area P. falciparum/mixed cases treated correctly	1	1	100	(-)
Species not registered	1025	40	3.9	(3 - 5)

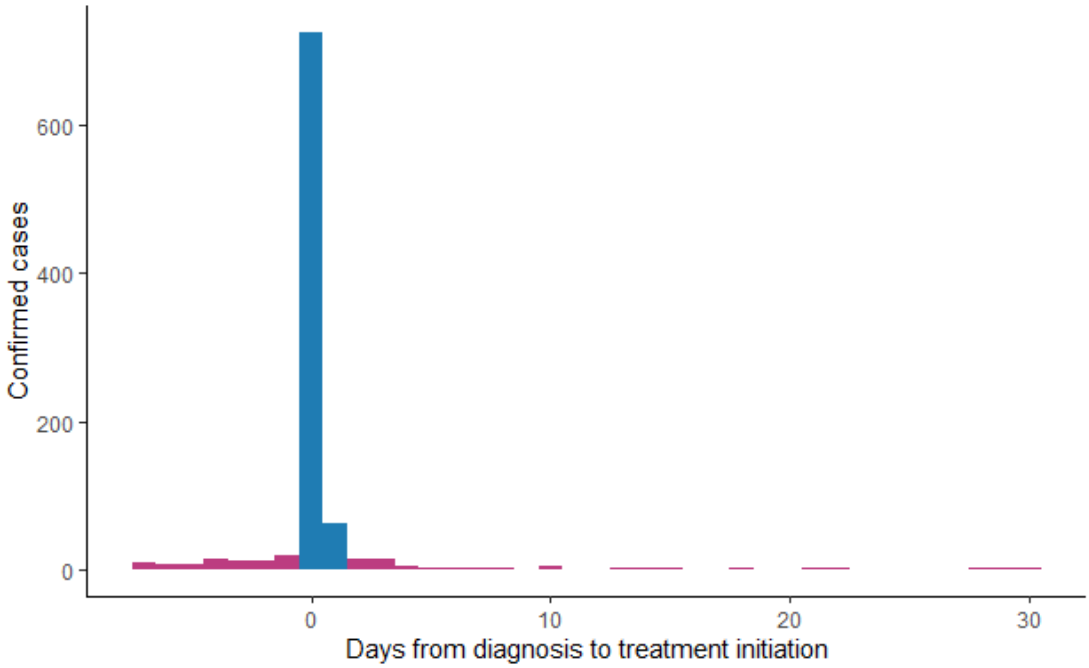
Table 7.15 shows the timing of administration of the first dose of antimalarial treatment. In 95.3% of the cases reviewed, both diagnosis and treatment date were registered. Evidence of any antimalarial treatment within one day of diagnosis was found in 81.2% of cases reviewed.

Table 7.15: Confirmed cases: Treatment timeliness

	N	n	%	95% CI
Diagnosis date registered	1025	987	96.3	(95 - 97)
Treatment start date registered	1025	1013	98.8	(98 - 99)
Both dates registered	1025	977	95.3	(94 - 96)
Excluded due to suspected inscription/data entry error (<-7 day or >30 day window)	1025	54	5.3	(4 - 7)
Any treatment within 24 hours of diagnosis	971	788	81.2	(79 - 83)

Figure 7.3 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 norm in Nicaragua. If treatment initiation was recorded more than seven days before or more than 30 days after diagnosis, 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 54 cases which are excluded from the figure.

Figure 7.3: 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 7.16. Among the cases reviewed, 90.6% had the antimalarial treatment corresponding to the parasite species registered correctly on the forms. In 81.2% of the cases, the first dose of any treatment was registered as administered within one day (24 hours) of diagnosis, and in 75.9% of the cases, the first dose of the appropriate treatment was registered as administered within one day of diagnosis. Table 7.17, Table 7.18, and Table 7.19 show the indicator result by malaria stratum, SILAIS health region, and diagnosis type respectively.

Table 7.16: Indicator 4.01: Timely treatment initiation

	N	n	%	95% CI
Total malaria cases	1025	1025	100	(-)
Correct treatment administered for species	1025	929	90.6	(89 - 92)
Diagnosis and treatment dates registered	1025	977	95.3	(94 - 96)
Excluded due to suspected inscription/data entry error (<-7 day or >30 day window)	1025	54	5.3	(4 - 7)
First dose treatment within 24 hours of diagnosis	971	788	81.2	(79 - 83)
Correct treatment administered within 24 hours of diagnosis	971	737	75.9	(73 - 78)

Table 7.17: Indicator 4.01: result by facility stratification

	N	n	%	95% CI
Timely treatment initiation				
Stratum 4	403	302	74.9	(70 - 79)
Stratum 5	568	435	76.6	(73 - 80)
Total	971	737	75.9	(73 - 78)

Table 7.18: Indicator 4.01: result by SILAIS health region

	N	n	%	95% CI
Timely treatment initiation				
Bilwi	697	498	71.4	(68 - 75)
Chinandega	26	24	92.3	(74 - 98)
Las Minas	208	182	87.5	(82 - 91)
Matagalpa	3	3	100	(-)
RAACS	21	17	81	(59 - 93)
Rio San Juan	16	13	81.2	(55 - 94)
Total	971	737	75.9	(73 - 78)

Table 7.19: Indicator 4.02: result by diagnosis test

	N	n	%	95% CI
Timely treatment initiation				
RDT	203	155	76.4	(70 - 82)
TBF	730	582	79.7	(77 - 82)
No test date registered	38	0	0	(-)
Total	971	737	75.9	(73 - 78)

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 3-7 days, even though symptoms may start to subside within a few days of treatment initiation. In Nicaragua, 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 7 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 7 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 7 days 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

7.4.1 Completion of malaria treatment

The Nicaragua malaria case investigation form includes space to register the number of tablets utilized for chloroquine, primaquine (15mg and 5mg separately), quinine, and others, suggesting that the number registered on the form may not map to the number of administrations of treatment but rather to the number of pills administered (sometimes more than one per dose). No assumption about the appropriate number of tablets is made in accounting for an administration, which could result in an inflated number of administrations documented in the data if the number recorded on the form actually reflects the number of tablets. According to the indicator definition, the patient must have received the exact number of administrations required in the treatment scheme in order for treatment to be considered complete; a number higher than the prescribed number of days of treatment is not accepted. Therefore, the treatment completion data collected from case investigation forms was often recorded in a format not suited to calculating the indicator, and patients whose treatment was recorded in tablets (as on the M-10 form)

rather than in administrations (as on the E-33 form) are thus less likely to meet the requirements of the indicator.

Table 7.20 shows treatment completion by parasite species as registered on the forms observed at the municipal headquarters. Forty of the cases reviewed did not have the parasite species registered, so the corresponding treatment scheme could not be identified and thus treatment is considered incomplete. *P. vivax* cases had evidence of complete treatment in 6.8% of cases, and 5.1% of *P. falciparum* cases without origin in chloroquine-resistant areas had evidence of complete treatment. Considering the cases with incomplete treatment registration because of the failure to record species, 6.1% of all reviewed cases had recorded evidence of adequate and complete treatment.

Table 7.20: Confirmed cases: Complete treatment by malaria species

	N	n	%	95% CI
Total cases with adequate treatment complete	1025	63	6.1	(5 - 8)
P. vivax cases with adequate treatment complete	783	53	6.8	(5 - 9)
P. falciparum (non-resistant) with adequate treatment complete	195	10	5.1	(3 - 9)
Mixed cases (non-resistant) with adequate treatment complete	6	0	0	(-)
Chloroquine-resistant area P. falciparum/mixed cases with adequate treatment complete	1	0	0	(-)
Species not registered	1025	40	3.9	(3 - 5)

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 Nicaragua, treatment supervision forms often were not found with confirmed malaria case records stored at the municipal headquarters where record review was carried out. Table 7.21 shows the indicator results. Only 6.1% of cases reviewed had evidence of complete and adequate treatment, and only 12.9% had evidence of any supervision. Overall, 6.1% of cases reviewed had evidence that treatment was adequate, complete, and supervised.

Table 7.21: Indicator 4.03: Complete treatment with supervision

	N	n	%	95% CI
Denominator: Total malaria cases	1025	1025	100	(-)
Adequate treatment and number of doses administered	1025	63	6.1	(5 - 8)
Evidence of at least one supervised dose	1025	132	12.9	(11 - 15)
Indicator Result: Complete treatment with supervision	1025	63	6.1	(5 - 8)

Figure 7.4 shows the indicator performance in each malaria stratum. Treatment was administered to standard in slightly more cases in stratum 5 than 4. Table 7.22 shows the result by SILAIS health region.

