NATIONAL MALARIA CONTROL PROGRAMME EVALUATION

PAPUA NEW GUINEA MALARIA INDICATOR SURVEY 2019-2020: FINAL REPORT ON MALARIA PREVENTION, INFECTION PREVALENCE, AND TREATMENT-SEEKING

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EXECUTIVE SUMMARY

Background
Malaria is endemic throughout Papua New Guinea (PNG) with the exception of the highland areas where low temperatures prevent stable transmission above altitudes of approximately 1600 m. The vision expressed in the National Malaria Strategic Plan (NMSP) 2021-2025 is "a malaria-free Papua New Guinea by 2030." The NMSP aims to reduce malaria burden by 63% and reduce malaria mortality by 90% by 2025.

With financial support from The Global Fund to Fight AIDS, Tuberculosis and Malaria, the PNG National Malaria Control Programme (NMCP) has distributed long-lasting insecticidal nets (LLIN) country-wide since 2004, scaled-up malaria rapid diagnostic tests (mRDT) and artemisinin-based combination therapies at health facilities since the latter part of 2011 and implemented home-based management of malaria programmes in selected areas of the country. In addition, behaviour change campaigns supported the roll-out of preventative and curative interventions.

Methods
In the frame of the continuous comprehensive evaluation of the NMCP, the Papua New Guinea Institute of Medical Research (PNGIMR) conducted a countrywide Malaria Indicator Survey (MIS) between October 2019 and October 2020 to assess the population coverage of malaria control interventions and the prevalence of malaria infection at national and regional levels. The survey was carried out in 114 villages across all provinces, covering 3,299 households and 17,313 individuals. In total, 13,939 capillary blood samples were collected for the diagnosis of malaria by mRDT and light microscopy.

Results
Across PNG, 69.3% of all households owned at least one LLIN, 57.4% of the population had access to a LLIN and 43.6% of household members slept under a LLIN the night before the survey. Among children <5 years, 52.7% slept under a LLIN (73.5% among those children living in households that owned at least one LLIN). Among pregnant women (15-49 years), 54.4% slept under a LLIN (73.6% among those who lived in a household owning at least one LLIN). LLIN ownership and use were higher in areas below 1600 m altitude than in highland areas. Among women (15-49 years) with a live birth in the two years preceding the survey, 23% reported receiving three doses of sulphadoxine-pyrimethamine (SP) as intermittent preventative treatment (IPTp) during their last pregnancy. Only 5.2% of household heads reported having received information on malaria in the past three months, mostly from health workers; other sources of information were rarely mentioned.

By light microscopy, malaria infection was detected in 2.1% of the population below an altitude of 1600 m, whereas only 0.03% was detected in highland areas at and above 1600 m. In children <5 years of age in villages <1600 m altitude, 2.4% were infected with malaria parasites, whereas no child was found positive in the villages at 1600 m and above. The provinces with the highest prevalence values were Sandaun (10.6%), East Sepik (8.6%), Oro (3.7%), East New Britain (2.6%), Madang (2.5%), and Milne Bay (2.2%). Whereas in Sandaun most of the surveyed villages had >10% prevalence in adults and similar values in young children (up to 35% in one Sandaun village), the other lowlands provinces had pockets of high prevalence in addition to

villages with infections only in older children and adults, and villages with no infections at all. In the Highlands Region, malaria infected individuals were found in two villages (out of 40), but no infection was detected in children < 5years, suggesting importation of infections rather than local transmission. The mRDT used in the MIS had a low sensitivity (73%) but high specificity (97%) when compared to light microscopy, indicating the presence of malaria antibodies (or false-positive results) in tested individuals, especially in endemic areas.

A recent fever was reported by 2.9% of all household members and 2% had an acute fever on the day of the survey. Anaemia was detected in 55.8% of all household members and 5.7% had severe anaemia. Anaemia was less common in the Highlands Region than in the lowlands, and decreased with age. Among children 2-9 years of age, 0.6% had an enlarged spleen (splenomegaly), specifically in the provinces of East New Britain (19.7%), East Sepik (2.1%), Sandaun (1%) and West New Britain (0.7%).

For 60.3% of recent fever cases in the general population and for 56.6% in children <5 years, treatment was sought outside the person's home. The most common source of treatment were health facilities (56.8% in the general population, 56.6% in children <5 years). The most frequently cited reason for not attending a health facility was a perception that the illness was not serious or that the person already felt better. A diagnostic test was performed in 38.0% of cases in the general population and 33.4% of cases in children <5 years. The most commonly used drugs were antipyretics (33.2%), antimalarials (33.2%) and antibiotics (14.6%). An antimalarial was taken by 30.6% of cases in children <5 years. The most frequently used antimalarial was the first-line treatment artemether-lumefantrine (26.7%). Use of artemisinin monotherapies, primaquine, SP or chloroquine were much less frequently reported. Use of artemether-lumefantrine to treat test-positive cases was high, with 90.5% and 96.4% among the general population and children <5 years, respectively.

Targets and results of key indicators used in the evaluation of the Global Fund support to the PNG NMCP are listed in the table on the following page. Maps depicting LLIN coverage and malaria prevalence by province in five consecutive surveys over the period 2008/09 to 2019/20 are shown on subsequent pages.

Conclusion

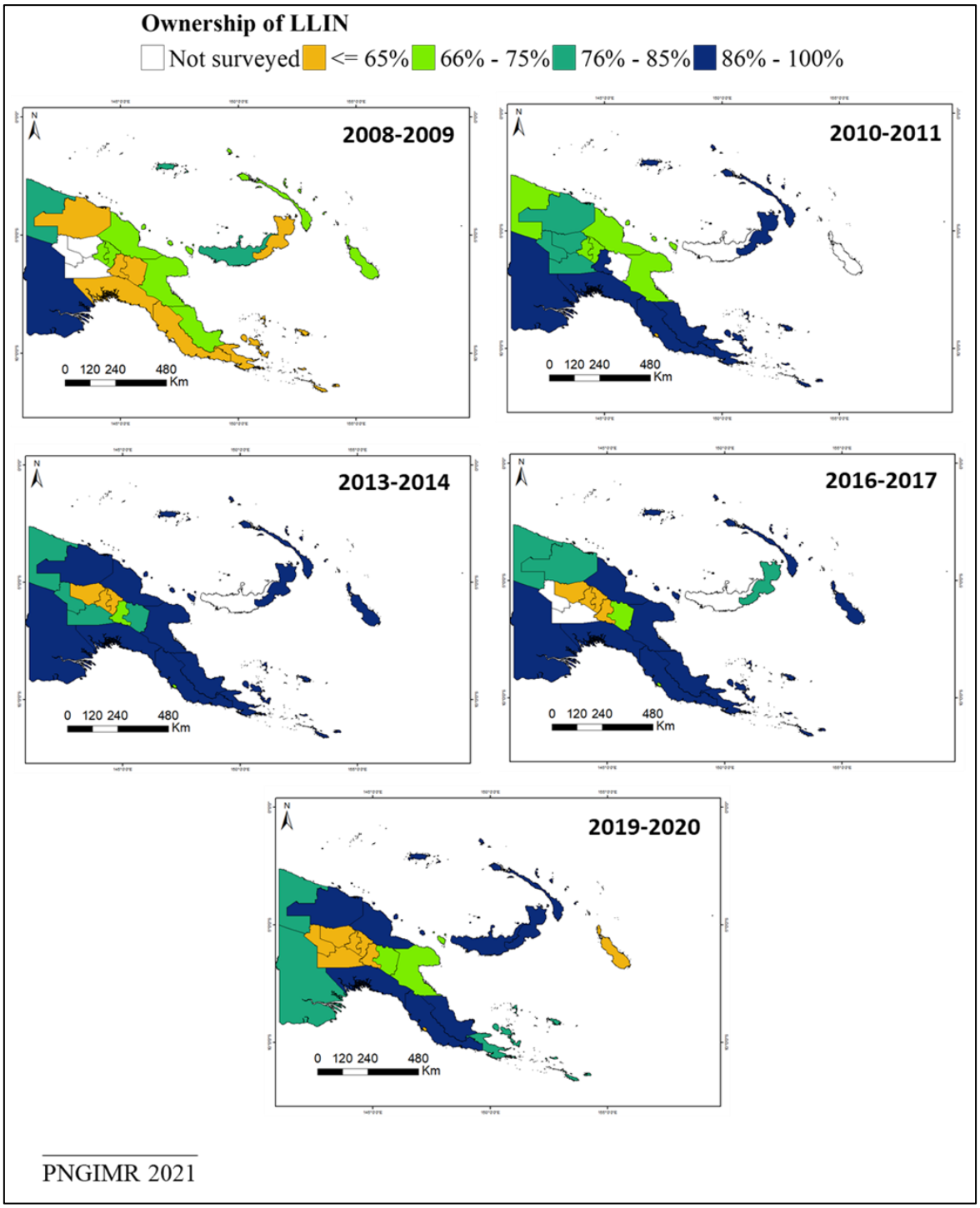
After a resurgence of malaria prevalence observed between 2013/14 and 2016/17, this report documents a decrease between 2016/17 and 2019/20 across PNG. Simultaneously, trends in LLIN coverage show a reduction at national level compared to 2016/17 but not in communities in low-lying areas. There is a need to evaluate the impact of adapting interventions to different settings in areas below 1600 m altitude and in the Highlands of PNG, where the transmission setting may allow local elimination.

Table of Global Fund Performance Framework indicators, targets, MIS 2017 and MIS 2020.

Global Fund Indicator	MIS 2016/17 (<1600m*)	Target 2019	MIS 2019/20 (<1600m*)
Parasite prevalence: Proportion of children aged 6-59 months with malaria infection (I-5)	8.8% (9.5%*)	1.5%	**2.1%** (2.4%)
Proportion of population that slept under an insecticide-treated net the previous night (O-1a)	51%	60%	**44%** (51%)
Proportion of children under five years old who slept under an insecticide-treated net the previous night (O-1b)	60%	65%	**53%** (59%)
Proportion of pregnant women who slept under an insecticide-treated net the previous night (O-1c)	60%	65%	**54%** (60%)
Proportion of population with access to an LLIN within their household (O-2)	67%	75%	**57%** (64%)
Proportion of population using an LLIN among the population with access to an LLIN (O-3)	77%	85%	**76%** (79%)
Proportion of households with at least one insecticide-treated net (O-5)	80%	85%	**69%** (77%)
Proportion of children under five years old with fever in the last two weeks for whom advice or treatment was sought (O-12)	45%	65%	**57%** (68%)
Proportion of women who received three or more doses of IPTp in ANC visits during their last pregnancy (O-10)			**23%** (27%)

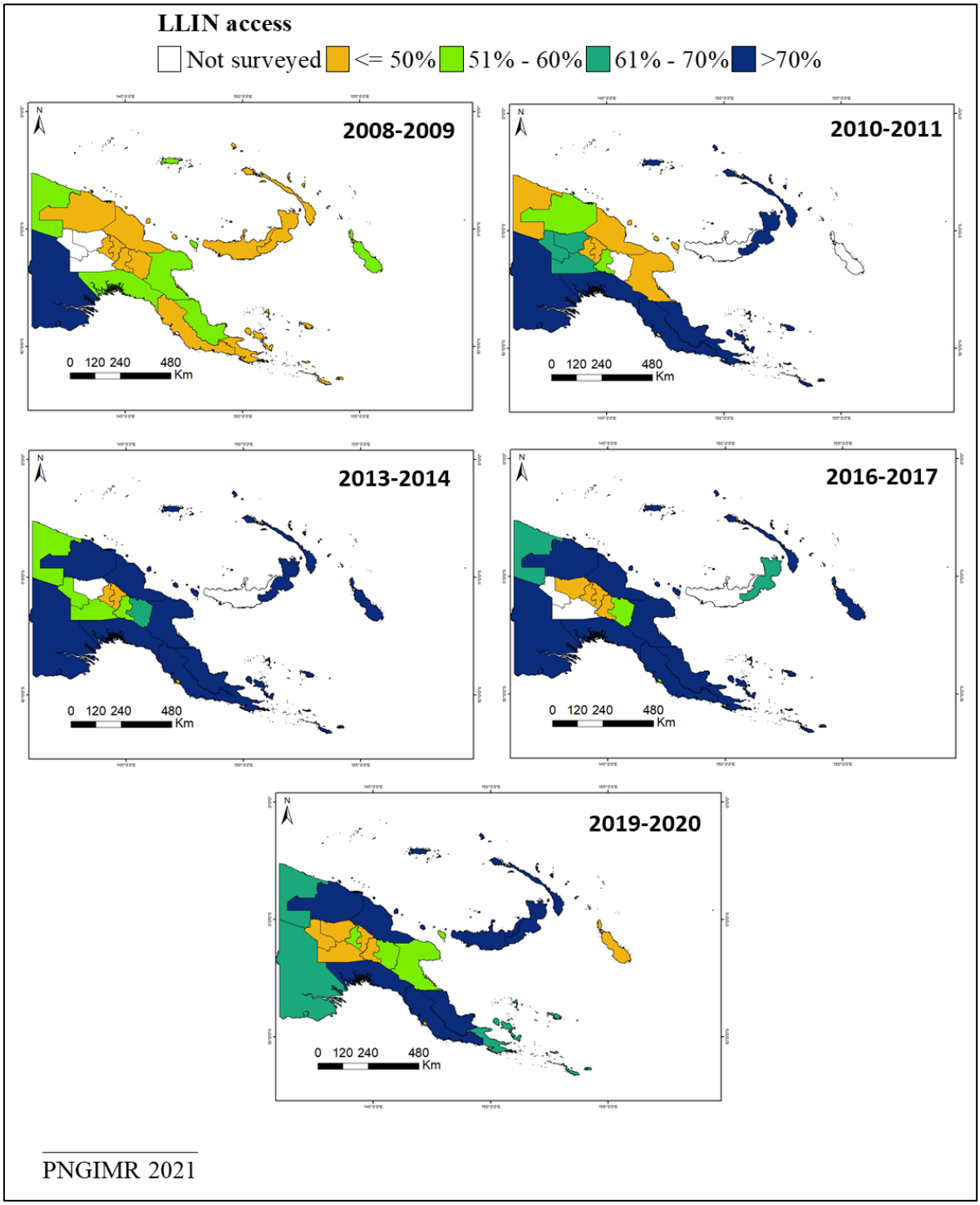
* In surveyed sites below 1600m

Trends in LLIN ownership, by province, Papua New Guinea (MIS: 2009, 2011, 2014, 2017 and 2020).
Percent of households owning at least one LLIN.