Table 7.23: Indicator 4.03: result by facility stratification

	N	n	%	95% CI
Complete treatment with supervision				
Stratum 4	427	12	2.8	(2 - 5)
Stratum 5	598	51	8.5	(7 - 11)
Total	1025	63	6.1	(5 - 8)

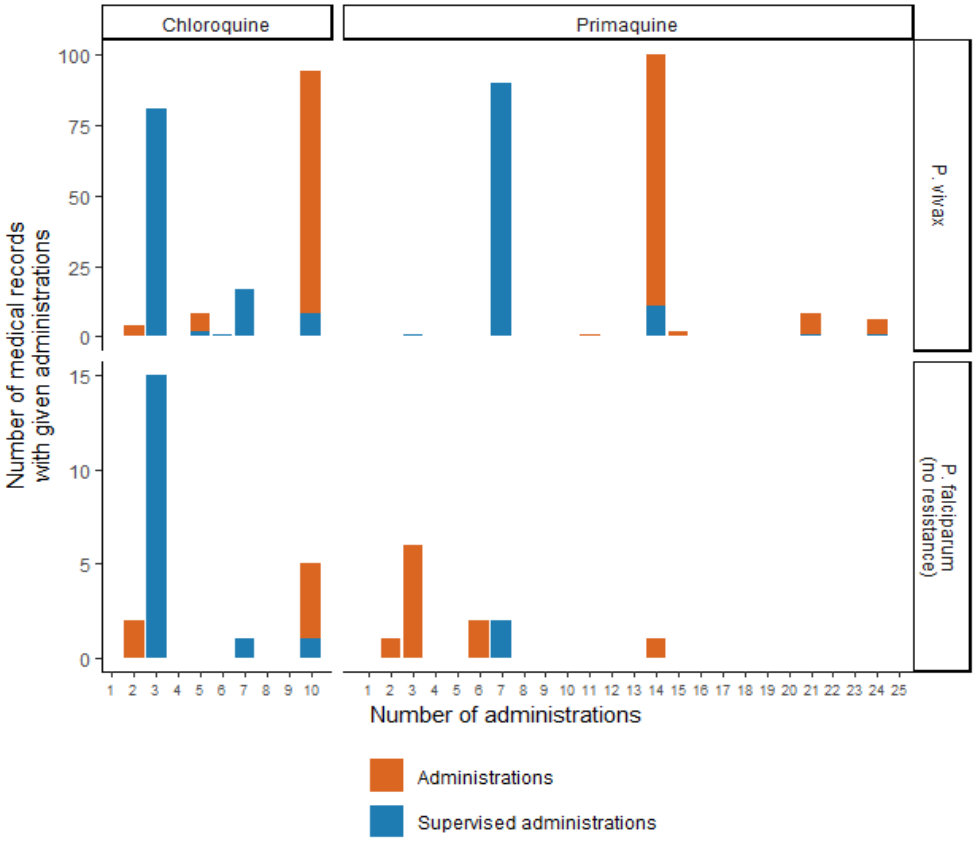
Table 7.22: Indicator 4.03: result by SILAIS health region

	N	n	%	95% CI
Complete treatment with supervision				
Bilwi	748	29	3.9	(3 - 6)
Chinandega	27	0	0	(-)
Las Minas	209	22	10.5	(7 - 15)
Matagalpa	3	0	0	(-)
RAACS	22	12	54.5	(34 - 74)
Rio San Juan	16	0	0	(-)
Total	1025	63	6.1	(5 - 8)

7.4.2 Supervision of malaria treatment

Figure 7.5 shows the number of doses with evidence of administration and supervision by species. The number of malaria cases with evidence of all doses supervised was generally much lower than the total number of doses registered. For *P. vivax*, a 14-day treatment scheme is most frequent in Nicaragua, though a 7-day treatment scheme is more frequently supervised, and only the 7-day scheme meets the requirement for the indicators. The results suggest that the data recorded on case investigation and treatment forms may sometimes reflect the number of pills taken, rather than the number of complete daily doses administered, as 10 is a frequent number of chloroquine doses recorded on the forms. However, only the exact number of administrations specified in each treatment scheme is considered adequate and complete treatment, so there may be potential to improve results for adequate treatment simply by standardizing registration to reflect the number of daily doses of treatment given.

Figure 7.5: Confirmed cases: number of doses administered and supervised



Chapter 8: Patient Follow-up and Case Investigation

As a country malaria program enters the elimination phase, it becomes important that every confirmed case 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. This chapter summarizes information captured during the review of confirmed malaria cases from 2018, which included review of the case investigation form whenever it was available at the municipal headquarters, as well as responses to the health facility interview relating to malaria case management.

8.1 Case investigation

8.1.1 Case investigation practices

In Nicaragua, the malaria case 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 M-10 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 (obtained from the provider or laboratory), and tracking of treatment administration and follow-up tests. A copy of the case investigation is filed at the municipal and SILAIS levels. The information is entered to the SIMALARIA information system at the municipal headquarters and transmitted to an electronic database accessible by local, regional, and central-level malaria personnel.

8.1.2 Case detection source and classification

During the confirmed case medical record review, field personnel reviewed 1025 cases, of which 666 were detected passively, 247 were detected during active or reactive search in the community, and 112 did not have the source of detection registered (Table 8.1).

According to the case investigation forms, 96.6% of malaria cases were autochthonous to Nicaragua (Table 8.2).

Table 8.1: Source of confirmed case detection

	N	n	%	95% CI
Case detection source:				
Passive search	1025	666	65	(62 - 68)
Active search	1025	247	24.1	(22 - 27)
Not registered	1025	112	10.9	(9 - 13)

Table 8.2: Classification of confirmed malaria cases

Classification	#	%
Autochthonous/indigenous/local	329	32.1%
Autochthonous and acute	646	63%
Imported	11	1.1%
Introduced and acute	8	0.8%
Autochthonous and reinfection and acute	6	0.6%
Autochthonous and reinfection	5	0.5%
Acute	4	0.4%
Imported and acute	3	0.3%
Autochthonous and congenital	2	0.2%
Autochthonous and relapse	1	0.1%
Autochthonous and relapse and acute	1	0.1%
Induced and acute	1	0.1%

Classification	#	%
Not registered	8	0.8%
Total cases	1025	

8.2 Case management

8.2.1 Patient follow-up testing: health facility interview

According to the health facility interview and as shown in Table 8.3, 84% of respondents said that malaria patients receive at least one follow-up test in order to ensure the malaria infection has gone away. Table 8.4 shows that the thick blood film sample is most frequent for follow-up testing.

Table 8.3: Follow-up testing after malaria treatment: facility interview

	N	n	%	95% CI
After a patient begins treatment for malaria, do they ever receive a follow-up test for malaria?	50	42	84	(71 - 92)

Table 8.4: Follow-up testing methods

	N	n	%	95% CI
Is an RDT or thick blood film more commonly used for follow-up tests?				
Only thick blood film used more commonly	42	35	83.3	(68 - 92)
Only RDT used more commonly	42	3	7.1	(2 - 20)
Both RDT and thick blood film: Samples are routinely taken for both tests at the same time	42	3	7.1	(2 - 20)
Don't know	42	1	2.4	(0 - 16)

The interview also asked how many follow-up tests are routinely administered according to facility practices (Figure 8.1), and when the first and last samples are taken from the patient for follow-up testing (Figure 8.2). Follow-up testing occurs within one month after treatment, with most facilities completing follow-up testing one week after treatment. Some facilities only conduct, or are only aware of, the first follow-up tests within one week of diagnosis.

Figure 8.1: Follow-up tests administered according to facility practices

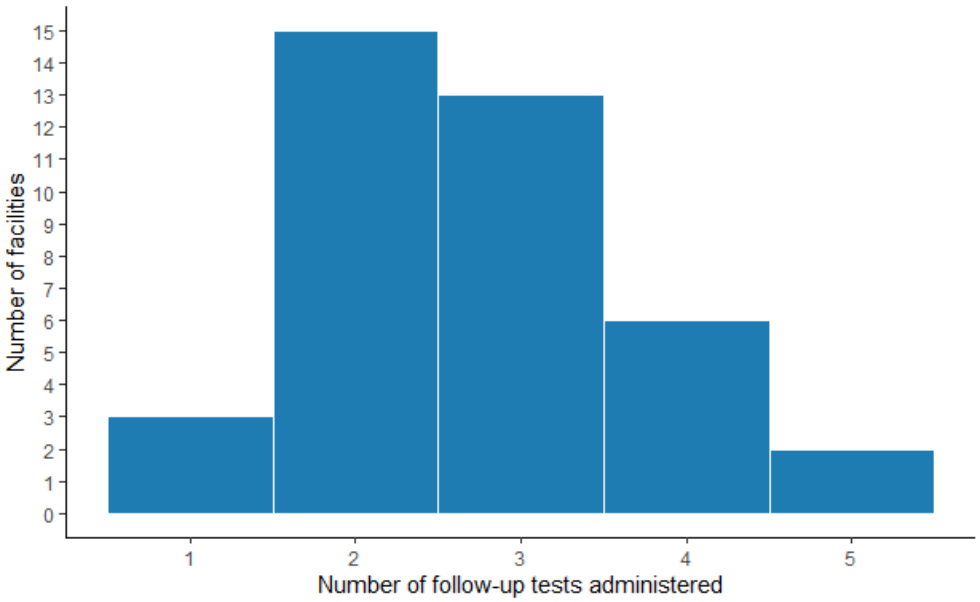
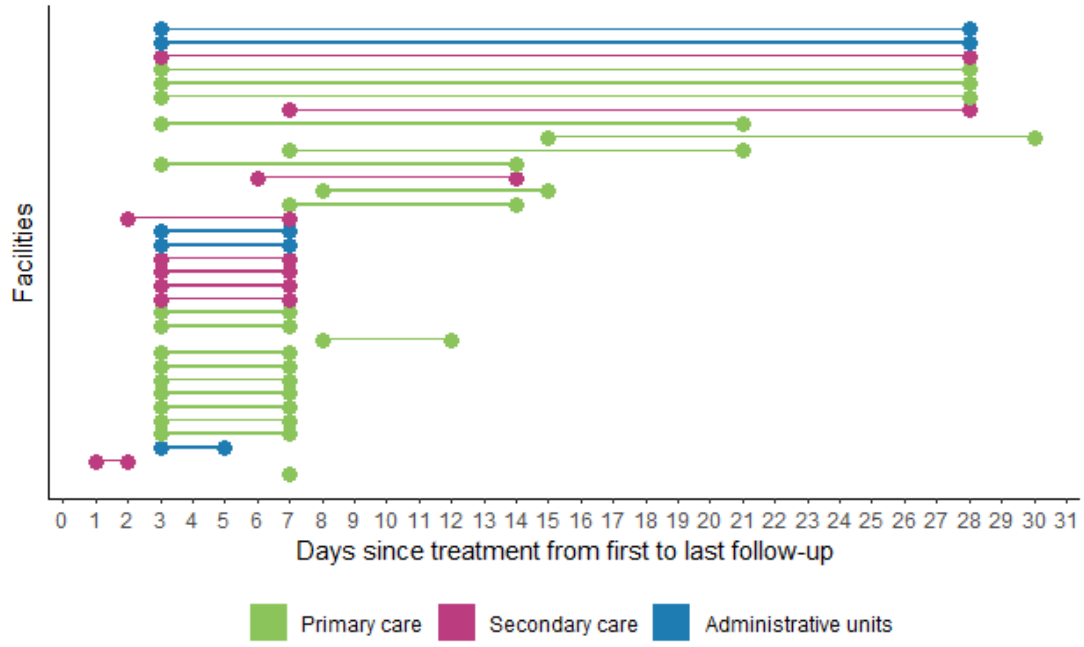


Figure 8.2: Timing from first to last follow-up test



8.2.2 Patient follow-up testing: medical record review

The M-10 case investigation form has space to track treatment administration and follow-up malaria testing on days 3, 7, 21, and 28, though in practice these activities may be tracked on separate, locally-developed forms and never updated on the case investigation form after it is entered to the SIMALARIA database and a copy sent to the municipal headquarters. Chapter 7 covers treatment administration practices in detail.