Trends in LLIN access, by province, Papua New Guinea (MIS: 2009, 2011, 2014, 2017 and 2020).

Percent of persons with access to an LLIN within their household.



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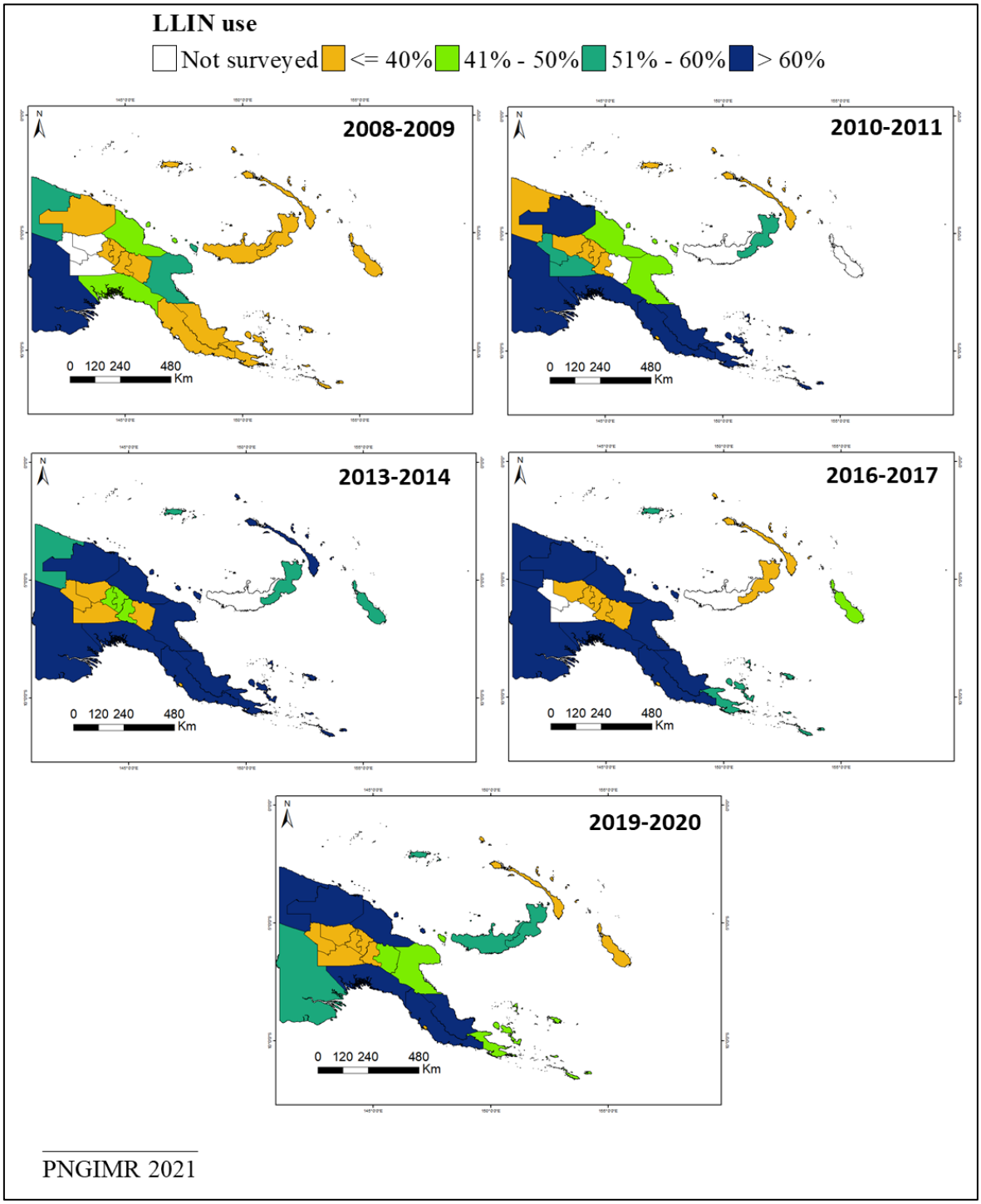
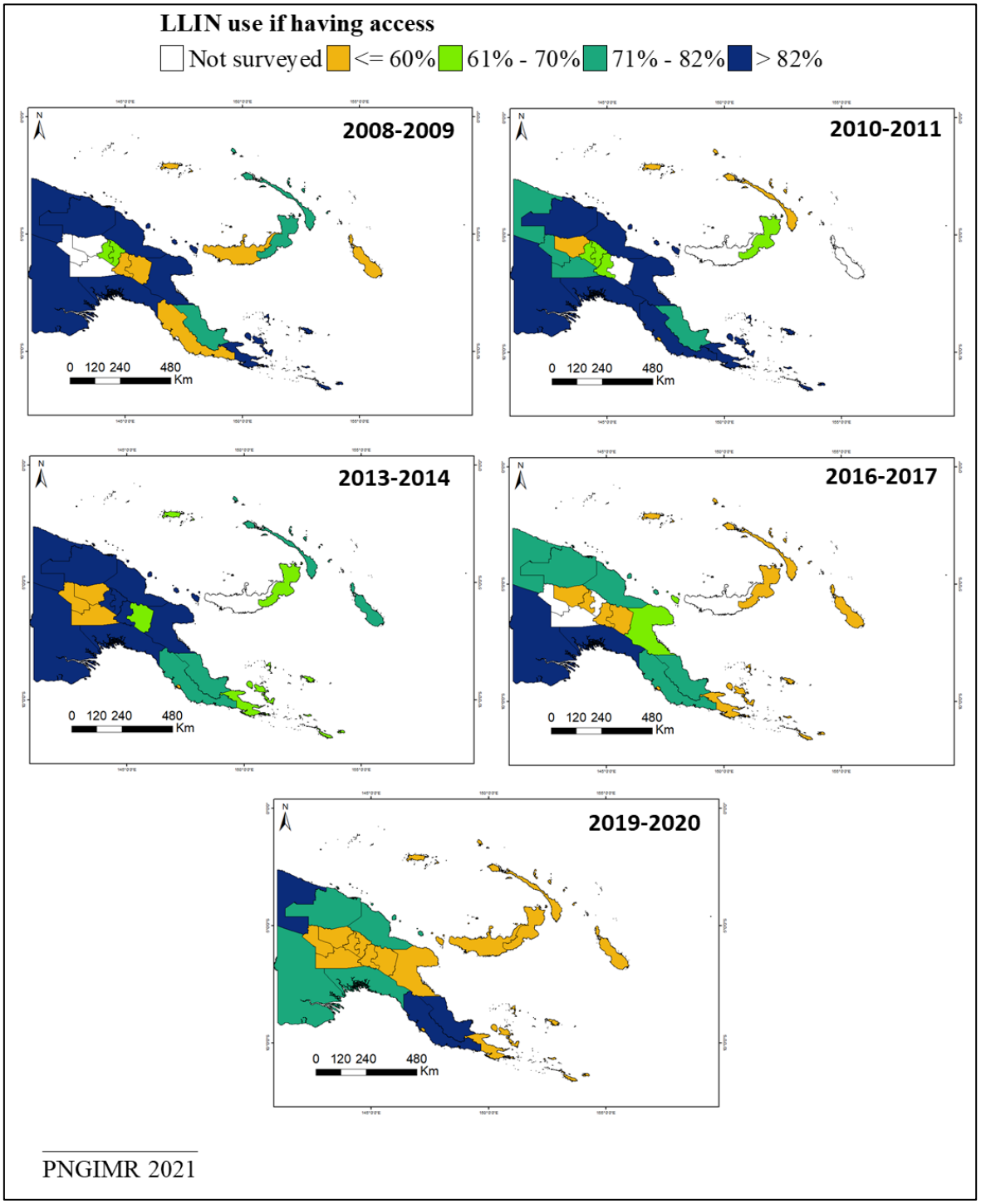
Trends in LLIN use, by province, Papua New Guinea (MIS: 2009, 2011, 2014, 2017 and 2020).

Percent of persons using a LLIN the night before the survey.



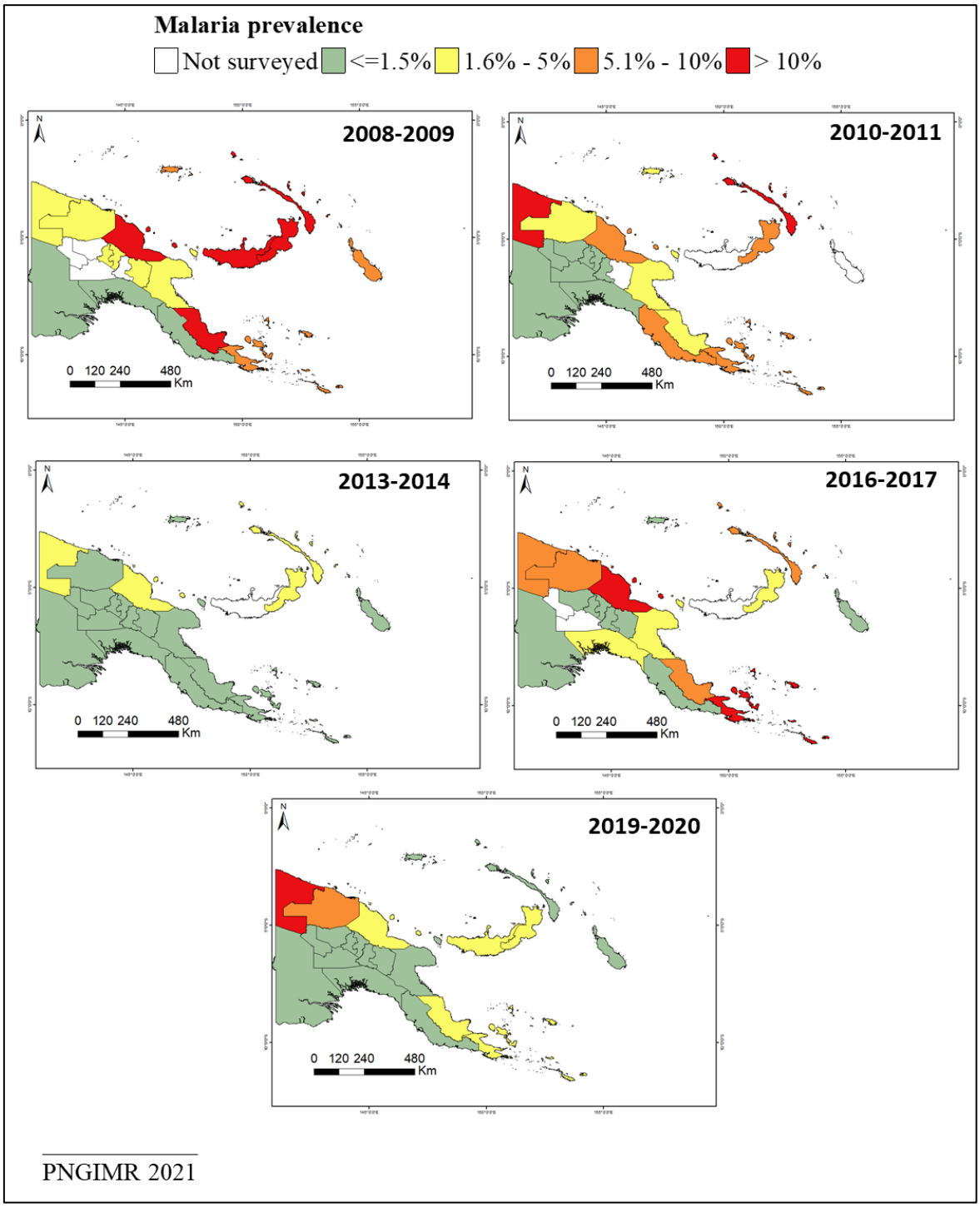
Trends in LLIN use among those with access, by province, Papua New Guinea (MIS: 2009, 2011, 2014, 2017 and 2020).

Percent of persons with access to LLIN using a LLIN the night before the survey.



Trends in malaria prevalence, by province, Papua New Guinea (MIS: 2009, 2011, 2014, 2017 and 2020).

Percent of persons infected with *Plasmodium* parasites (any species).



CONTENTS

1 INTRODUCTION

1.1 The PNG National Malaria Control Programme

Historically, malaria has been endemic throughout Papua New Guinea (PNG) with the exception of highland areas over 1600 m altitude where low temperatures prevent stable local transmission, though occasional epidemics have occurred [1, 2]. Four human pathogenic malaria parasites occur in PNG (*Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae* and *Plasmodium ovale*), transmitted by a variety of *Anopheles* mosquitoes that are adapted to distinct ecological niches [3].

The Global Fund to Fight AIDS, Tuberculosis and Malaria (The Global Fund) has financially supported the PNG National Malaria Control Programme (NMCP) since 2004. National distribution campaigns have provided long-lasting insecticidal nets (LLIN) to households since 2004 and malaria rapid diagnostic tests (mRDT) and artemisinin-based combination therapy (ACT) have been scaled up at health facilities throughout the country since late 2011 [4, 5]. In selected areas of the country, home-based management of malaria programmes were implemented and behaviour change campaigns supported the roll-out of preventative and curative interventions.