There was evidence of at least one follow-up test for 86.1% of confirmed cases reviewed (Table 8.5). The number of follow-up tests recorded on the forms used for case review is shown in Figure 8.3 - most frequently there is only evidence of one follow-up test. Considering the discrepancy with the information reported in the health facility interview, it is possible that patients receive more than one test, but the dates and results for subsequent tests are not recorded on the case investigation form filed at the municipal headquarters.

Table 8.5: Follow-up testing after malaria treatment: medical record review

	N	n	%	95% CI
Received at least one follow-up test for malaria?	768	661	86.1	(83 - 88)

Figure 8.3: Follow-up tests administered: medical record review

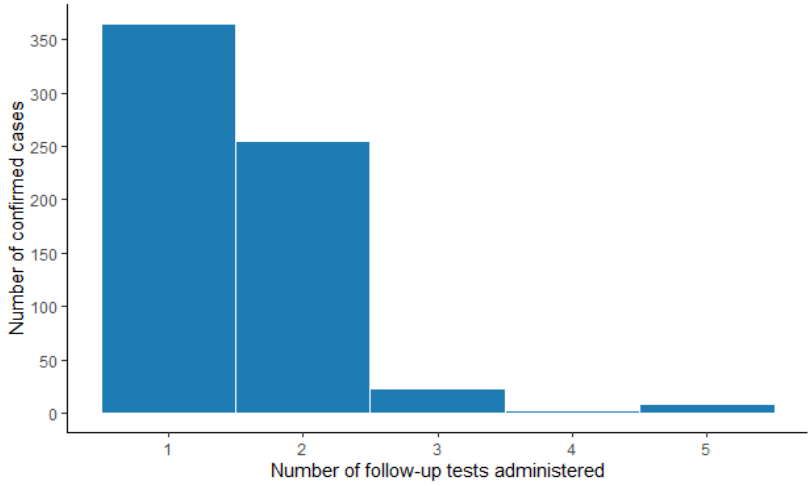


Figure 8.4: Days to first follow-up test: medical record review

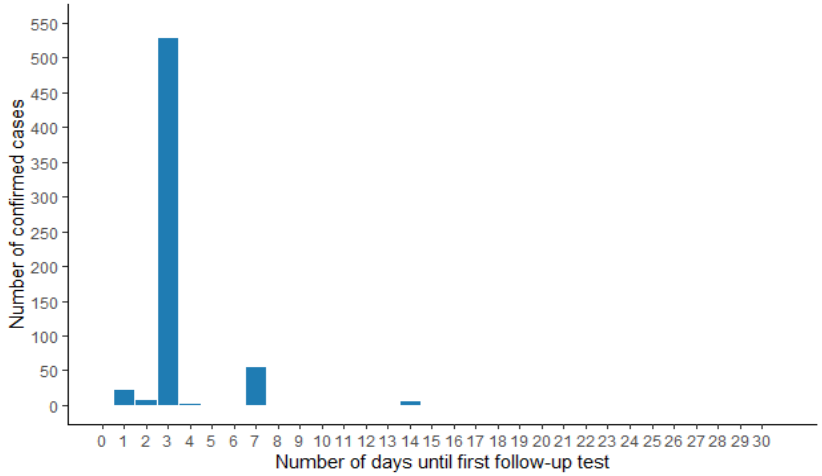
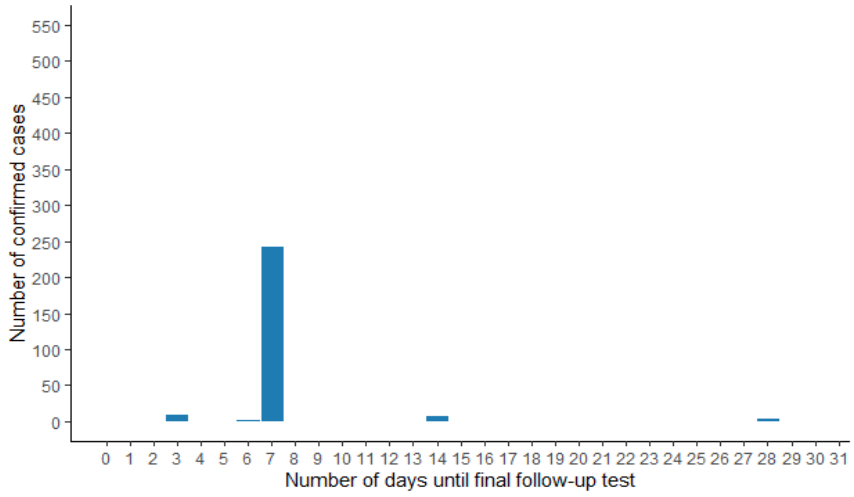


Figure 8.5: Days to final follow-up test: medical record review, among cases with multiple follow-up tests



8.3 Case response

Information extracted from the case investigation also allows vector control programs to plan community activities in response to a confirmed malaria case. Some of these activities are registered on the case investigation forms reviewed during the confirmed case review. Among the 1,025 cases reviewed, 150 had information about the environmental investigation and case response recorded. Table 8.6 shows the results of the environmental investigation, among the 150 cases with information.

Table 8.6: Medical record review case response

	N	n	%	95% CI
Is there information about dwelling/environmental investigation and case response in the file?	1025	150	14.6	(13 - 17)
Mosquito nets in house	150	10	6.7	(4 - 12)
Patient used/slept under net	150	3	2	(1 - 6)
House had been sprayed with insecticide	150	135	90	(84 - 94)
Anopheles vector present	150	80	53.3	(45 - 61)
Breeding areas observed around the home	150	111	74	(66 - 80)
Household members tested for malaria	1025	259	25.3	(23 - 28)
Other contacts tested for malaria	1025	263	25.7	(23 - 28)

The case investigation form also specifies details about active case detection in a radius of the case, as well as insecticide application in the neighborhood. The results observed during the medical record review are shown in Table 8.8. Figure 8.6 shows the distribution of households visited for active case detection as recorded in the confirmed case investigations reviewed, among reviews with at least one household visited. Figure 8.7 shows the number of RDTs collected during active case detection and Figure 8.8 shows the number of TBFs collected during active case detection. Figure 8.9 shows the distribution of households where indoor residual spraying was applied.

Table 8.8: Evidence of active case detection in medical records

	N	n	%	95% CI
Was active case detection conducted?	150	149	99.3	(95 - 100)
Were houses sprayed?	150	137	91.3	(86 - 95)
Were houses fogged?	150	105	70	(62 - 77)

Figure 8.6: Households covered during active case detection

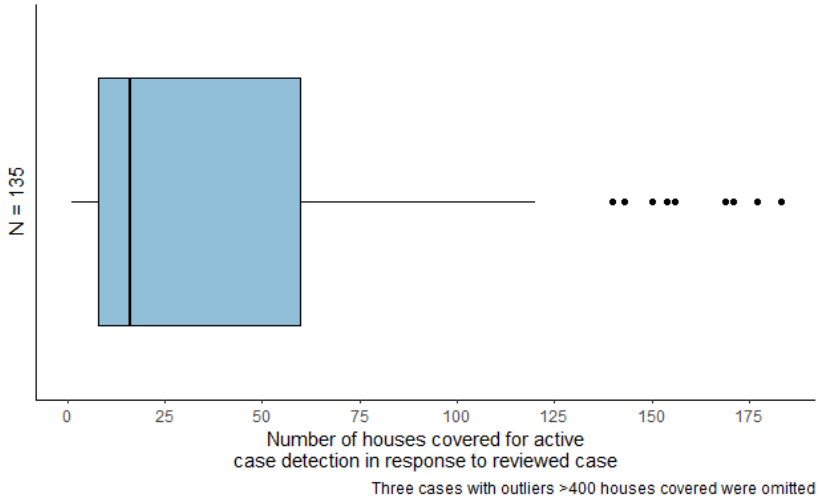


Figure 8.7: RDTs taken during active case detection

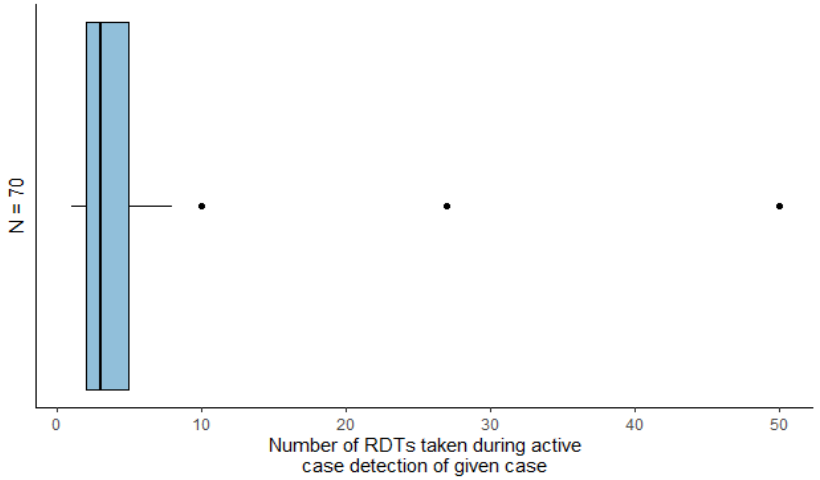


Figure 8.8: Thick blood film samples taken during active case detection

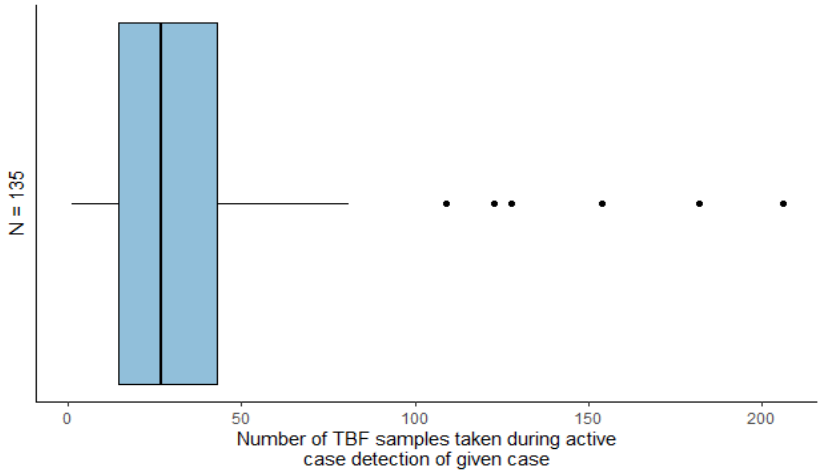
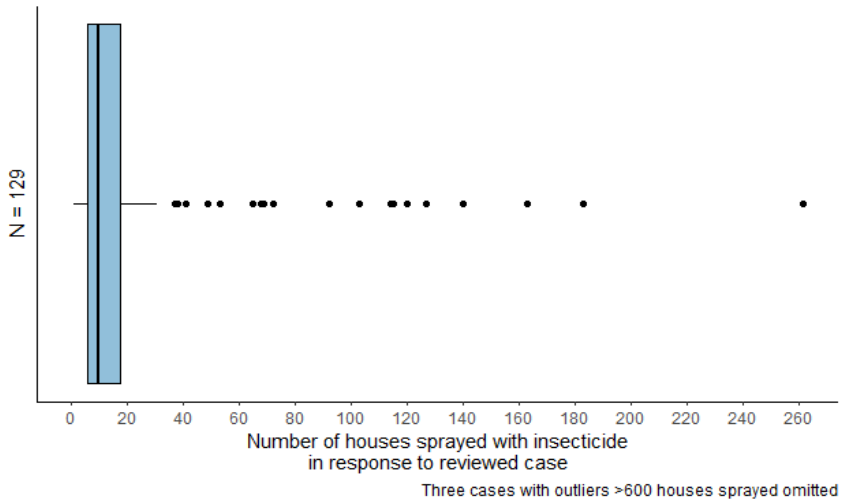


Figure 8.9: Houses sprayed (IRS) during case response



Chapter 9: Surveillance, Notification, and Reporting

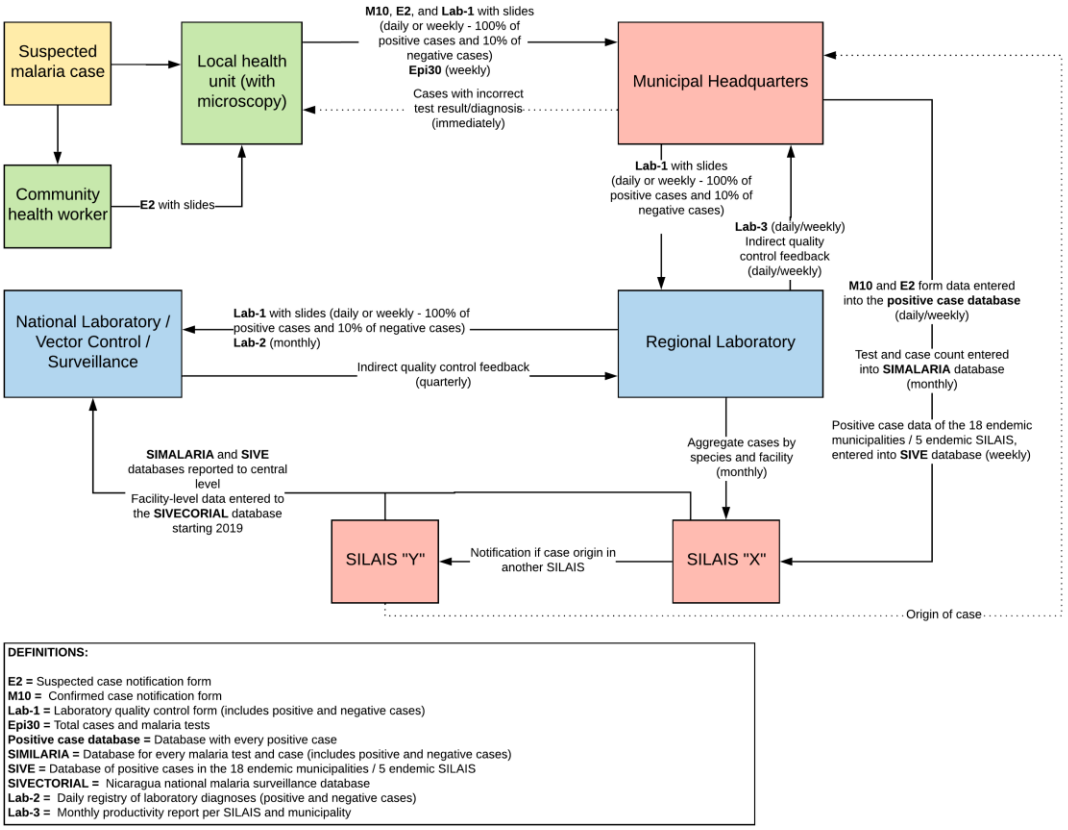
This chapter provides an overview of the malaria surveillance system in Nicaragua based on the fact-finding visit and health facility surveys, and summarizes results related to case reporting and laboratory reporting and quality control indicators.

9.1 Background

The fact-finding trip in April 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 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 9.1 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 inform the municipal headquarters of malaria test results. Positive results may be notified immediately to relevant personnel at the municipal as well as SILAIS headquarters and laboratory, especially in municipalities with lower transmission levels. Positive results will also be included in aggregate monthly laboratory reporting to the municipal or SILAIS headquarters of the case's origin as well as the national vector control program. Facilities with capacity to diagnose malaria are obligated to prepare weekly malaria case reports (or reports of zero cases). In practice, this requirement did not seem to be universally implemented in 2018 (or, reports from 2018 were infrequently archived) in Nicaragua.

Figure 9.1: Nicaragua surveillance system flow diagram



9.2 Notification of malaria test results

9.2.1 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. Table 9.1 and Table 9.2 show the method by which a patient is notified of a negative test result among the 12 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 to these questions. It is frequently health personnel from the facility where the sample was taken who are responsible for notifying the patient of the negative test result (in 91.7% of facilities). Among the 11 facilities where facility personnel are responsible to notify at least some patients of the test result, the notification is often in person (in 100% of facilities).

Table 9.1: Notification to patient of negative test results (among facilities that send slides elsewhere for examination): personnel

	N	n	%	95% CI
Who notifies the patient of a negative test result?				
Health personnel from this facility	12	11	91.7	(57 - 99)
The laboratory that tested the sample	12	1	8.3	(1 - 43)

Table 9.2: Notification to patient of negative test results (among facilities that send slides elsewhere for examination): method

	N	n	%	95% CI
How is the patient notified of a negative test result? (among those notified by facility personnel)				
In person	11	11	100	(-)
Phone call	11	4	36.4	(14 - 67)
Phone message (SMS)	11	2	18.2	(4 - 52)
Physical document delivery	11	1	9.1	(1 - 45)

In the case of a positive test result, 25 facilities that send slides elsewhere for examination reported they receive positive test results for the slides they send. Among these facilities, 80% are sometimes or always responsible to notify the patient of the positive test result by their own personnel (Table 9.3). Among these 20 facilities, the most common modality for notification of a positive test result is in person (Table 9.4).

Table 9.3: Notification to patient of positive test results (among facilities that send slides elsewhere for examination): personnel

	N	n	%	95% CI
Who notifies the patient of a positive test result?				
Health personnel from this facility	25	20	80	(59 - 92)
The laboratory that tested the sample	25	4	16	(6 - 36)
Vector control personnel	25	3	12	(4 - 32)
Community health worker	25	1	4	(1 - 25)
Volunteer collaborator / promoter	25	1	4	(1 - 25)
Other	25	1	4	(1 - 25)

Table 9.4: Notification to patient of positive test results (among facilities that send slides elsewhere for examination): method

	N	n	%	95% CI
How is the patient notified of a positive test result? (among those notified by facility personnel)				
In person	20	18	90	(67 - 98)
Phone call	20	6	30	(14 - 53)
Phone message (SMS)	20	2	10	(2 - 33)
Physical document delivery	20	1	5	(1 - 29)
Other	20	1	5	(1 - 29)

9.2.2 Notification to patient among facilities that examine slides for malaria

Other health facilities reported their own microscopic diagnosis capacity in-house. In these 12 facilities, health personnel from the facility where the sample was taken are responsible for notifying at least some patients of a negative test result in 75% of facilities (Table 9.5). In the case that a positive test result is detected in the facility, 58.3% are sometimes or always responsible to notify the patient of the positive test result by their own personnel.