Since the inception of the Global Fund support, the PNG NMCP has been operating as a partnership with various organizations, including the National and Provincial Departments of Health, non-governmental organizations, the private sector and academic and research institutions. Under the funding arrangement that ended in December 2017, the Global Fund supported two Principal Recipients (PR), namely Rotarians Against Malaria (RAM), responsible for the distribution of LLIN, and Population Services International (PSI), responsible for implementing the home-based management of malaria programme and nation-wide behaviour-change communication.

The vision of the National Malaria Strategic Plan (2021-2025) is “A malaria-free Papua New Guinea by 2030” with short-term goals to reduce morbidity by 63% and mortality by 90% compared to 2019 and to eliminate malaria transmission in Bougainville. This vision is also in line with the goal of the Asia Pacific Leaders Malaria Alliance (APLMA), to eliminate malaria in PNG by 2030 [6].

A comprehensive monitoring and evaluation component has been established as part of the Global Fund grants. The Papua New Guinea Institute of Medical Research (PNGIMR) has been responsible for the overall independent evaluation of the outcomes and impact of the NMCP and provides scientific evidence of the country’s progress in scaling up control measures and reducing the malaria burden. The Swiss Tropical and Public Health Institute (Swiss TPH) has

been providing technical and scientific support to the evaluation programme. The PNGIMR evaluation assesses key outcome and impact indicators against targets defined in the Global Fund grant performance frameworks. It also aims to provide accurate, up-to-date information on different aspects of the changing malaria epidemiology in PNG. The evaluation plan developed by the PNGIMR combines several complementary data collection mechanisms aiming to simultaneously assess changes in intervention coverage as well as trends in malaria morbidity, mortality and transmission [7].

Epidemiological studies conducted by the PNGIMR demonstrated that the financial support from the Global Fund allowed PNG to make significant progress in malaria control, leading to an unprecedented decline in malaria between 2004 and 2014. Prevalence of malaria infection in villages below 1600 m altitude decreased from 11% in 2008/09 to less than 1% in 2013/14, as measured in subsequent national malaria indicator surveys (MIS) [8]. Incidence of test-confirmed cases in sentinel surveillance sites dropped by 85-90% immediately after the first country-wide distribution of LLIN and National Health Information System (NHIS) data confirmed a decline after the scale up of interventions; however, the latter is more difficult to interpret due to the scale-up of mRDTs over the same period [9, 10]. A subsequent MIS conducted in 2016/17 then found a resurgence in prevalence to 9.5% in areas below an altitude of 1600 m, coinciding with a decrease in available funding for malaria control and a decrease in the availability of ACT and mRDTs across PNG [11]. A recent study also found that LLINs distributed after 2013 had a low bio-efficacy against local *Anopheles* vectors [12].

1.2 Objectives of the Malaria Indicator Survey

The MIS 2019-2020 aimed to assess population coverage of malaria control interventions and prevalence of malaria infection in all age groups against targets in the Global Fund grant performance framework. The survey was designed to provide national and regional estimates of results that can be compared with results from surveys conducted in previous years.

1.3 Map of PNG

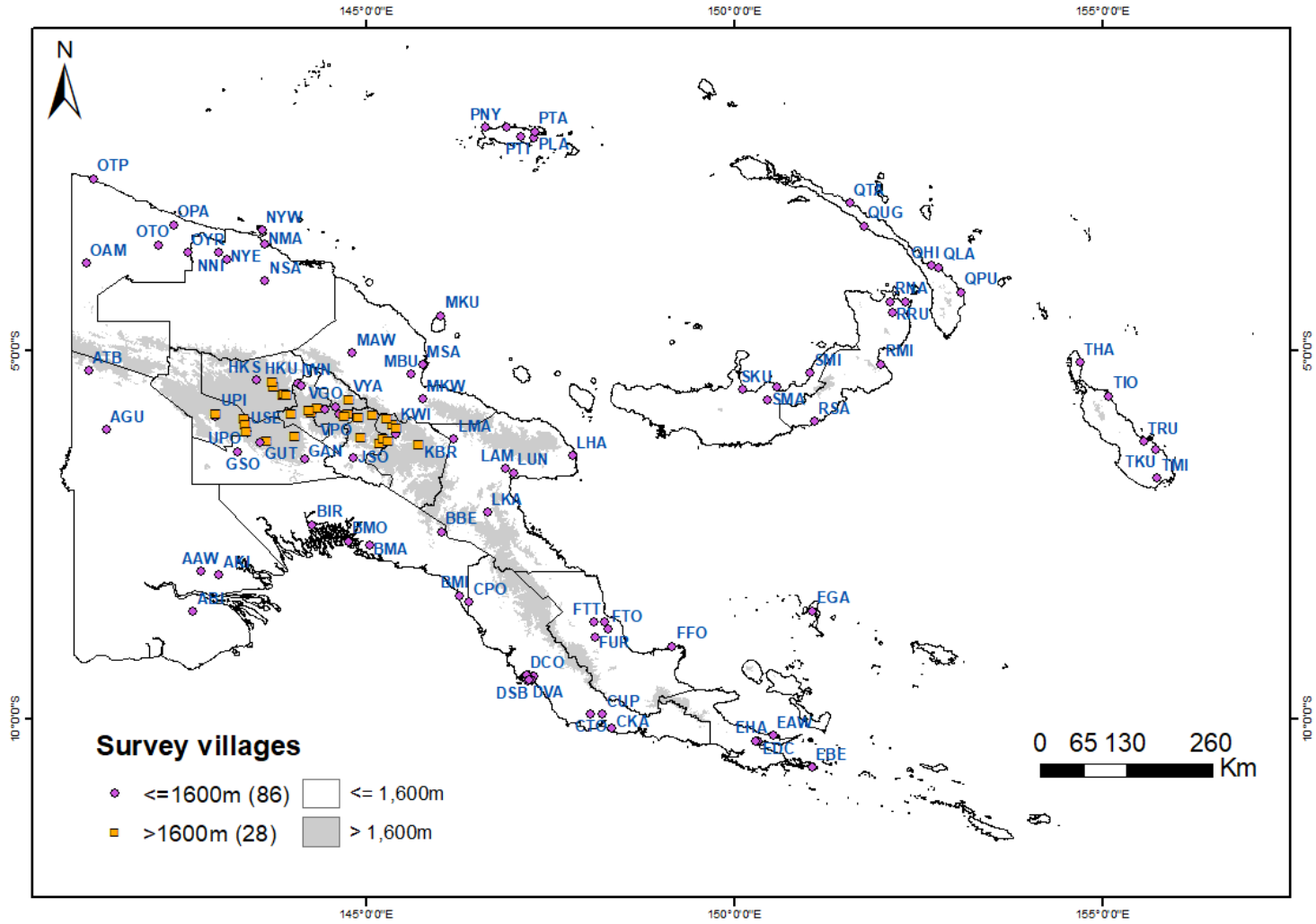


Figure 1: Map of Papua New Guinea showing provincial borders and the location of survey villages in two altitudinal strata

2 METHODOLOGY

2.1 Sample design

The sampling procedure was consistent with that of the MIS previously conducted in 2010/11, 2013/14 and 2016/17 in the frame of the NMCP evaluation [4, 8]. Selection of villages for the survey was based on a province-stratified multi-stage sampling approach using the 2011 National Census database of villages ("census units") as a sampling frame[1]. A random sample of five villages were selected per province using Stata 14.2 software (Stata Corp LLP, College Station, TX, USA). For each province, an equal number of villages were sampled as a back-up, excluding the originally sampled villages. Whenever a village was inaccessible due to major logistic or security constraints, it was substituted with a nearby back-up village. Within each selected village, a maximum of 30 households were then randomly sampled from a census of households established by the survey team leader upon arrival in the village and in consultation with local village representatives. A random number table was used for sampling the households. Within each selected household, an adult member acting as the household head, women aged 15-49 years and parents of recently sick children were eligible for interviews. All household members, however, were eligible for providing a finger-prick blood sample.

2.2 Questionnaires

Four structured electronic questionnaires were used during the survey and administered to the household head and/or other household members, as described below. They were adapted from the MIS template questionnaires [13] and included: 1) a household questionnaire; 2) a treatment seeking questionnaire; 3) a prevalence form; and 4) a women's questionnaire. Questionnaires were programmed in Open Data Kit (ODK) and administered using Android-based tablet computers. Paper copies of each questionnaire were available as back-up.

2.2.1 Household questionnaire

The household questionnaires were completed with the adult household heads of the randomly selected households. The information obtained covered the ownership and use of LLINs, exposure to behaviour change messages and other interventions, alongside demographic information of each household member as well as indicators of the household's socio-economic status.

[1] 2011 was the latest census for which village-level data was accessible.

2.2.2 Treatment seeking questionnaire

The treatment seeking questionnaire was completed with household members or caregivers (in the case of persons under the age of 15 years) who reported having experienced a febrile illness in the two weeks prior to the survey. The information obtained concerned the signs, symptoms and duration of the illness and subsequent treatment seeking behaviour, including sources of treatment, completion of a diagnostic test and types of any drugs administered.

2.2.3 Prevalence form

The prevalence form was completed with every available household member. The information obtained concerned treatment history (use of an antimalarial in the two months prior to the survey and any other medication at the time of survey), recent travel history and experience of fever within the past two days. In addition, consent to collect a blood sample for haemoglobin (Hb) and malaria testing was recorded alongside the results of the Hb measurement, the mRDT test result and the Hackett grade indicating the size of the spleen that was palpitated in children aged 2 to 9 years. Axillary temperature was measured by electronic thermometer and recorded. Any treatment administered by the research nurse or referral to a health facility was also recorded in the form.

2.2.4 Women's questionnaire

The women's questionnaire was administered to female members of the selected households aged between 15 to 49 years. The form was used to collect information about the total birth history of the women (including all live births and deaths of children) and coverage with Intermittent Preventive Treatment of malaria during pregnancy (IPTp).

2.3 Testing for malaria and anaemia

A trained nursing officer collected a finger-prick blood sample from each member of the selected households aged six months or older who were present at the time of the survey. From the finger-prick, one thick and one thin blood smear were prepared on the same glass slide for diagnosis of malaria by light microscopy, an mRDT (CareStart Malaria HRP2/pLDH Combo Test, Access Bio) was performed and a microcuvette sample was prepared to measure Hb levels using a handheld HemoCue Hb 201+ analyser (HemoCue, Ängelholm, Sweden). An mRDT was performed on all individuals reporting a fever in the past two days. In addition, mRDTs were performed on all household members for a real-time assessment of prevalence. All mRDT positive participants were treated for malaria by the nursing officer following the national treatment protocol [14].

Malaria diagnosis by light microscopy was performed at the PNGIMR in Madang following established procedures [15, 16]. Each slide was examined independently by two trained

microscopists, each viewing a minimum of 200 thick film fields. Slides with discordant results were examined by a third senior microscopist. A slide was considered positive for malaria if judged positive by at least two microscopists.

2.4 Survey implementation procedures

The MIS was conducted between October 2019 and October 2020 by six trained field teams working simultaneously at different sites. The Covid-19 pandemic resulted in the countrywide lockdown between March and April 2020, withdrawal of field teams and the suspension of the survey until May 2020. Furthermore, provincial health authorities continued to impose travel restrictions based on the local situation that also caused substantial delays in the timeline of the survey.

Each field team consisted of at least one nursing officer, one or more scientific officer and one or two research assistants. All members of the field teams received extensive training covering the project background, the survey protocol and methods, the survey instruments and blood sample collection techniques for the nursing officers who collected them.

The survey was conducted in 22 provinces including the National Capital District[2]. In West New Britain where a survey team of 5 PNGIMR staff disappeared without trace in 2011, the survey was implemented by previously trained local health staff under the supervision of a senior project manager with extensive experience from previous MIS rounds.

Prior to conducting the survey in a particular province, provincial health authorities were informed of the scope of the survey, the selected sites and the timing of the survey. A local health officer was requested to accompany the survey team. Upon arrival in the survey village, the team established contact with local village leaders or councillors in order to explain the purpose and procedures of the survey. After the community's approval to conduct the survey, with the assistance of the village leader or councillor, the team leader established a household list and performed random sampling of households using a random number table. Village locations and their elevation above sea level were recorded with a hand-held GPS device (Garmin). The survey teams spent on average 3 to 5 days in each village.

2.5 Data management and analysis

All data were collected electronically using the Open Data Kit (ODK) Collect application installed on tablet computers. All data were checked and finalized by the field team leader prior to submission. Completed and checked forms were then uploaded directly to the main server at

[2] For practical reasons, the pre-2012 province structure was still applied in this survey, i.e. Western Highlands and Jiwaka were considered as one province and Southern Highlands and Hela were considered as one.

the Swiss TPH in Basel, Switzerland, using the local mobile phone network (digicel). PNGIMR investigators had unlimited direct access to the uploaded data. ODK Briefcase v1.4.9 was used to download and export datasets for analysis in Stata/IC 14.2 (StataCorp LLC, College Station, TX, USA).

Aggregated national and regional level weighted proportions were calculated with logit transformed 95% confidence limits for all coverage indicators using the survey design command set in Stata (*svy*). Sampling weights were calculated as the inverse of an observation's probability of selection. To account for the staged sampling design, the overall probability of selection was calculated as a product of the selection probabilities at each sampling stage, i.e. the probability of a village being selected within a district and the probability of a household being selected within a village. Since all individuals of the sampled household were eligible, individual level weights equalled the weights of the households to which an individual belonged.