Table 9.5: Notification to patient of negative test results (among facilities that examine slides): personnel

	N	n	%	95% CI
Who notifies the patient of a negative test result?				
Health personnel from this facility	12	9	75	(44 - 92)
Community health worker/health promotor	12	3	25	(8 - 56)
Vector control personnel	12	3	25	(8 - 56)
The patient is not notified	12	1	8.3	(1 - 43)

	N	n	%	95% CI
Volunteer collaborator	0	0		-
Other	12	2	16.7	(4 - 49)

Table 9.6: Notification to patient of positive test results (among facilities that examine slides): personnel

	N	n	%	95% CI
Who notifies the patient of a positive test result?				
Health personnel from this facility	12	7	58.3	(30 - 82)
Community health worker/health promoter	12	3	25	(8 - 56)
Vector control personnel	12	2	16.7	(4 - 49)
Volunteer collaborator	0	0		-
Other	12	5	41.7	(18 - 70)

9.2.3 Notification to health authorities among facilities that examine slides for malaria or perform rapid diagnostic tests

When a case of malaria is confirmed in Nicaragua, notification must be sent to health authorities. Among all facilities that either examine TBF slides or perform RDTs, 61.8% notify the municipal health authority and 47.1% notify the regional health authority (Table 9.7).

Table 9.7: Notification to health authorities of positive test results

	N	n	%	95% CI
Who is notified when a confirmed case of malaria is detected?				
Municipal health authority	34	21	61.8	(44 - 77)
Regional health authority	34	16	47.1	(31 - 64)
Epidemiological surveillance unit	34	8	23.5	(12 - 41)
Regional laboratory	34	4	11.8	(4 - 28)
National malaria program	34	1	2.9	(0 - 19)
Local vector control unit	34	1	2.9	(0 - 19)
Other	34	2	5.9	(1 - 21)

9.3 Malaria surveillance data and reporting

All health facilities in the sample were asked if they have access to an electronic health information system as shown in Table 9.8. Three percent of primary care facilities, 90.9% of secondary care facilities, and 100% of administrative units 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 90% of secondary care facilities and 90.9% of administrative units reported access to a system used for malaria information.

Table 9.8: Access to electronic information systems

	N	n	%	95% CI
Health posts				
Access to an electronic health information system for capturing and/or consulting health statistics	32	1	3.1	(0 - 20)
Access to an electronic health information system for entering malaria-specific information	1	1	100	(-)
Health centers & primary hospitals				

	N	n	%	95% CI
Access to an electronic health information system for capturing and/or consulting health statistics	11	10	90.9	(55 - 99)
Access to an electronic health information system for entering malaria-specific information	10	9	90	(52 - 99)
Administrative units & National Lab				
Access to an electronic health information system for capturing and/or consulting health statistics	11	11	100	(-)
Access to an electronic health information system for entering malaria-specific information	11	10	90.9	(55 - 99)

9.3.1 Indicator 2.03: Malaria case reporting

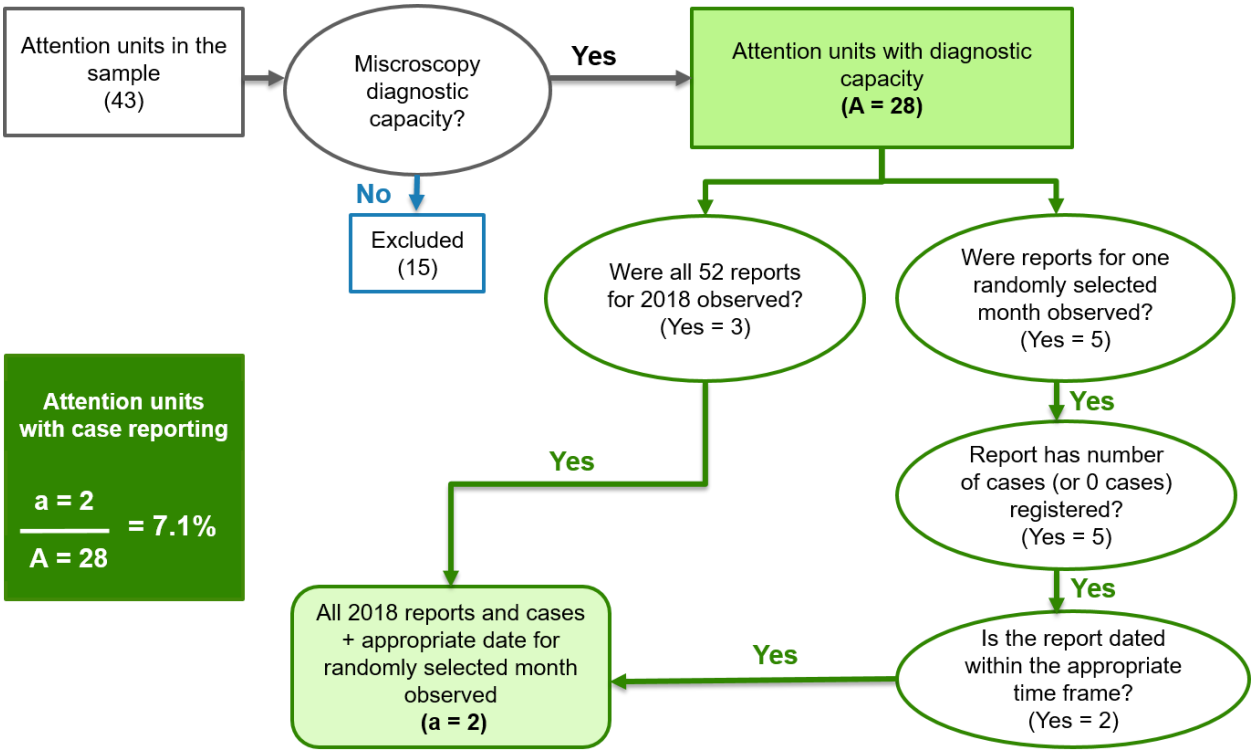
RMEI indicator 2.03 has two parts: case reporting and laboratory reporting. According to the negotiated definition for case reporting, health units in Nicaragua that conduct malaria diagnosis (by RDT or microscopy) must send weekly reports to the municipal or SILAIS headquarters that include the aggregate number of malaria cases detected during the week, or a notification that zero malaria cases were detected. The report is to be sent within the first three days of the close of each week (no later than the next Tuesday) 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 primary and secondary level facilities 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 or all 52 weekly reports for the year 2018. If a week 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 (or set of four epidemiological weeks). 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 9.2.

Table 9.9 shows the results of the case reporting component of the indicator, which requires the following:

- that the reports be in a weekly format
- that all 52 reports be observed for the year 2018
- that all four weekly reports be observed for the selected month with send date
- that all four send dates are verified to be within the first three days of the close of the selected week (by the following Tuesday)

Figure 9.2: Eligibility of health facilities for Indicator 2.03 (case reporting)



28 facilities that provide attention to patients are eligible for consideration in the indicator. The results are shown in Table 9.9 and two units met all the requirements of the indicator. Case reporting by malaria stratum is shown in Table 9.10.

Table 9.9: Indicator 2.03: Case reporting

	N	n	%	95% CI
Indicator: Attention units				
Relevant units	43	43	100	(-)
Units with diagnostic capacity[1]	43	28	65.1	(49 - 78)
Units indicating reporting of malaria cases	28	27	96.4	(78 - 100)
At least one weekly report from 2018 observed	28	5	17.9	(7 - 37)
All 52 weekly reports from 2018 observed	28	3	10.7	(3 - 29)
Four weekly reports for randomly selected month observed	28	5	17.9	(7 - 37)
Number of cases (or zero) recorded for all reports of randomly selected month[1]	28	5	17.9	(7 - 37)
Dates for reports of randomly selected month observed	28	3	10.7	(3 - 29)
Dates for reports of randomly selected month are valid	28	2	7.1	(2 - 25)
Result: Malaria case reporting to standard	28	2	7.1	(2 - 25)

[1] Two attention units had monthly reports available for which all 12 reports were observed, including dates.

Table 9.10: Indicator 2.03 - Case reporting: result by malaria stratum

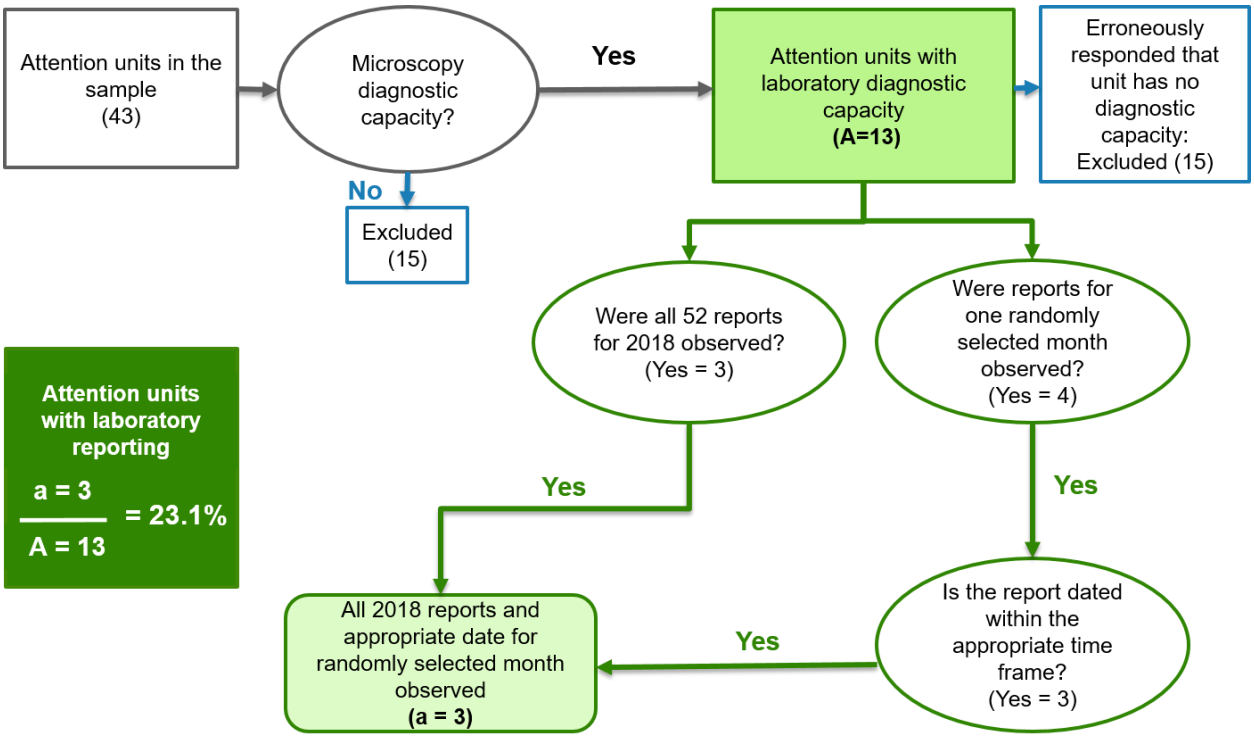
	N	n	%	95% CI
Malaria case reporting to standard				
Stratum 3	3	0	0	(-)
Stratum 4	13	0	0	(-)
Stratum 5	12	2	16.7	(4 - 49)

9.3.2 Indicator 2.03: Laboratory production reporting

The other component of Indicator 2.03 is the observation of weekly laboratory production reports (Lab-3) that show the number of TBF slides examined and the number of RDTs performed. All facilities that conduct malaria diagnosis (by RDT or microscopy) must send these reports to the municipality or to the SILAIS each week. 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 9.3. The indicator required:

- that the reports be in a weekly format
- that all 52 reports be observed for the year 2018
- that the report be observed for the randomly selected month with send date
- that all four send dates are verified to be within the first three days of the close of the selected week (by the following Tuesday)

Figure 9.3: Eligibility of health facilities for Indicator 2.03 (laboratory reporting)



13 facilities that provide attention to patients are eligible for consideration in the indicator. The results are shown in Table 9.11. Laboratory reporting by malaria stratum is shown in Table 9.12.

Table 9.11: Indicator 2.03: Lab reporting

	N	n	%	95% CI
Indicator: Attention units				
Relevant units	43	43	100	(-)
Excluded due to survey error[1]	43	15	34.9	(22 - 51)
Units with diagnostic capacity	28	13	46.4	(29 - 65)
At least one weekly report from 2018 observed	13	4	30.8	(12 - 60)
All 52 weekly reports from 2018 observed[2]	13	3	23.1	(7 - 53)
Four weekly reports for randomly selected month observed	13	4	30.8	(12 - 60)
Dates for reports of randomly selected month observed	13	4	30.8	(12 - 60)
Dates for reports of randomly selected month are valid	13	3	23.1	(7 - 53)
Result: Lab production reporting to standard	13	3	23.1	(7 - 53)

[1] Missing data for 15 units that erroneously informed they do not do primary diagnosis
[2] Three attention units had monthly reports available for which all 12 were observed.

Table 9.12: Indicator 2.03 - Lab reporting: result by malaria stratum

	N	n	%	95% CI
Lab production reporting to standard				
Stratum 3	2	1	50	(5 - 95)
Stratum 4	7	0	0	(-)
Stratum 5	4	2	50	(12 - 88)

The destination where laboratory production reports are sent is shown in Table 9.13.

Table 9.13: Destination of lab production reports observed

	N	n	%	95% CI
Where are laboratory production reports sent?				
Regional health authority	39	17	43.6	(29 - 60)
Municipal health authority	39	10	25.6	(14 - 42)
Other	29	4	13.8	(5 - 32)

9.4 Indicator 3.02: Laboratory quality control

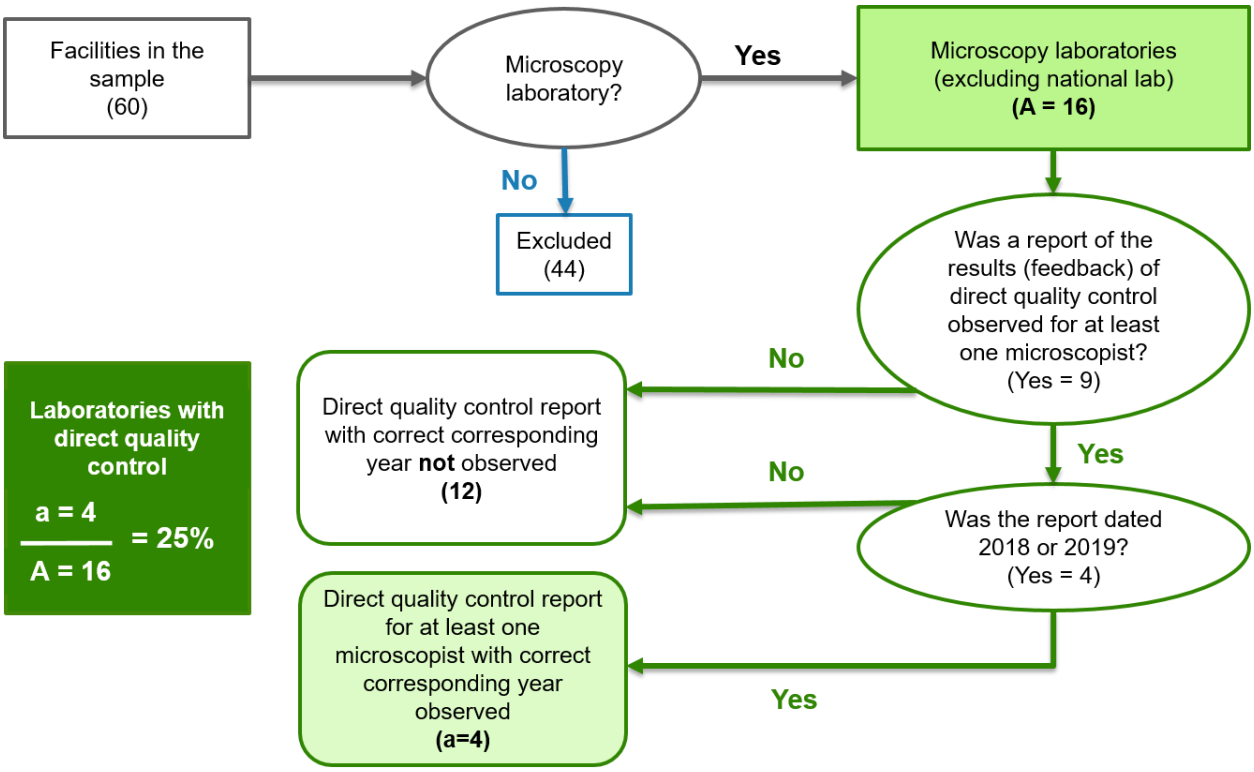
The RMEI indicators also require participation of the national reference laboratory for malaria in an external quality control certification with the Pan-American Health Organization, which was observed at the Nicaragua national reference laboratory for the year 2019.

Additionally, all laboratories and microscopy posts that diagnose malaria through microscopy must participate in direct and indirect quality control exercises with their corresponding regional reference laboratory (at the SILAIS), and personnel of the regional laboratory must participate in the same exercises with the national reference laboratory. Thus, 16 laboratories at the primary, secondary, and regional levels 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. According to Table 9.14, while 81.2% of local and regional laboratories reported participating in indirect quality control, complete evidence of participation in direct quality control was

observed at only 25% 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. Health facility eligibility was determined according to a decision algorithm shown in Figure 9.4.

Figure 9.4: Eligibility of health facilities for Indicator 3.02 (direct)