Mosquito net ownership and use indicators were calculated following standard procedures [17]. The proportion of the population with access to a LLIN was calculated by dividing the number of LLIN sleeping spaces (assuming two per LLIN) by the number of people sleeping in the household and then multiplied each household observation by the number of people in the household the previous night. The "proportion of people with access using a LLIN" was calculated by dividing the number of people using a LLIN by the total population with access (derived from applying the weighted proportion with access to the total population). This approach was required as the access indicator is calculated at a household level and does not allow allocation of access to individuals [18].

Measures of the prevalence of malaria infection and morbidity were age-standardized using the standard population for Asia given by the International Network for the Demographic Evaluation of Populations and Their Health (INDEPTH) [19]. To account for stratified sampling, national estimates were weighted, as described above. Considering the close association of altitude and malaria transmission, and to ensure comparability with previous surveys, prevalence measures are presented separately for villages below 1600 m altitude (national estimate) and for villages at 1600 m altitude and above.

Splenomegaly in children aged 2-9 years was defined as palpable spleen (Hackett grade 1-5) and anaemia following WHO definitions including age-specific cut-offs and altitude correction [20].

Binary variables were compared using $\chi 2$ tests and logistic regression, and non-normally distributed variables were compared using the non-parametric Mann–Whitney U test.

2.6 Ethical considerations

The study protocol was approved by the Institutional Review Board of the PNGIMR (IMR IRB No. 1808) and the Medical Research Advisory Committee of the National Department of Health (MRAC No. 15.21). In addition, the protocol was reviewed by the Ethics Committee of Northwestern and Central Switzerland (EKNZ, No. Req-2018-01063).

Prior to commencing work in a selected village, a community meeting was called to communicate the purpose of the study and questions were answered at individual and community levels. Villagers were informed about the confidentiality of the data, the purpose of the finger prick blood samples collected and permission was sought to conduct the survey in the particular village.

Participation in this survey was voluntary. All members from the selected households consented individually prior to participation. Written informed consent was obtained from the household head and verbal informed consent was obtained from each interviewee and from individuals or caretakers prior to the collection of a blood sample. Household members who refused to be finger-pricked were only administered the accompanying questionnaire.

Study participants diagnosed with malaria were offered treatment according to national guidelines free of charge. As a community service, PNGIMR nursing officers also provided treatment for minor ailments or referral advice to the general public in the survey villages.

3 RESULTS

3.1 Survey sample characteristics

This chapter presents details of the survey population by location and basic demographic and socioeconomic characteristics of households.

Information on the socioeconomic situation from the MIS provides context for interpreting demographic and health indicators, can furnish an approximate indication of the representativeness of the survey and hence help in the extrapolation of survey findings. Specific socioeconomic characteristics are useful for understanding the factors that affect use of health services and other health behaviours related to malaria control. In addition, socioeconomic indicators shed light on the general living conditions of the population of PNG.

The socioeconomic indicators presented in this report include information on the sources of drinking water, sanitation, housing characteristics, ownership of durable goods, and composition of the household population.

3.1.1 Survey sample

The survey was carried out in 114 villages located in 22 provinces. Seventy-seven (67.5%) villages were located below 1200 m altitude, 9 (7.9%) villages between 1200 and 1599 m, and 28 (24.5%) villages at 1600 m or above (Figure 1). Fifteen (13.2%) villages in the lowest altitude category were considered to be part of an urban area.

The survey was completed in 3,299 households comprising a total *de jure* population of 17,546 usual residents. The *de facto* population of individuals present in the household the night prior to the survey amounted to 17,313.

> The *de jure* population are all persons who are usual residents of the selected households, whether or not they stayed in the household the night before the interview. The *de facto* population includes all persons who stayed in the selected households the night before the interview (whether usual residents or visitors). All calculations are based on the *de facto* population, unless specified otherwise.

Of the *de facto* population, 12.8% were children below 5 years of age and 48.9% were female. The survey also included 126 women aged 15-49 years who reported to be pregnant and 134 household members (incl. 26 children <5 years) who had experienced a febrile illness episode in the past 2 weeks. A total of 13, 339 blood samples were collected for diagnosis of malaria by mRDTs and light microscopy.

The distribution of surveyed households and of the population by location, altitude, age group, and sex is shown in Table A1, Appendix A.

The population pyramid in Figure 2 shows the study population distribution by sex and by 5-year age groups. The broad base of the pyramid is indicative of a young population, typical of developing countries, with a high fertility rate and low life expectancy. The similar length of the lowest two age groups could suggest a recent reduction in birth rate or a recent increase in child mortality. There appears to be a certain imbalance in the study population between males and females in children (more males) and young adults (more females).

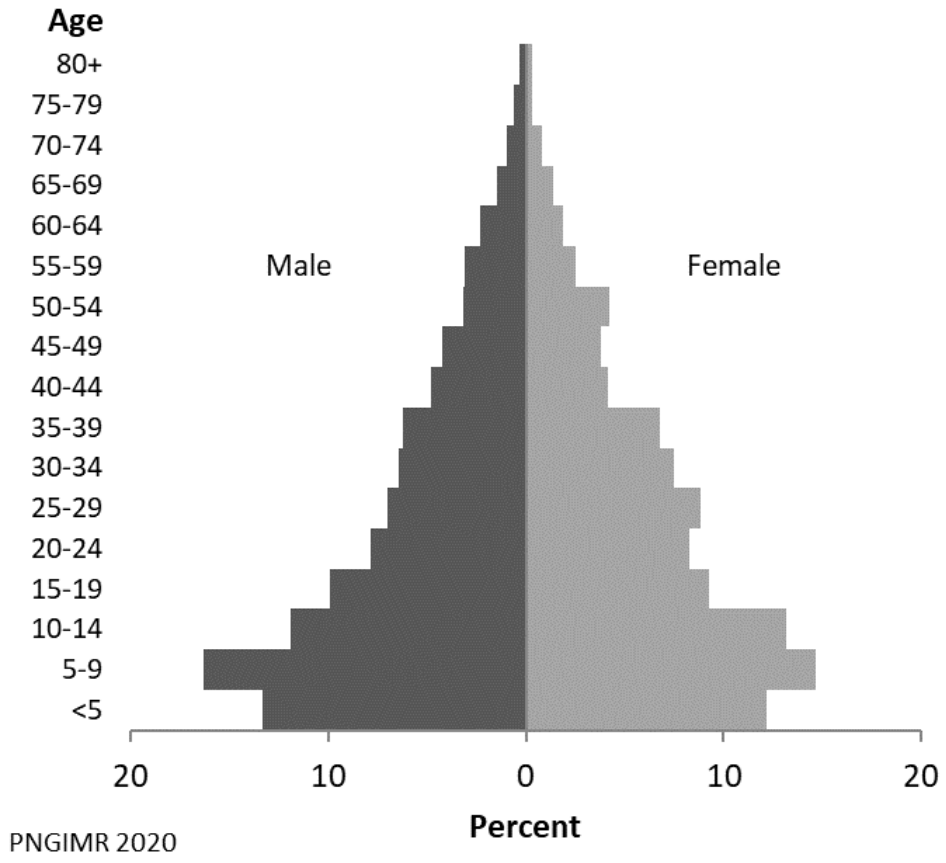


Figure 2. Population pyramid
Percent distribution of the household population by sex and five-year age group

3.1.2 Water and sanitation

Improved sources of drinking water include piped water, public taps, standpipes, protected wells and springs, boreholes, and rainwater.

Across PNG, only 46.9% of households used an improved source of drinking water, while 52.2% of households relied on surface water such as rivers, streams, lakes and ponds and open wells. Urban and rural households relied on different sources of drinking water; 45.6% of households in urban settings had piped water available in their house or in the neighbourhood compared to 13.7% of rural households. Conversely, 54.9% of rural households used surface water for drinking compared to 9.7% of urban households (Table 1). Unimproved sources of drinking water, such as untreated surface water, are prone to contamination with organic and chemical pollutants originating for example from human and animal waste or from pesticide use in agriculture.

Table 1. Household drinking water

Percent distribution of households and de jure population by source of drinking water, according to residence, Papua New Guinea, 2019-2020

	Residence[1]		
Characteristic	Rural	Urban	Total
Main source of drinking water			
Improved source			
Piped into dwelling	4.5	35.8	11.5
Piped into neighborhood / public tap	9.2	9.8	9.3
Protected well (public/private)	2.4	0.0	1.9
Water tank/rainwater	20.5	37.1	24.2
Unimproved source			
Open well (public/private)	8.4	3.4	7.3
Surface water (river, stream, lake, pond, etc.)	54.9	9.7	44.8
Other source	0.1	4.2	1.0
Number of households	2726	573	3299

[1] Weighted proportions

Improved toilet facilities include toilets of the following types: own or shared pit latrines with slab, own or shared flush toilet and composting toilets[3].

The most common toilet facilities that were used across PNG were open pit latrines, which were used by 60.6% of households. Open defecation was still practiced in 7.8% of households. Urban households had better access to their own flush toilets than rural households (40.3% vs. 3.5%) (Table 2).

Table 2. Household sanitation facilities

Percent distribution of households and de jure population by type of toilet/latrine facilities, according to residence, Papua New Guinea, 2019-2020

	Residence[1]		
Type and location of toilet/latrine facility*	Rural	Urban	Total
Improved sanitation			
Shared pit latrine with slab	2.2	2.3	2.2
Own pit latrine with slab	2.8	5.1	3.3
Shared flush toilet	1.5	3.0	1.8
Own flush toilet	3.5	40.3	11.7
Unimproved sanitation			
Shared open pit latrine	12.9	8.5	11.9
Own open pit latrine	67.3	37.5	60.6
Closet over sea/river	0.8	0.0	0.6
Open defecation (no facility/bush/field)	9.1	3.3	7.8
Number of households	2726	573	3299

[1] Weighted proportions
* Multiple answers were allowed

Unsafe water, inadequate sanitation and hygiene contribute to the death of some 842,000 people globally every year, diarrhoea represents 58% of those deaths. Approximately 361,000 of these deaths occur in children aged under five years [21]. While 91% of the world's population are by now using an improved source of drinking water [22], the majority of people in PNG appear to belong to the 663 million people worldwide who still lack access to improved water sources. The majority of rural households still lack access to improved sanitation facilities that prevent the likely contact with human waste and reduces the transmission of typhoid, cholera and other diseases. The United Nation's Sustainable Development Goal 6 is to ensure access to safe water and sanitation for all [23].

[3] Other surveys usually consider any type of shared toilets as unimproved sanitation.

3.1.3 Housing characteristics and household possessions

The survey collected data on the characteristics of houses people live in such as access to electricity, flooring, wall and roofing material and types of fuel used for cooking. The information on these characteristics, in addition to other information on the ownership of household durable goods, provides an indication of the socioeconomic status of households and of the living conditions of the population. Some specific information may be relevant for other health indicators.

The majority of households (76.4%) had no access to electricity through the power grid or from a generator (Table 3). The most commonly used method of lighting in rural areas was lamps/lanterns powered by batteries or fuel/kerosene (41.9%). The majority of rural households (42.4%) had access to solar power.

Firewood, coconut shells, and similar materials were the predominant fuel used for cooking in urban and rural areas (88.1%). Electricity and gas were primarily used in urban areas (27.4% and 11.4%, respectively). Exposure to smoke produced from solid fuels is a potential health hazard.

The majority of houses across PNG are constructed with unprocessed natural materials. Floors and outer walls of most houses in rural areas are made from wood, palm leaves, bamboo or different types of grass. Processed materials such as polished wood, plywood, masonite, cement, tiles, bricks or iron sheets are primarily found as building materials in urban areas. The majority of houses (87.8%) in urban areas have corrugated iron roofs, while in rural areas, roughly equal proportions have roofs made of thatched grass (30.2%), palm/sago leaves (27.5%), and corrugated iron (41.6%).

Table 4 provides details on possession of selected durable household goods, means of transport and livestock. The majority of households in urban and rural areas owned a mobile phone (92.1% and 68.5%, respectively). Radio and television were found primarily in urban areas; only 15% of rural households owned a radio and 9.5% a television. Ownership of a mobile phone, radio or television may be of practical importance for the planning of mass communication campaigns in the context of promoting malaria control intervention uptake.

Households across PNG do not generally own any means of transport. The most commonly found means of transport was a canoe/boat without motor (11%) and bicycle (10.2%). In urban areas, there were higher proportions of households with bicycles (22.5%) and cars or trucks (17.7%). Means of transport may be important in the case of a sick household member requiring transport to a health facility. Ownership of any means of land transport may, in many parts of PNG, be a mere function of the (non-) existence of usable roads.

Table 3. Housing characteristics

Percent distribution of households by housing characteristics, according to residence, Papua New Guinea, 2019-2020

	Residence[1]		
Housing characteristic	Rural	Urban	Total
Lighting			
None	2.7	0.3	2.2
Candle	0.6	0.3	0.5
Lantern/lamp	2.7	5.4	3.3
Battery lantern	39.3	10.1	32.8
Solar power	42.4	17.6	36.8
Electricity	11.3	66.0	23.6
Pressure lamp/ Coleman	0.1	0.3	0.1
Other	1.0	0.0	0.8
Flooring material			
Earth/sand	28.7	8.9	24.3
Palm/bamboo/grass	29.2	6.0	24.0
Wood	34.1	54.9	38.8
Polished wood	2.5	21.7	6.8
Cement/tiles	5.5	7.9	6.1
Other	0.0	0.5	0.1
Outer wall material			
Bamboo / pitpit	55.2	13.8	45.9
Sago, palm leaves	17.0	6.8	14.7
Wood	11.2	25.3	14.4
Plywood	2.7	17.2	6.0
Masonite/Fibro	3.9	16.9	6.8
Cement or bricks	1.0	2.1	1.2
Iron sheets	8.5	16.8	10.4
Other	0.6	1.0	0.7
Roofing material			
Thatched grass	30.2	5.3	24.6
Sago palm leaves	27.5	5.8	22.6
Corrugated iron	41.6	87.8	51.9
Wood planks	0.1	0.0	0.1
Cement	0.1	0.0	0.1
Other	0.6	1.1	0.7
Cooking fuel			
Firewood	95.4	59.2	87.2
Small twigs/tree branches/coconut shell	1.0	0.8	0.9
Kerosene	0.3	1.2	0.5
Gas	2.0	11.4	4.1
Electricity	1.4	27.4	7.2
Other	0.0	0.0	0.0
Number of households	**2,726**	**573**	**3,299**

[1] Weighted proportions

The most commonly kept livestock animals were pigs (43.5%) and chickens (27.3%), both being more frequently kept by rural households. In rural households in the Highlands and the Islands, pigs were far more commonly found than chickens (71% vs. 22.3% and 42.7% vs. 33.4%, respectively), while in the Southern and the Momase Regions, chickens were more common than pigs (data not shown in table).