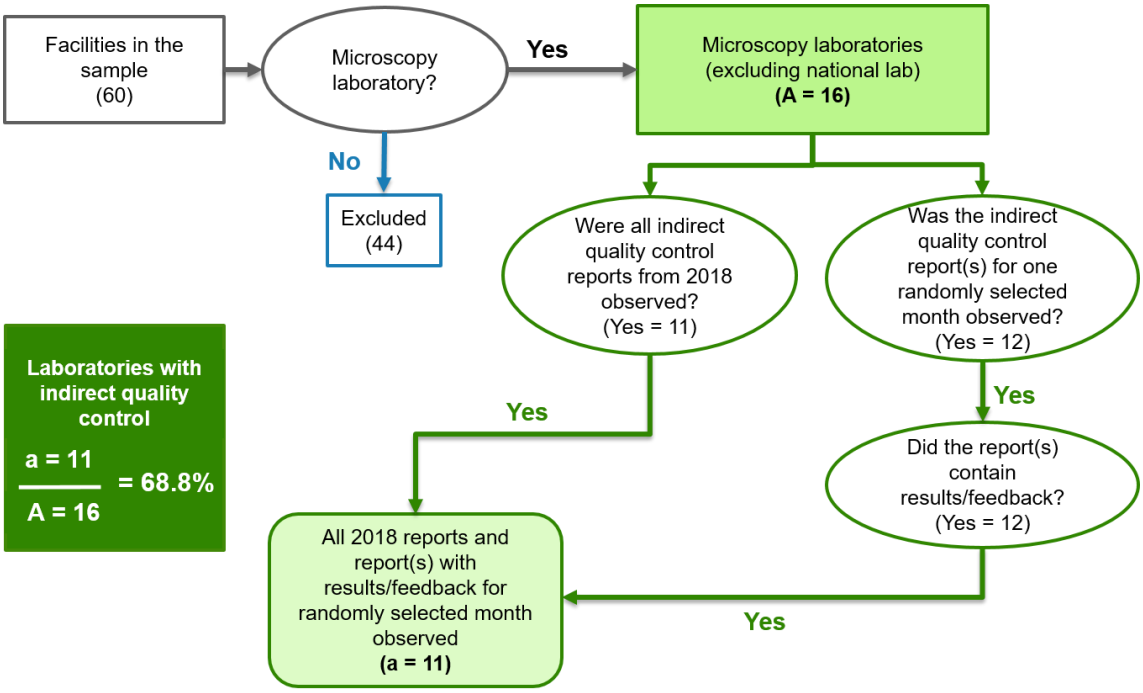


The second exercise, indirect quality control, is a cross-check of a set proportion of the slides initially diagnosed by each local laboratory (or in the case of the regional laboratory, of the slides first cross-checked) by a senior microscopist. In Nicaragua, local laboratories must send 10% of the slides with a negative test result for malaria and 100% of the slides with a positive test result to the regional lab for cross-checking each month. The selection method for the 10% of negative slides may vary regionally or locally. Regional laboratories must send 100% of the positive slides cross-checked and 10% of the negative slides received there for cross-checking (thus, 1% of the total negative slides initially diagnosed at the local level) to the national laboratory. Based on the fact-finding visit to Nicaragua, we expected that some municipal labs may have been conducting cross-checks of slides for local labs, but during the survey, local labs reported sending slides to the SILAIS laboratory only. Health facility eligibility was determined according to a decision algorithm shown in Figure 9.5.

While 87.5% of local and regional laboratories reported participating in indirect quality control, only 68.7% 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 AND
- 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 9.5: Eligibility of health facilities for Indicator 3.02 (indirect)



The detailed results of the indicator are shown in Table 9.15 and Table 9.16. A breakdown of the direct and indirect components of the indicator by malaria stratum are shown in Table 9.17.

Table 9.14: Indicator 3.02: Quality control

	N	n	%	95% CI
External quality control: 2018 National Lab Evaluation form observed	1	1	100	(-)
Direct	16	4	25	(9 - 52)
Indirect	16	11	68.7	(43 - 87)

Table 9.15: Indicator 3.02: Indirect and direct quality control

	N	n	%	95% CI
Facilities with microscopy (excluding national lab)	60	16	26.7	(17 - 40)
Facilities passing direct quality control (DQC) component	16	4	25	(9 - 52)
Facilities that report participating in DQC	16	13	81.2	(54 - 94)
Feedback for at least one assessment in 2018 was observed	16	9	56.2	(32 - 78)
Feedback report with results was dated 2018	16	4	25	(9 - 52)
Facilities passing indirect quality control (IDQC) component	16	11	68.7	(43 - 87)
Facilities that report participating in IDQC	16	14	87.5	(60 - 97)
Randomly selected month report was observed	16	12	75	(48 - 91)
Cross-checked results and feedback were observed on randomly selected report	16	12	75	(48 - 91)
All reports observed for 2018	16	11	68.7	(43 - 87)
Facilities passing both direct and indirect quality control	16	2	12.5	(3 - 40)

Table 9.16: Indicator 3.02: Indirect quality control in detail

	N	n	%	95% CI
Facilities who have microscopy (excluding national lab)	60	16	26.7	(17 - 40)
At least one report was observed for 2018	16	12	75	(48 - 91)
Reports are monthly	16	6	37.5	(17 - 63)
1-3 reports observed	16	0	0	(-)
4-7 reports observed	16	0	0	(-)
8-11 reports observed	16	0	0	(-)
12 reports observed	16	6	37.5	(17 - 63)
Reports are weekly	16	6	37.5	(17 - 63)
1-17 reports observed	16	0	0	(-)
18-34 reports observed	16	0	0	(-)
35-51 reports observed	16	1	6.3	(1 - 35)
52 reports observed	16	5	31.3	(13 - 57)
All reports observed for 2018	16	11	68.7	(43 - 87)

Table 9.17: Indicator 3.02: result by malaria stratum

	N	n	%	95% CI
Stratum 3				
Facilities passing direct quality control (DQC) component	2	0	0	(-)
Facilities passing indirect quality control (IDQC) component	2	2	100	(-)
Facilities passing both direct and indirect quality control	2	0	0	(-)
Stratum 4				
Facilities passing direct quality control (DQC) component	10	1	10	(1 - 48)
Facilities passing indirect quality control (IDQC) component	10	6	60	(29 - 85)
Facilities passing both direct and indirect quality control	10	0	0	(-)
Stratum 5				
Facilities passing direct quality control (DQC) component	4	3	75	(23 - 97)
Facilities passing indirect quality control (IDQC) component	4	3	75	(23 - 97)
Facilities passing both direct and indirect quality control	4	2	50	(12 - 88)

Chapter 10: Challenges, Conclusions, and Recommendations

10.1 Challenges and limitations

10.1.1 Challenges for health facility data collection

In Nicaragua, field personnel were generally able to gain authorization to interview in selected health facilities and to observe relevant service areas. RDTs were observed at relatively few facilities, and records of stock (in particular, stock of laboratory supplies) were sometimes not available or insufficiently detailed to determine stock-out over a three-month period. Often, laboratory supplies for malaria diagnosis and malaria treatments are tracked under a separate system from other pharmacy and lab inputs. Sometimes stock records are not maintained at the local facility, but rather at the municipal or SILAIS headquarters of the malaria program.

10.1.2 Challenges for suspected case review

Sampling of suspected malaria cases in Nicaragua was designed to be conducted through use of fever logbooks and attention registries at primary and secondary care facilities. However, as mentioned in Chapter 2, it became clear during fact-finding and data collection that the protocol at many facilities in areas with high malaria burden was to test all patients presenting with fever for malaria and that these patients were not registered in a general attention registry, but rather on the E-2 blood sample form or TBF logbook alone. For this reason, there were no attention registries or fever logbooks from which to sample suspected cases. In order to meet the quota for suspected cases at these facilities, data collectors used the E-2 forms and/or laboratory logbooks to sample suspected cases, with the caveat that all fever cases at the facility in question must have been included in these sources to be considered validly sampled. The absence of fever logbooks and the subsequent necessity to sample suspected cases from E-2 blood sample forms or TBF logbooks presents challenges, particularly around assuring that the facilities in question indeed tested every patient presenting with fever for malaria and that indicators can be measured comparably if testing norms or registration practices change as malaria burden drops in the future.

10.1.3 Challenges for confirmed case review

In Nicaragua, malaria case investigation (M-10) forms were generally found for most confirmed cases of malaria and could be reviewed at the municipal headquarters. The information found on these forms was sufficient to measure most indicators, with two exceptions. Sometimes the species of the parasite was not registered on the forms, making it impossible to determine what treatment scheme should have been followed. Additionally, treatment records were often not sufficiently complete to measure complete and continuous treatment, and evidence of treatment supervision was not often found. From the fact-finding visit, we anticipated these obstacles to measurement. The E-33 treatment supervision form is used widely in Nicaragua, but a copy may not be sent to the municipal archive in most cases.

10.1.4 Challenges for case and lab reporting review

In Nicaragua, standard formats are in use for aggregate reporting of malaria cases and laboratory production, but the forms do not typically include the date sent or received, complicating the attempt to evaluate timeliness of submission. Additionally, field personnel were sometimes unable to observe the reports or the laboratory quality control forms from the year 2018 when archives had not been maintained since 2018 or facility personnel were unable to find the files. This was a particular problem where there had been changes in lab or statistics personnel since 2018.

10.1.5 Challenges for household data collection

Household data collection in Nicaragua 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 quite small.

10.2 Key findings and recommendations

Detection of malaria cases was found to be higher in strata 4 and 5 than in stratum 3. It is important that health providers in stratum 3 also be vigilant for suspected malaria. In general, registration of confirmed malaria cases is effective in Nicaragua. Forms should be reviewed in order to ensure essential information is captured (in particular information about treatment administration, supervision, and follow-up parasitological testing), and more importantly, the pipeline from recording on paper in the field to the final electronic database should be reviewed and improved to ensure the highest data quality. 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 regional 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. Vector control teams in the field must inform to the malaria program, while patients visit health facilities that are part of a separate reporting chain to the SILAIS. Coordination in Nicaragua is currently strong, but circumstances in neighboring RMEI countries suggest a risk that when malaria transmission decreases and the scope of the malaria program is reduced, mutual understanding and communication between health facilities and the program could weaken, just as the malaria elimination strategy prescribes increased dependence on passive case detection. To reach malaria elimination, stakeholders will have to work to bridge gaps and reduce fragmentation in service provision.

At the local level, there is a notable variation in practices among health facilities, in particular notification flows and detection and record-keeping protocols for patients with fever presenting at a health facility (suspected malaria cases), 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
P2.02	Fever cases with blood sample	62	43.5	(26 - 63)
P2.03	Case reporting with quality	28	7.1	(2 - 25)
	Lab production reporting	13	23.1	(7 - 53)
P3.02	Quality control (external)	1	100	(-)
	Quality control (direct)	16	25	(9 - 52)
	Quality control (indirect)	16	68.7	(43 - 87)
P4.02	Diagnosis within 48 hours	997	27.8	(25 - 31)
P4.01	Treatment within 24 hours	971	75.9	(73 - 78)
P4.03	Treatment complete and supervised	1025	6.1	(5 - 8)
P6.01	Vector control coverage	2326	46.1	(29 - 65)
P7.01	Equipment and instruments for diagnosis and treatment	46	15.2	(7 - 29)

A.2 Monitoring indicator matrix

#	Indicator	N	%	CI
M2.01	Suspected cases with malaria test (MRR)	891	81.1	(78 - 84)
E2.04	Notified within 24 hours of detection	1001	23.7	(21 - 26)
E3.03	Equipment and instruments for sampling, diagnosis and RDTs	45	22.2	(12 - 37)
E4.05	Health facilities without stockouts of first-line treatments	43	62.8	(47 - 76)
E6.03	Population protected by IRS	3875	5.7	(5 - 6)
E6.05	Population protected by ITNs	3900	37.9	(36 - 39)

#	Indicator	N	Median	CI
4.03	Median time between onset of symptoms and start of treatment (days): passive surveillance	651	4	(-)
	Median time between onset of symptoms and start of treatment (days): active surveillance	245	3	(-)
	Median time between onset of symptoms and start of treatment (days): surveillance type not registered	110	5	(-)

Appendix B: Indicator Definitions

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

M2.01: 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 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 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

P2.02: Fever cases with blood sample

Source: Household survey

Denominator: People in strata 3, 4 and 5 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: Health facilities with self-reported diagnostic capacity (microscopy or RDTs)

Numerator: Health facilities with weekly epidemiological surveillance reports observed

- Reports list the aggregate number of malaria cases or report of zero cases
- Reports observed for all 52 weeks of the year 2018
- Reports in randomly selected month list sending date
- All observed dates within 3 business days of the following week (by the following Tuesday)

Exclusions: Municipal and regional health units, national reference laboratory

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

Source: Health facility observation

Denominator: Health facilities with self-reported diagnostic capacity (microscopy or RDTs)

Numerator: Health facilities with monthly (or weekly) laboratory production reports observed

- Reports list the malaria samples taken (thick blood film or RDT)
- Reports observed for all 52 weeks of the year 2018
- Reports in randomly selected month list sending date
- All observed dates within 3 business days of the following week (by the following Tuesday)

Exclusions: Municipal and regional health units, national reference laboratory

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: Health facilities with self-reported microscopic diagnostic capacity

Numerator: Health facilities with observation of Evaluation Results Report (for slide panel exam) from the reference laboratory for at least one microscopist responsible for malaria diagnosis, dated 2018

Exclusions: National reference laboratory

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

Source: Health facility observation

Denominator: Health facilities with self-reported microscopic diagnostic capacity

Numerator: Health facilities 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: National reference laboratory

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)
- 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

P4.02: 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 and *P. ovale* cases: 3 days of chloroquine and 7 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 7 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 7 days 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 (as informed at surveyed health facility)

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

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

- All Health Posts, Health Centers, and Primary Hospitals in stratum 3 or above

Antimalarial medications for severe malaria: Quinine or Artesunate [tablets, IV, or rectal]

- All Primary Hospitals in stratum 3 or above

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

- All Health Posts, Health Centers, and Primary Hospitals in stratum 3 or above

Forms for sending slide samples

- All Health Posts, Health Centers, and Primary Hospitals in stratum 3 or above

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

- All Health Posts and Primary Hospitals in stratum 3 or above

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

- All Health Centers, Primary Hospitals, and SILAIS Headquarters 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 Health Centers, Primary Hospitals, and SILAIS Headquarters 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 Health Centers, Primary Hospitals, and SILAIS Headquarters that reported microscopic diagnostic capacity

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

- Eleven 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

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

Appendix C: Sample design and methods

C.1 Sample size

The size of the sample of health facilities for Nicaragua was defined as a part of the funding proposal to cover 60 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 60 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 32 communities with 25 households surveyed in each, or a total of 800 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 Nicaragua, 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

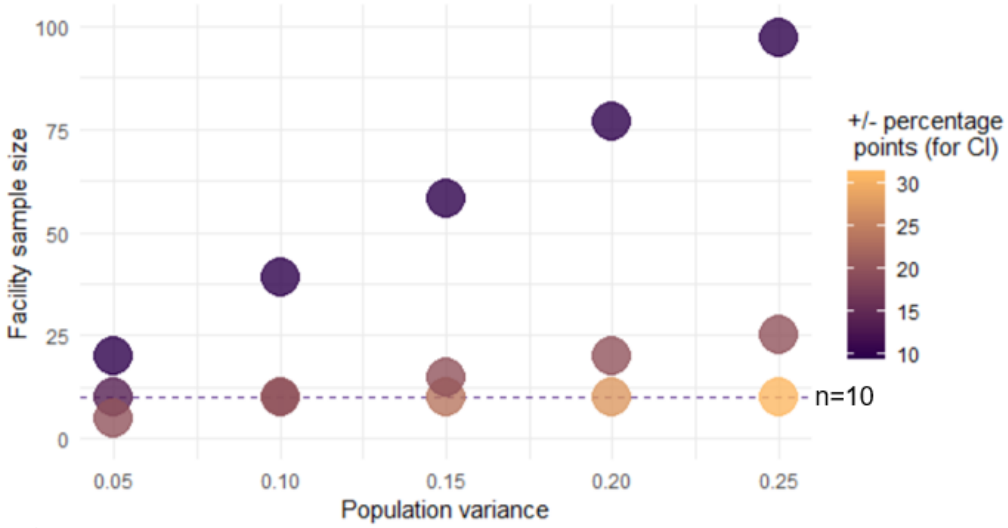


Figure 1. Facility sample sizes and corresponding margins of error across different levels of population variance. Potentially acceptable margins of error range from +/-10 ppts (ideal) to +/-30 ppts (considered high) on either side of the point estimate.

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 *Puestos de Salud* in municipalities in malaria strata 3, 4A, and 4B based on referral networks and facility lists provided by the Nicaragua Ministry of Health. All facilities in malaria strata 4A and 4B were assumed to have vector control measures (ITN distribution or IRS) implemented in their catchment areas per a directive IHME received from the Ministry of Health. Primary care facilities were sorted by a random variable and a sample was drawn in three strata: facilities in malaria stratum 4B, facilities in malaria stratum 4A, and facilities in malaria stratum 3. Two additional facilities per municipality 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 only a few health posts have microscopy capabilities, a substantial sample of health centers and primary hospitals were also selected to the sample to match the selected health posts to ensure a sufficient denominator to measure laboratory inputs, equipment, and reporting. We built a list of the eligible municipal offices, regional offices (SILAIS), and primary hospitals according to the referral network, including each municipality with primary care units already selected to the sample. This sampling frame consisting of, respectively, municipal offices, regional offices, and hospitals, was sorted by a random variable and the first facilities in the list selected up to a fixed sample size by facility type. Matched municipal headquarters were selected among those with autochthonous cases during 2018. Matched SILAIS were selected among the six that must report malaria cases to the central level. We assigned each administrative unit (*"sede municipal", "sede SILAIS"*) to the maximum stratum found in its service area (SILAIS with any municipalities in stratum 4B are therefore assigned to stratum 4B). The remaining facilities not selected from the sampling frame were ordered and listed to use as an alternate sample in case a facility could not be surveyed and required substitution. The national reference laboratory for malaria was selected with certainty.

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 Nicaragua, during the fact-finding visit and during data collection many facilities reported that all patients presenting with fever receive a malaria test and that they are not registered on any attention registry or fever book, but registered only in laboratory logbooks or E-2 blood sample taking forms. Though malaria laboratory records are not generally considered to be a suitable source for drawing the sample of suspected cases, since all patients recorded there are known to have had a sample taken for a malaria test, the sample was drawn from laboratory logbooks or E-2 forms in the selected health facilities in malaria strata 4A (8/13 selected facilities) and stratum 4B (15/15 selected facilities) where facility staff reported to interviewers that all febrile patients receive a malaria test and are not registered besides in laboratory records.

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

In selected municipal offices where the number of malaria cases during 2018 did not exceed the assigned quota, interviewers reviewed all malaria cases from 2018. In selected municipal offices where the number of malaria cases during 2018 exceeded the assigned quota, interviewers selected a sample of confirmed cases manually by first entering the total number of confirmed cases during 2018 to the Quotas Module to receive a randomly generated start date during 2018 and a calculated skip interval to use to select records. Using a registry or folders of the malaria case forms sorted by week, they began at the provided start date, and then skipped through the list or the stack of forms according to the provided skip interval. Information from each selected case was extracted but identifiable patient information was never entered to the survey modules.

C.2.4 Selecting communities

At each selected primary care facility, the field supervisor asked for information about the facility's catchment area, including the number of communities served, name and population of each community, and recent vector control activity in each community (IRS or distribution of ITN). The supervisor input the information to a Sample Selection Module which automated the process of selecting at random among eligible communities served by the facility. If any facilities in the catchment area had received vector control interventions, a community was selected at random among those with interventions. If no communities received interventions or the intervention status of all communities was unknown, a community in the catchment area was selected at random. A second community from the catchment area was selected as a 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 800 households, we sought to complete interviews with residents of 25 randomly selected households in each of the 32 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. For each community, the Sample Selection Module discussed in the previous section output 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 31 households. Counts of absent households range from 0 to 10 households. Counts of refused households range from 0 to 5 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) Nicaragua 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

Emily Linebarger, BA
Data Analyst, IHME

Erin Palmisano, MPH
Senior Research Manager, IHME

Max Thom, BS
Data Specialist, IHME

Acknowledgements

The Regional Malaria Elimination Initiative and this measurement are funded by the Bill & Melinda Gates Foundation, the Carlos Slim Foundation, and the Global Fund to Fight AIDS, Tuberculosis, and Malaria. RMEI is administered by the Inter-American Development Bank (IDB) in collaboration with the Pan American Health Organization (PAHO) and the Clinton Health Access Initiative (CHAI) in close coordination with the Council of Ministers of Central America and the Dominican Republic (COMISCA) and with the Project Mesoamerica. We thank all the health personnel and families who willingly participated in the study. We thank central and local governments for the support they extended to the study teams and their facilitation of access to communities and health facilities. We extend our gratitude to UNIMER for their implementation of data collection in Nicaragua for this project.