Table 4. Household possessions

Percentage of households possessing various household effects, means of transportation, and livestock/farm animals, according to residence, Papua New Guinea, 2019-2020.

	Residence[1]		
Possession	Rural	Urban	Total
Household effects			
Radio	15.0	31.9	18.8
Television	9.5	53.6	19.4
Mobile phone	68.5	92.1	73.8
Non-mobile telephone	0.8	7.1	2.2
Refrigerator	4.6	39.9	12.5
Means of transport			
Bicycle	6.6	22.5	10.2
Motorbike	0.6	7.5	2.2
Car/truck	2.6	17.7	6.0
Dugout, canoe (without motor)	11.6	8.8	11.0
Boat with a motor	1.9	8.6	3.4
Ownership of farm animals[1]			
Chicken	29.1	21.4	27.3
Cassowaries	0.7	7.2	2.2
Goats and sheep	3.8	7.7	4.7
Pigs	50.1	20.9	43.5
Cows	0.7	7.3	2.2
Number of households	**2,726**	**573**	**3,299**

[1] Weighted proportions

3.2 Malaria prevention: mosquito net coverage

This chapter provides results on the population coverage with mosquito nets, particularly long-lasting insecticidal nets (LLIN)[4]. Mosquito net coverage was assessed for all households (N = 3,299) and use was assessed for all *de facto* households members (N = 17,546).

The following targets were defined in the Global Fund grant performance framework:	
Proportion of population that slept under an insecticide-treated net the previous night (O-1a)	**60%**
Proportion of children under five years old who slept under an insecticide-treated net the previous night (O-1b)	**65%**
Proportion of pregnant women who slept under an insecticide-treated net the previous night (O-1c)	**65%**
Proportion of population with access to an LLIN within their household (O-2)	**75%**
Proportion of population using an LLIN among the population with access to a LLIN (O-3)	**85%**
Proportion of households with at least one insecticide-treated net for every two people (O-6)	**65%**

3.2.1 Mosquito net ownership

Across PNG, 71.4% (95% CI 67.3, 75.3) of households owned at least one mosquito net and 69.3% (95% CI 65.1, 73.3) at least one LLIN. The average number of nets per household was 1.9 (95% CI 1.8, 2.1) for any type of net and 1.8 (95% CI 1.7, 2) for LLIN. At least one LLIN per two people who stayed in the household the night before the survey was available in 55.1% (95% CI 51.5, 58.7) of households (Table 5 & Table B1, Appendix B).

There was a significant difference in mosquito net and LLIN ownership between Momase and the Islands Regions, where over 85% of households owned a LLIN, and the Southern and Highlands Regions, where only 75.2% and 49.4% of households owned a LLIN ($P < 0.001$), respectively. Households in villages located at ≥ 1600 m altitude were less likely to own a LLIN than households in lower-lying villages (77.4% vs. 45.2%, $P < 0.001$). There was no significant difference in ownership between surveyed urban and rural locations. LLIN ownership was below the national average in the Highlands and Southern Regions.

[4] All insecticide treated nets distributed through Global Fund supported campaigns are LLINs.

Table 5. Household ownership of mosquito nets

Percentage of households with at least one mosquito net (treated or untreated) and long-lasting insecticidal net (LLIN); average number of nets and LLINs per household; and percentage of households with at least one net and LLIN per two persons who stayed in the household the night prior to the survey, according to background characteristics, Papua New Guinea, 2019-2020

Background characteristics	Percentage of households with at least one mosquito net		Percentage of households with at least two LLIN	Average number of nets per household		Percentage of households with at least one LLIN for every two persons*	Number of households with at least one person*
	Any mosquito net	LLIN		Any mosquito net	LLIN		
Residence							
Rural	71.9	69.8	55.6	1.9	1.8	55.5	2,721
Urban	69.9	67.7	53.5	2.0	1.9	53.9	572
	P = 0.773	P = 0.759	P = 0.782	P = 0.546	P = 0.5744	P = 0.729	
Altitude							
<1600m	78.7	77.4	63.1	2.1	2.1	54.4	2,473
≥1600m	49.7	45.2	31.1	1.2	1.1	58.7	820
	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P = 0.555	
Region							
Southern	76.9	75.2	61.5	2.3	2.3	59.4	819
Highlands	53.1	49.4	34.5	1.2	1.1	55.0	1,179
Momase	86.9	86.4	73.5	2.4	2.4	51.3	603
Islands	86.9	85.9	70.0	2.3	2.2	57.7	692
	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P = 0.512	
Total	**71.4**	**69.3**	**55.1**	**1.9**	**1.8**	**55.1**	**3,293**
(95% CI)	(67.3,75.3)	(65.1,73.3)	(51.1,59.1)	(1.8, 2.1)	(1.7, 2)	(51.5,58.7)	

* who stayed in the household last night

Target: The 85% target of household ownership of at least one LLIN was not reached on a national level but was in 9/22 surveyed provinces. The target was missed in Milne Bay, Sandaun, Morobe and Western provinces by a small to moderate margin; and in all surveyed Highlands provinces, NCD and Bougainville by a wider margin (Table B1, Appendix B).

Trend: Household ownership of nets and LLINs declined in 2019/20 compared to a steady trend during the previous four surveys. Similarly, the proportion of households owning one net per two people has decreased, indicating a decline in the number of nets in net-owning households (Figure 3).

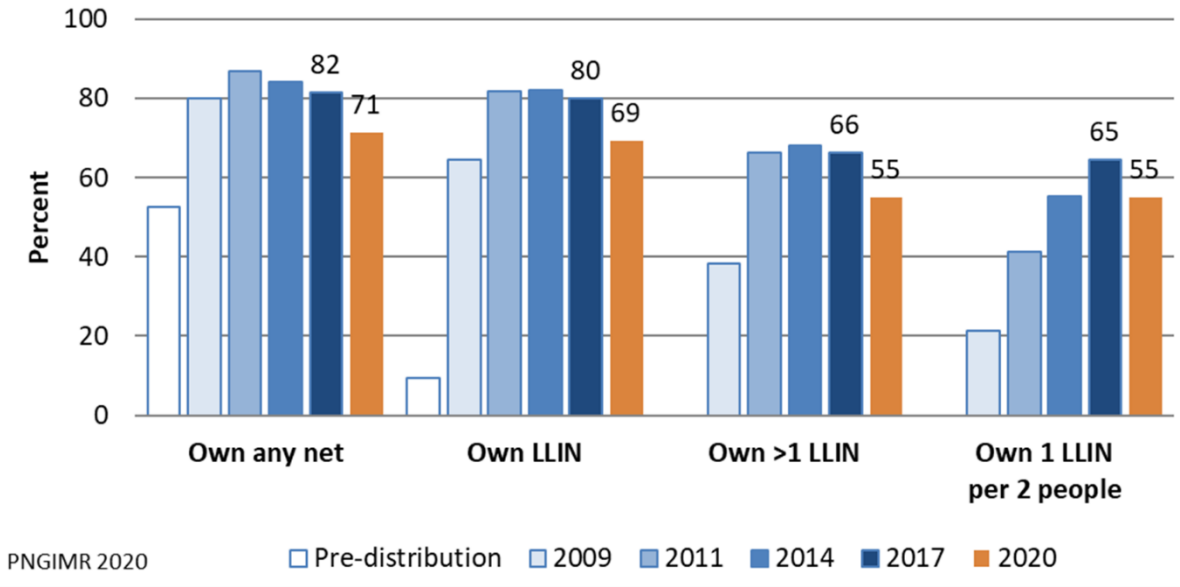


Figure 3. Trend in ownership of mosquito nets.
Pre-distribution estimate and national survey results 2009-2020. Data source: PNGIMR surveys.

3.2.2 Mosquito net access and use

In this context, access to an LLIN is defined as the percentage of the *de facto* household population who could sleep under a LLIN if each LLIN in the household was used by up to two people. For example, in a household with 10 household members and five nets, 100% of the members have access, whereas in a household with 10 members and two nets, only 40% (4 out of 10) of members have access.

Across PNG, 57.4% (95% CI 53, 61.8) of the population had access to a LLIN. Access was significantly lower in the Highlands (39.5%) than in the other regions ($P < 0.001$) (Table 6). Access was below the national average in all Highlands provinces and half of the Southern provinces, Sandaun, Morobe and Bougainville (Table B2, Appendix B). Using these numbers an "access gap" can be calculated, which reflects the number of people requiring additional LLINs[5]. Based on the predicted 2020 population of PNG, an estimated 4.2 million people were without access to a LLIN requiring approximately 2.1 million LLINs to fill this gap (Table 7).

[5] The calculation of the "access gap" is a snapshot at one point in time and does not take into consideration new LLINs distributed and the attrition of LLINs following the date of the survey.

Table 6. Access to a LLIN

Percentage of the de facto population with access to a LLIN in the household, according to background characteristics, Papua New Guinea, 2019-2020

Background characteristics	Percentage of the *de facto* population with access to a LLIN[1]
Residence	
Rural	57.9
Urban	55.8
	P = 0.7634
Altitude	
<1600m	64.3
>=1600m	36.6
	P < 0.001
Region	
Southern	63.5
Highlands	39.5
Momase	71.9
Islands	72.5
	P < 0.001
Total	**57.4**
95% CI	(53, 61.8)

[1] Percentage of *de facto* household population who could sleep under a LLIN if up to two people used each a LLIN in the household.

Table 7. Access to LLIN gap

Population with access to a LLIN, "gap" of people without access and number of LLINs required to fill the "access gap" based on two people per LLIN

Region	Population*	Percent with access to a LLIN	Population with access to a LLIN	Access gap	Number of LLINs required
Southern	1,787,150	63.5	1,440,366	346,784	173,392
Highlands	4,280,378	39.5	2,503,949	1,776,429	888,215
Momase	2,323,200	71.9	2,012,037	311,163	155,582
Islands	1,350,133	72.5	870,009	480,124	240,062
Total	**9,740,861**	**57.4**	**5,591,254**	**4,149,607**	**2,074,803**

* 2020 Population projection

Across PNG, 44.3% (95% CI 39, 49.8) of the population slept under a mosquito net and 43.6% (95% CI 38.2, 49.2) under a LLIN the night before the survey. The small difference between

the use of any type of net and the use of a LLIN is a reflection that non-LLINs have become less common after multiple rounds of free LLIN distributions. In households that owned at least one LLIN, 62.1% (95% CI 56.2, 67.6) of the people used such a net (Table 8 and Table B3, Appendix B). Among the population with access to a LLIN in their household (based on the access indicator), 76% of the people slept under one the previous night (Table 9). Use among those with access to a LLIN was lowest in the Highlands (58.5%) and the Islands (64.4%) Regions.

The highest LLIN use was recorded in the Momase Region (62.3%), followed by the Southern (51.2%), Islands (46.7%) and Highlands (23.1%) Regions. The difference in LLIN use between villages located at ≥1600 m altitude (18.7%) and lower-lying villages (50.6%) was significant ($P < 0.001$). LLIN use by the general population was below the national average in the Highlands provinces, NCD, New Ireland, Morobe and Bougainville.

Differences in LLIN use between rural (45.4%) and urban areas (38.4%) were not found to be statistically significant ($P = 0.35$).

Table 8. Use of mosquito nets by persons in the household

Percentage of the *de facto* household population who slept the night before the survey under a mosquito net (treated or untreated) and under a long-lasting insecticidal net (LLIN); and among the *de facto* household population in households with at least one LLIN, percentage who slept under a LLIN the night before the survey, according to background characteristics, Papua New Guinea, 2019-2020

	Household population			Household population in households with at least one LLIN	
Background characteristic	Percentage who slept under any mosquito net last night	Percentage who slept under a LLIN last night	Number of persons	Percentage who slept under a LLIN last night	Number of persons
Age					
<5	54.0	52.7	2,210	73.5	1,621
<1	66.6	64.1	265	81.6	204
1-4	59.9	58.7	1,945	72.4	1,417
5-9	49.7	49.0	2,676	67.9	1,945
10-14	42.8	42.2	2,175	60.1	1,580
15-19	37.4	36.6	1,657	55.8	1,160
20+	41.9	41.2	8,595	58.8	6,091
	P<0.001	P<0.001		P<0.001	
Sex					
Female	46.0	45.2	8,845	64.1	6,326
Male	42.6	42.0	8,468	60.0	6,071
	P = 0.0065	P = 0.0109		P = 0.0017	
Residence					
Rural	45.9	45.4	13,866	63.8	10,099
Urban	39.7	38.4	3,447	56.8	2,298
	P = 0.4062	P = 0.351		P = 0.2637	
Altitude					
<1600m	51.1	50.6	3,594	66.0	10,697
>=1600m	20.4	18.7	3,719	39.5	1,700
	P<0.001	P<0.001		P<0.001	
Region					
Southern	52.1	51.2	4,868	68.0	4,054
Highlands	24.1	23.1	5,525	45.5	2,634
Momase	62.9	62.3	3,481	74.5	2,843
Islands	46.7	46.7	3,439	53.5	2,866
	P<0.001	P<0.001		P= 0.0046	
Overall	**44.3**	**43.6**	**17,313**	**62.1**	**12,397**
(95% CI)	(39, 49.8)	(38.2,49.2)		(56.2, 67.6)	

Table 9. Use of LLIN among those with access

Percentage of the *de facto* household population who slept the night before the survey under a long-lasting insecticidal net (LLIN) among the *de facto* household population that had access to a LLIN within their household, Papua New Guinea, 2019-2020

Background characteristic	Percentage of the *de facto* population with access to a LLIN[1]	Percentage who slept under a LLIN last night	Number of persons	Number of persons with access to a LLIN	Number of persons who slept under a LLIN last night	Percentage who slept under a LLIN among those with access[2]
Region						
Southern	63.5	51.2	4,868	3,090	2,490	80.6
Highlands	39.5	23.1	5,525	2,181	1,276	58.5
Momase	71.9	62.3	3,481	2,503	2,168	86.6
Islands	72.5	46.7	3,439	2,494	1,607	64.4
Overall	**57.4**	**43.6**	**17,313**	**9,938**	**7,548**	**76**

[1] Percentage of *de facto* household population that could sleep under a LLIN if each LLIN in the household were used by up to two people.
[2] Calculation of indicator according to Kilian A *et al.* Malar J 2013, 12:314 [16].

Young children were more likely to use an LLIN than adolescents and adults. Among children <5 years of age, 52.7% (95% CI 46.4, 58.9) slept under a LLIN the night prior to the survey (Table 10 and Table B4, Appendix B) amounting to 73.5% (95% CI 68.2, 78.3) in households that owned at least one LLIN. The lowest LLIN usage was recorded in the age group 15-19 years (36.6%).

Table 10. Use of mosquito nets by children

Percentage of the *de facto* household population who slept the night before the survey under a long-lasting insecticidal net (LLIN) among the *de facto* household population that has access to a LLIN within their household, Papua New Guinea, 2019-2020

	Children under age 5 in all households			Children under age 5 in households with at least one LLIN	
Background characteristic	Percentage who slept under any mosquito net last night	Percentage who slept under an LLIN last night	Number of children	Percentage who slept under an LLIN last night	Number of children
Sex					
Female	55.7	54.3	1,079	75.5	797
Male	52.4	51.1	1,131	71.7	824
	P = 0.291	P = 0.27		P = 0.149	
Residence					
Rural	55.1	54.3	1,786	75.0	1,327
Urban	50.7	47.9	424	69.0	294
	P = 0.581	P = 0.443		P = 0.385	
Altitude					
<1600m	60.0	59.1	1,780	76.4	1,407
>=1600m	29.2	26.3	430	54.6	214
	P < 0.001	P < 0.001		P = 0.003	
Region					
Southern	61.9	59.9	622	80.1	513
Highlands	31.9	30.2	653	57.2	337
Momase	72.4	71.4	454	84.2	374
Islands	58.0	58.0	481	66.9	397
	P < 0.001	P < 0.001		P = 0.015	
Overall	54	52.7	2,210	73.5	1,621
(95% CI)	(47.9, 60)	(46.4, 58.9)		(68.2,78.3)	

Note: Table is based on children who stayed in the household the night before the interview.

Female household members were significantly more likely to use a LLIN than their male counterparts (P < 0.01). Differences between male and females were most prominent in late adolescents and adults (Figure 4). Among pregnant women aged 15-49 years, 55.2% (95% CI 45.3, 64.7) slept under a LLIN the night prior to the survey, amounting to 73.6% (95% CI 62.7, 82.2) if they lived in a household owning at least one LLIN (Table 11). Pregnant women living in urban areas or in places with < 1600 m of altitudes were significantly more likely to sleep under a LLIN the night before the survey. Only about one-third of the pregnant women who lived in highlands slept under a mosquito net, but this number increased up to 51.8% among pregnant women living in household with at least one LLIN.

Table 11. Use of mosquito nets by pregnant women

Percentage of pregnant women age 15-49 who, the night before the survey, slept under a mosquito net (treated or untreated) and under a long-lasting insecticidal net (LLIN); and among pregnant women age 15-49 in households with at least one LLIN, percentage who slept under a LLIN the night before the survey, according to background characteristics, Papua New Guinea, 2019-2020

	Among pregnant women age 15-49 in all households			Among pregnant women age 15-49 in households with at least one LLIN	
Background characteristic	Percentage who slept under any mosquito net last night	Percentage who slept under a LLIN last night	Number of pregnant women	Percentage who slept under a LLIN last night	Number of pregnant women
Residence					
Rural	44.8	43.7	153	65.9	94
Urban	76.9	76.6	42	85.5	32
	P =0.001	P < 0.001		P = 0.022	
Altitude					
<1600m	60.4	60.3	162	79.9	106
>=1600m	32.3	28.4	33	42.5	20
	P= 0.025	P = 0.012		P = 0.009	
Region					
Southern	69.9	69.3	49	73.9	44
Highlands	28.0	26.0	58	51.8	27
Momase	81.8	81.8	29	89.3	25
Islands	55.4	55.4	59	73.9	30
	P < 0.001	P < 0.001		P = 0.065	
Education					
No education	41.9	37.0	23	68.9	12
Primary	58.4	57.9	40	68.3	30
Secondary	54.0	54.0	84	73.6	55
More than secondary	63.5	63.5	48	80.1	29
	P= 0.688	P = 0.544		P = 0.871	
Wealth quintile					
Lowest	65.7	61.0	24	97.2	13
Second	36.6	36.6	35	57.0	21
Middle	38.1	38.1	39	59.9	26
Fourth	66.6	66.0	32	76.2	26
Highest	59.6	59.6	65	74.1	40
	P= 0.177	P = 0.233		P = 0.195	
Total	**55.2**	**54.4**	**195**	**73.6**	**126**
(95% CI)	(45.3,64.7)	(44.4,64.0)		(62.7,82.2)	

Note: Table is based on women who stayed in the household the night before the interview.

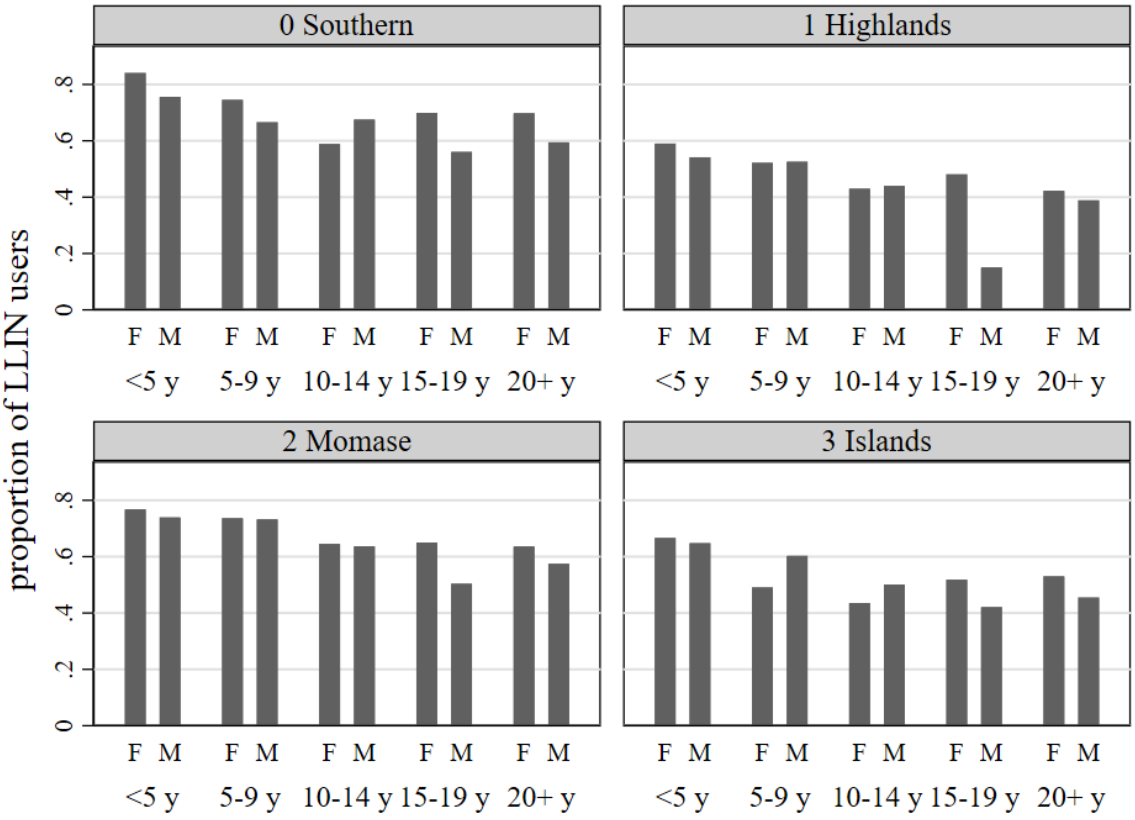


Figure 4. Use of mosquito nets according to sex, age group and region

Target: On a national level, the targets of 75% LLIN access, 60% LLIN use among all age groups, 65% use in children <5 years and pregnant women, and 85% use among those with access were missed in the general population. However, in households owning at least one LLIN, all usage targets were exceeded. The LLIN usage target for all age groups was missed in sixteen provinces: NCD, Milne Bay, Morobe, Western, the Highlands and Islands Provinces, while only six provinces in the Southern and Momase Regions reached the target (Appendix B). The situation was similar for children <5 years; however, in the Western, ENB and Manus Provinces, coverage in this age group was above 65%. The pregnant women target was reached on a regional level in Southern and Momase Regions; due to the small sample size, provincial measures were not calculated.

Trend: Overall, access, usage of any net and LLINs in the general population, in children <5 years of age and in pregnant women declined in 2020 after being largely stable between 2014-2017 (Figure 5).

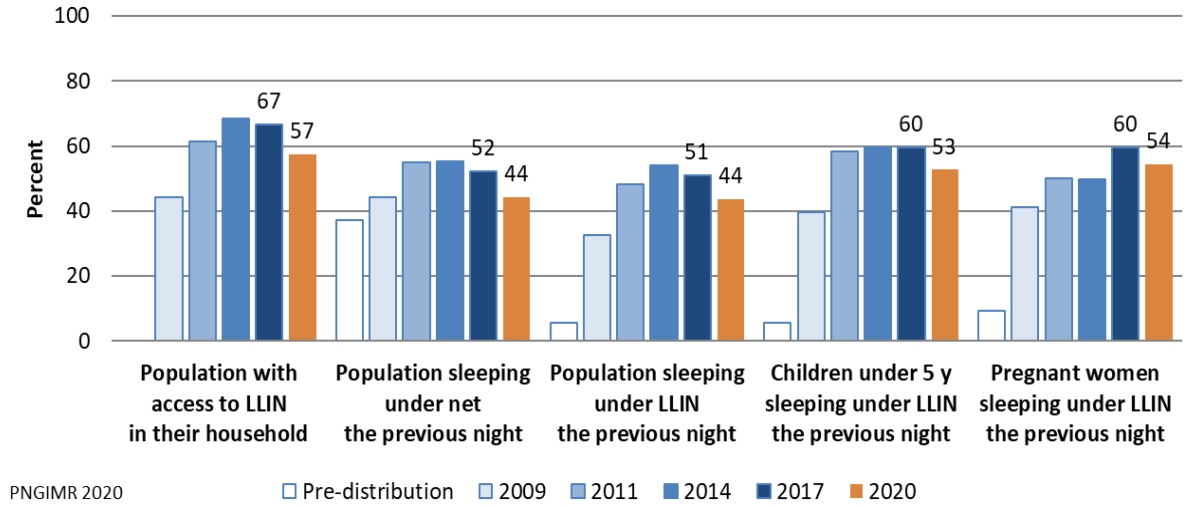


Figure 5. Trends in access to and use of mosquito nets
Pre-distribution estimate and national survey results 2009-2020. Data source: PNGIMR surveys.

3.2.3 Use of intermittent preventive treatment (IPTp)

The use of intermittent preventive treatment (IPTp) by women during their last pregnancy is defined in this context as the percentage of women aged 15-49 years with a live birth in the 2 years preceding the survey who, during the pregnancy that resulted in the last live birth, received three or more doses of SP (e.g. Fansidar®). The receipt of at least three doses of SP serves as a proxy measure of coverage.

Across PNG, 23% (95% CI 16.3, 31.5) of the population of women between the ages of 15-49 years had reported receiving three doses of SP or more during their last pregnancy. The rural subpopulation had significantly less access to IPTp compared to urban women, 16.6% and 46%, respectively ($P<0.05$). Further, the use of three doses of IPTp was significantly higher in areas below 1600 m compared to higher altitudes, 27% and 5.1%, respectively. By region, use of IPTp was significantly lower in the Highlands (9.9%) than in the other regions ($P < 0.05$). Women lacking any education were less likely to use IPTp during their pregnancy compared with those having some education ($P<0.05$). The proportions of women using IPTp were higher when they received less than three doses of SP indicating low levels of adherence to recommendations (Table 12).

Table 12. Use of intermittent preventive treatment (IPTp) by women during pregnancy

Percentage of women age 15-49 with a live birth in the 2 years preceding the survey who, during the pregnancy that resulted in the last live birth, received one or more doses of SP (e.g. Fansidar®), received two or more doses of SP, and received three or more doses of SP, according to background characteristics, Papua New Guinea 2019-2020

Background characteristic*	Percentage who received one or more doses of SP	Percentage who received two or more doses of SP	Percentage who received three or more doses of SP	Number of women with a live birth in the 2 years preceding the survey
Residence				
Urban	63.9	58.2	46.0	133
Rural	24.7	21.6	16.6	547
	P = 0.002	P = 0.005	P = 0.016	
Altitude				
<1600m	39.4	34.5	27	561
>=1600m	16.9	14.2	5.1	119
	P=0.006	P=0.018	P=0.002	
Region				
Southern	48.7	46.2	36.7	181
Highlands	20.3	17.6	9.9	177
Momase	36.4	32.6	27.5	154
Islands	41.5	29.4	19	168
	P = 0.063	P = 0.060	P = 0.042	
Education				
No education	22.3	18.1	3.7	111
Primary	32.5	29.2	27.6	184
Secondary	39.7	35.9	27.3	332
More than secondary	45.2	29.1	20.7	53
	P = 0.170	P = 0.235	P = 0.018	
Wealth quintile				
Lowest	22.9	21.9	20.5	124
Second	29.1	28.2	23.3	123
Middle	17.4	16.1	10.4	128
Fourth	30.0	23.7	20.5	143
Highest	60.2	53.5	37.5	162
	P < 0.001	P = 0.005	P = 0.139	
Total (95% CI)	**35.5** (27.6-44.2)	**30.8** (23.2-39.6)	**23** (16.3-31.5)	**680**

* Weighted proportions

3.3 Malaria prevention: exposure to malaria messages

Among all heads of the surveyed households, 5.2% (95% CI 3.9, 7.0) reported receiving information about malaria in the past three months. There were significant regional differences; household heads in the Islands Region most frequently reported having received information about malaria (10.6%) (Table 13). The most frequently reported source of information were health workers. It is not possible to establish whether this exposure occurred during a health facility visit or during outreach activities (Figure 6).

Table 13. Media exposure to malaria messages

Percentage of household heads who have seen or heard a message about malaria in the past 3 months, Papua New Guinea, 2019-2020

Background characteristic	Information from any source[1]	Number of household heads
Residence		
Rural	5.3	2,726
Urban	4.8	573
	P = 0.077	
Altitude		
<1600m	5.5	2,479
>=1600m	4.1	820
	P = 0.379	
Region		
Southern	5.3	821
Highlands	4.9	1,180
Momase	3.0	606
Islands	10.6	692
	P = 0.065	
Total	**5.2**	**3,299**
(95% CI)	(3.9, 7.0)	

[1] Weighted proportions

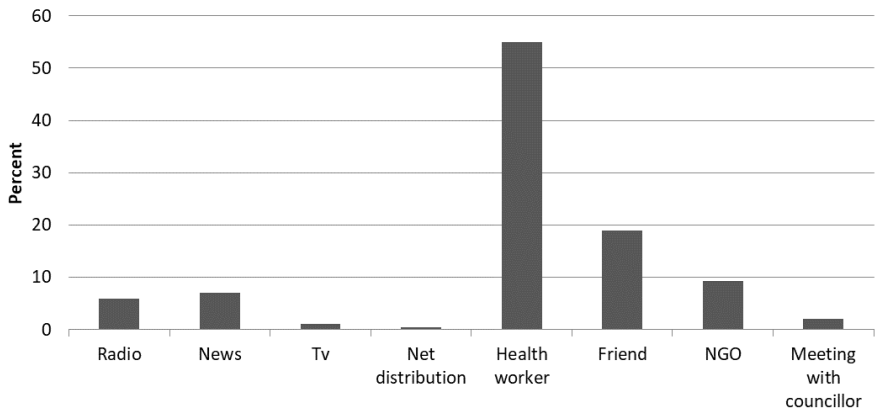


Figure 6. Sources of malaria information among household heads who received information in the past 3 months. More than one answer was allowed.

3.4 Prevalence of malaria infection

This chapter presents prevalence results of malaria infection in the general population assessed in household members above 6 months of age. Two tests were performed to assess malaria infection among tested persons: light microscopy and mRDT.
Malaria microscopy results are presented overall and by *Plasmodium* species: *P. falciparum* (*P.f.*), *P. vivax* (*P.v.*), *P. malaria*, and mixed infections of *P.f.* and *P.v.* Differences in malaria prevalence observed between the mRDT and microscopy results are expected. Microscopic detection of malaria parasites depends on the observation of stained parasites under a microscope, whereas the diagnosis of malaria by mRDT relies on the interaction between a parasite antigen present in the blood and an antibody on the mRDT. Hence, results of microscopy reported in this chapter are more indicative of a current infection, whereas mRDT results (provided in the appendix) should be interpreted with caution as they may represent a past infection (or a false-positive result). Province and village-levels results using microscopy and mRDT are presented in Appendix C.

The following target was defined in the Global Fund grant performance framework:	
Parasite prevalence: Proportion of children aged 6-59 months with malaria infection (I-5)	**1.5%**

Overall, a total of 13,858 individuals were tested by both microscopy and mRDT while 62 persons were tested only by mRDT. The brand of mRDT (CareStart Malaria Pf/PAN (HRP2/pLDH) Ag Combo RDT) used in the survey had a low sensitivity (73.2%) but high specificity (97.3%) of compared to the double-read microscopy. The mRDT detects both the *P. falciparum*-specific, histidine-rich protein-2 (HRP-2), that can persist in the blood for up to a month or more after parasite clearance, and the pan malaria-specific antigen (pLDH) which is expressed by all malaria parasites but relatively short-lived after an effective treatment [24-26]. The performance of mRDTs compared to light microscopy as a gold standard in this survey is described in Appendix D.

Below 1600 m altitude, 2.1% (95% CI 1.31, 3.39) of the surveyed people were infected with malaria parasites. In highland areas at 1600 m and above, only 0.1% (95% CI 0.01, 0.28) of the population tested positive. On a national level, infections with *P. falciparum* were more common than *P. vivax* in areas below 1600m, while the latter was the only detected malaria parasite in highland areas (Table 14).

Among children <5 years living in areas <1600 m altitude, 2.4% (95% CI 1.29, 4.58) tested positive using light microscopy, while there was no malaria infection in the 242 children surveyed in highland villages at 1600 m and above (Table 15).

Malaria prevalence was the highest in the Momase Region (4.1%) and lowest in the Highlands Region (0.03%) (Table 16). No infection was found in villages between 1200 and 1600 m

altitude but due to the population distribution in PNG [1] the survey sample at these altitudes was small. Overall, infections were significantly less common in urban than in rural areas.

West Sepik (Sandaun) stood out as the province with the highest prevalence, reaching 10.6%, followed by East Sepik (8.6%), Oro (3.7%), East New Britain (2.9%), Madang (2.5%), Milne Bay (2.2%) and West New Britain (1.6%) (Tables C1 and C2, Appendix C).

Table 14. Prevalence of malaria infection

Percentage of persons above 6 months of age classified by light microscopy as having malaria, in villages <1600 m altitude, ≥1600 m altitude, and overall, Papua New Guinea, 2019-2020

	Malaria prevalence according to microscopy[1]					
Altitude	Any species	*P. falciparum*	*P. vivax*	*P. malariae*	Mixed *P.f.* & *P.v.*	Number of persons
<1600 m (95% CI)	**2.1** (1.31, 3.39)	**1.6** (0.84, 2.82)	**0.6** (0.38, 0.83)	**0.04** (0.01, 0.16)	**0.04** (0.01, 0.11)	**11,208**
≥1600 m (95% CI)	**0.1** (0.01, 0.28)	**0.0**	**0.1** (0.01, 0.28)	**0.0**	**0.0**	**2,650**
Overall (95% CI)	**1.8** (1.13, 2.68)	**1.3** (0.73, 2.19)	**0.5** (0.34, 0.68)	**0.03** (0.01, 0.11)	**0.03** (0.01, 0.08)	**13,858**

[1]Age-standardized and weighted

Table 15. Prevalence of malaria infection in children <5 years of age

Percentage of children between 6 months and 5 years of age classified by light microscopy as having malaria, in villages <1600 m altitude, ≥1600 m altitude, and overall, Papua New Guinea, 2019-2020

	Malaria prevalence according to microscopy[1]					
Altitude	Any species	*P. falciparum*	*P. vivax*	*P. malariae*	Mixed *P.f.* & *P.v.*	Number of persons
<1600 m (95% CI)	**2.4** (1.29, 4.58)	**1.7** (0.87, 3.12)	**0.8** (0.29, 2.1)	**0.04** (0.004, 0.35)	**0.03** (0.004, 0.3)	**1,326**
≥1600 m (95% CI)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**242**
Overall (95% CI)	**2.1** (1.17, 3.62)	**1.4** (0.79, 2.47)	**0.7** (0.27, 1.6)	**0.03** (0.005, 0.24)	**0.03** (0.004, 0.2)	**1,568**

[1]Weighted

Table 16. Prevalence of malaria by background characteristics*

Percentage of persons classified in two tests as having malaria, using light microscopy and RDTs, Papua New Guinea, 2019-2020.

Background characteristic	Malaria prevalence according to microscopy						Malaria prevalence according to RDT[1]	
	Any species	*P. falciparum*	*P. vivax*	*P. malariae*	Mixed *P.f.* & *P.v.*	Number of persons	RDT positive	Number of persons
Altitude in meters								
<1200	2.5	1.9	0.7	0.0	0.0	10,071	7.1	10,114
1200 to 1599	0.0	0.0	0.0	0.0	0.0	1,137	0.1	1,141
1600+	0.1	0.0	0.059	0.0	0.0	2,650	0.5	2,665
	P = 0.08	P = 0.6	P = 0.1	P = 0.9	P = 0.9		P=0.009	
Residence								
Rural	2.1	1.6	0.5	0.0	0.0	11,274	4.9	11,322
Urban	0.6	0.3	0.3	0.0	0.0	2,584	4.8	2,598
	P = 0.005	P = 0.0005	P = 0.2	P = 0.4	P = 0.3		P=0.65	
Region								
0 Southern	1.1	0.5	0.7	0.0	0.1	3,855	2.9	3,870
1 Highlands	0.03	0.0	0.03	0.0	0.0	4,183	0.3	4,202
2 Momase	4.1	3.2	0.9	0.0	0.1	3,060	9.2	3,086
3 Islands	1.4	1.0	0.2	0.2	0.0	2,760	10.4	2,762
	P < 0.001	P < 0.001	P < 0.001	P = 0.006	P = 0.8		P < 0.001	
Age in years								
<5	2.1	1.4	0.7	0.0	0.0	1,568	4.16	1,580
<1	0.0	0.0	0.0	0.0	0.0	41	0.0	42
1-4	2.1	1.5	0.7	0.0	0.0	1,527	4.3	1,538
5-9	2.9	1.2	1.6	0.0	0.0	2,216	8.2	2,218
10-14	2.7	2.4	0.2	0.0	0.0	1,651	6.1	1,664
15-19	3.2	2.3	0.9	0.2	0.2	1,166	7.6	1,168
20-39	1.5	1.3	0.2	0.0	0.0	4,247	3.8	4,269
40+	0.5	0.3	0.2	0.0	0.0	3,010	2.6	3,021
	P < 0.001	P = 0.014	P < 0.001	P = 0.3	P = 0.4		P < 0.001	

Table 16. Prevalence of malaria by background characteristics*

Percentage of persons classified in two tests as having malaria, using light microscopy and RDTs, Papua New Guinea, 2019-2020.

Background characteristic	Malaria prevalence according to microscopy						Malaria prevalence according to RDT[1]	
	Any species	*P. falciparum*	*P. vivax*	*P. malariae*	Mixed *P.f.* & *P.v.*	Number of persons	RDT positive	Number of persons
Sex								
Female	1.3	0.9	0.4	0.0	0.0	7,444	4.6	7,468
Male	2.2	1.7	0.6	0.0	0.0	6,414	5.3	6,452
	P < 0.001	P < 0.001	P = 0.24	P = 0.26	P = 0.9		P=0.06	
Women 15-49 years								
Not pregnant	1.5	1.2	0.3	0.1	0.0	3,566	3.7	3,574
Pregnant	0.0	0.0	0.0	0.0	0.0	177	4.5	177
	P = 0.49	P = 0.58	P = 0.6	P = 0.8	P = 0.77		P = 0.79	

* All weighted, and all age standardized except age groups. P indicates probability value of difference between categories using Pearson's chi-squared test.

[1]RDT = malaria Rapid Diagnostic Test

From the 114 villages surveyed, there were no malaria infections detected in 71 villages (62%) and no infections detected in children <5 years in 98 villages (86%). Villages in which infections were found exclusively in older children or adults may be less likely to have ongoing local transmission. For example, in the Highlands Region, malaria infected individuals were found in only two villages out of 40 villages, while no infection was detected in the children under five years tested in 39 villages, suggesting imported cases rather than local transmission in most villages (Table C4, Appendix C).

At the other end of the spectrum, twelve villages with prevalence values >5% were found in all regions, except in the Highlands. In West Sepik Province, most of the surveyed villages had >10% prevalence in adults and similar values in young children (up to 34.8% in children <5 years in the village of Amini). In the other non-Highlands provinces, there appeared to be pockets of high prevalence in children and adults, some villages with infections only in older children and adults, and some villages with no infections at all (Table C2, Appendix C).

Prevalence was higher in males than in females (Table 16) but the difference was only statistically significant in particular age groups in the Momase Region (Figure 7). In children below five years of age living in the villages surveyed <1600 m altitude, there was no statistically significant difference between the overall prevalence in female (1.8%) and male (3.0%) children (P > 0.05) (Table C3, Appendix C). In women aged 15-49 years, prevalence in women reporting to be pregnant was lower than non-pregnant women but the difference was not statistically significant (Table 16).

Malaria species composition

P. falciparum, including mixed infections of P.f/P.v., was the dominant species on both a national and regional level (Tables 14-16). However, individual villages with a notably higher prevalence of *P. vivax* than *P. falciparum* were found in the following provinces: Gulf (1), Central (2), NCD (1), Milne Bay (2), Oro (2), Enga (2), Morobe (1), East Sepik (1), West Sepik (1), New Ireland (2), New Ireland (2), East New Britain (1), and Bougainville (1). In five of these villages, *P. vivax* was also dominant in children <5 years (Table C4, Appendix C).

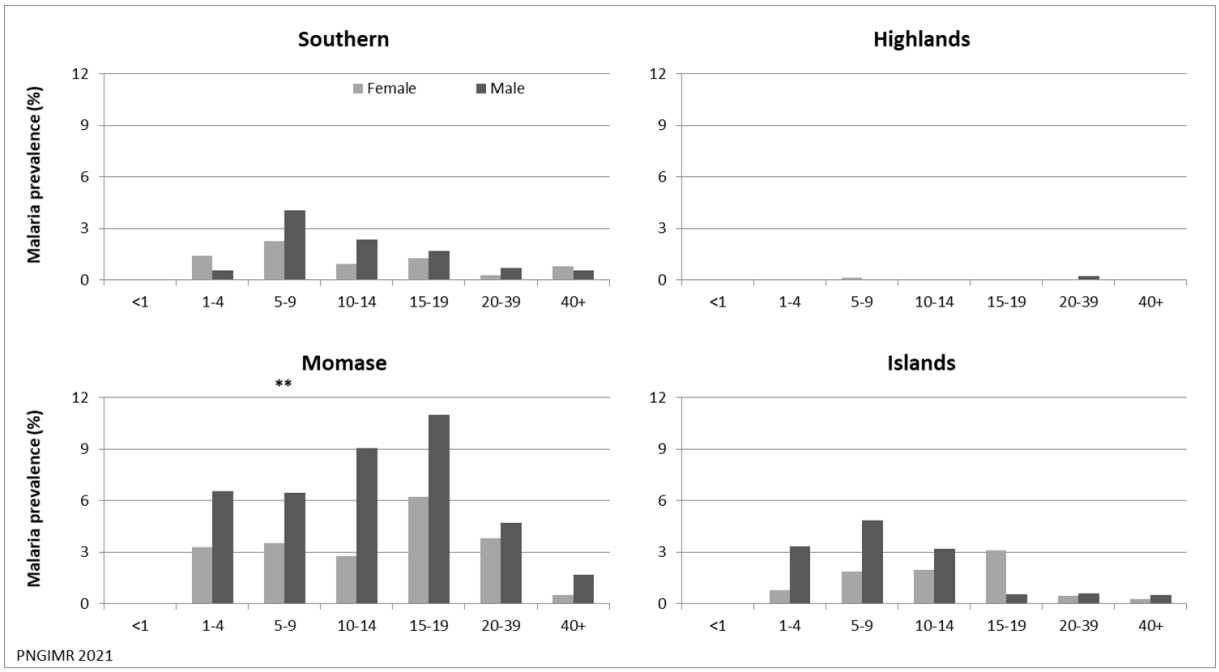


Figure 7. Malaria prevalence by age group, sex and region
Statistically significant differences are indicated by ** ($p < 0.01$).

Target: The target of 1.5% prevalence in children <5 years of age was not reached on a national or regional level in areas <1600 m altitude where malaria conditions are favourable for transmission. On a provincial level, the target was met in all provinces in the Highlands Region, in 4/6 provinces in the Southern Region (Western, Central, NCD and Milne Bay), in 2/4 provinces in the Momase Region (Morobe and Madang) and in 2/5 provinces in the Islands Region (Manus and Bougainville) (Table C2, Appendix C).

Trend: Malaria prevalence has decreased across PNG since the spike revealed in the previous national survey in 2016/17 (Figure 8). The decrease is most pronounced in Momase and Southern Regions (Figure 9). On a national level, the prevalence of infection with malaria parasites in the general population was not lower in 2019/20 (2.1%) than the seen record in 2013/14 (0.9%) [27]. This measure does not yet account for infections with low-level parasitaemia, which are common in PNG [13], and all of which need to be treated effectively with a full course of an efficacious drug in order to interrupt malaria transmission.

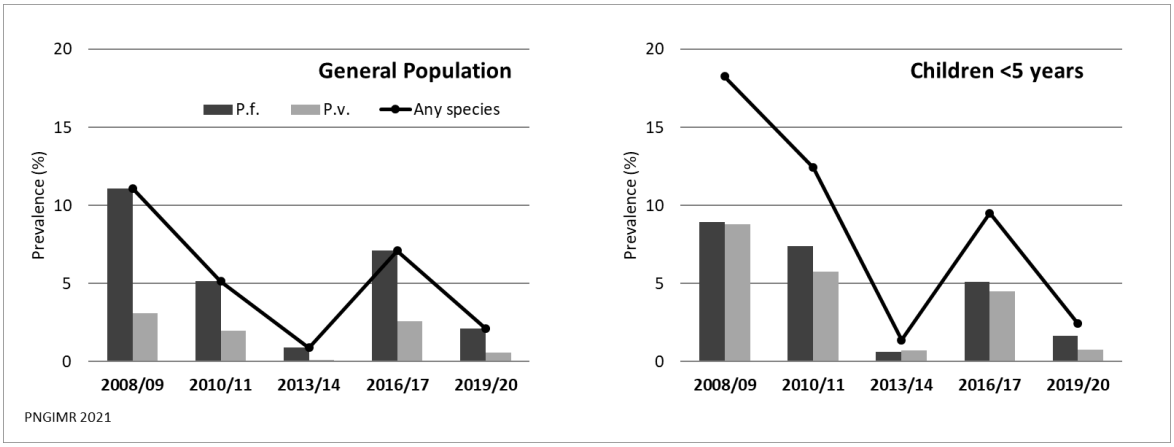


Figure 8: Country-wide malaria parasite prevalence in the general population and in children <5 years of age (< 1600 m altitude).

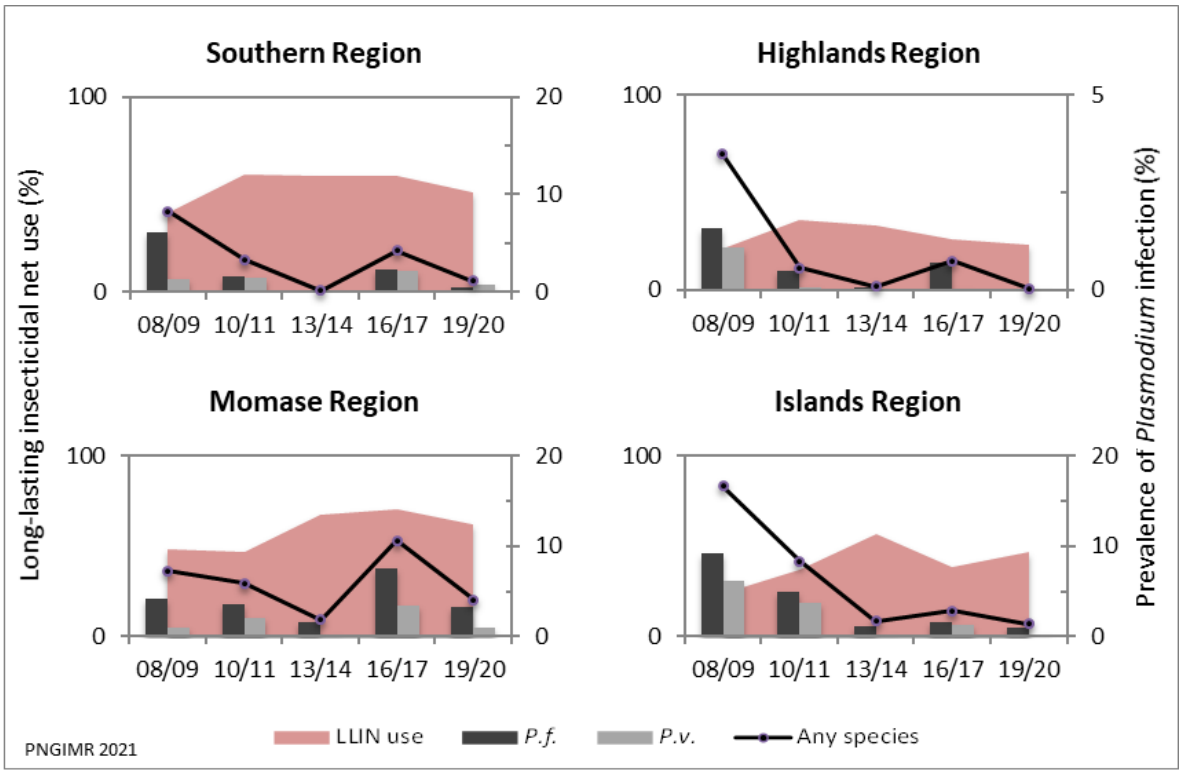


Figure 9: LLIN use and malaria parasite prevalence in the general population by region
Note: right y-axes (prevalence) have different scales.

3.5 Prevalence of malaria-associated morbidity

This chapter presents selected indicators of morbidity that are generally associated with malaria, including fever, anaemia and splenomegaly. Anaemia is multifactorial [28], influenced by factors such as infectious diseases, nutrition or genetic blood disorders, whereas splenomegaly has been associated with chronic malaria infection.

A recent fever was reported by 2.9% (95% CI 2, 4.4) of all household members and 2% (95% CI 1.2, 3.2) had measured axillary temperature >37.5°C on the day of the survey. Reported fever was most common in children 5-9 years while axillary temperature >37.5°C was often in children 15-19 years (Table 17). Fever was more common in rural than in urban areas and less common with increasing altitude.

Anaemia was detected in 55.8% (95% CI 50.8, 60.7) of all household members and 5.7% (95% CI 3.6, 8.9) had severe anaemia. Anaemia was less common in the Highlands Region than in the lowlands. Both anaemia and severe anaemia prevalence decreased with altitude and age, see Table 17.

Of all children 2-9 years of age, 0.6% (95% CI 0.2, 2.4) had an enlarged spleen (splenomegaly). Splenomegaly was only detected in the provinces of East New Britain (19.7%), East Sepik (2.1%), Sandaun (1%) and West New Britain (0.7%) (Table E1, Appendix E).

Table 17. Fever, anaemia, severe anaemia, and splenomegaly

Percentage of persons with reported fever, acute fever, haemoglobin below the WHO threshold for anaemia and severe anaemia, and splenomegaly, according to background characteristics, Papua New Guinea, 2019-2020

Background characteristic	Reported fever	Number of persons	Acute fever[1]	Number of persons	Anaemia[2]	Severe anaemia[2]	Number of persons	Splenomegaly[3]	Number of children
Altitude (m)									
<1200	2.6	10,068	1.7	10,068	67.5	5.6	10,068	1.6	2,594
1200 to 1599	1.6	1,137	1.5	1,137	37.6	2.0	1,137	0.0	266
1600+	1.5	2,650	1.0	2,650	34.7	0.9	2,650	0.0	544
Residence									
Rural	2.4	11,272	1.7	11,272	58.8	4.6	11,272	1.4	2,806
Urban	1.8	2,583	1.0	2,583	56.8	3.7	2,583	0.2	598
Region									
Southern	1.6	3,855	0.9	3,855	64.3	4.8	3,855	0.0	956
Highlands	1.4	4,181	1.1	4,181	36.3	1.4	4,181	0.0	909
Momase	3.9	3,060	2.3	3,060	79.6	7.9	3,060	0.7	792
Islands	2.9	2,759	2.2	2,759	62.5	4.7	2,759	4.8	747
Age in years									
<5	2.8	1,567	1.6	1,567	70.1	8.0	1,567	0.5	1,223
<1	2.5	40	2.5	40	75.0	25.0	40	0.0	0
1-4	2.8	1,527	1.6	1,527	69.9	7.5	1,527	0.5	1,223
5-9	3.0	2,215	2.0	2,215	68.1	4.3	2,215	1.8	2,181
10-14	2.1	1,651	1.5	1,651	60.1	2.9	1,651		
15-19	2.8	1,166	2.6	1,166	56.6	3.4	1,166		
20-39	2.1	4,246	1.7	4,246	51.3	3.1	4,246		
40+	2.0	3,010	0.6	3,010	55.9	4.0	3,010		
	P =0.13		P < 0.001		P < 0.001	P < 0.001		P = 0.244	
Sex									
Female	2.2	7,442	1.5	7,442	60.8	4.6	7,442	1.3	1356
Male	2.5	6,413	1.5	6,413	56.0	3.5	6,413	1.4	1499
	P = 0.26		P = 0.955		P < 0.001	P = 0.001		P = 0.887	
Total	**2.9**	**13,855**	**2.0**	**13,855**	**55.8**	**5.7**	**13,855**	**0.6**	**3,404**
(95% CI)	(2, 4.4)		(1.2, 3.2)		(50.8, 60.7)	(3.6, 8.9)		(0.2, 2.4)	

[1] Acute fever was defined as axillary temperature >37.5°C. [2] Anaemia and severe anaemia were defined according to WHO recommendations, which include age-specific cut-offs and altitude corrections (WHO 2011). [3] Splenomegaly was defined as a palpable spleen (i.e. Hackett grade 1 to 5) in children aged 2-9 years.

3.6 Treatment-seeking for fever

This section presents details on the treatment-seeking behaviour of the 272 household members reporting an episode of fever in the two weeks preceding the survey. Sixteen (5.9%) of these cases reported at least one symptom of severe disease (incl. difficulty breathing, convulsions or a loss of consciousness).

The following target was defined in the Global Fund grant performance framework:

Proportion of children under five years old with fever in the last two weeks for whom advice or treatment was sought	**65%**

For 60.3% (95% CI 41.4, 76.5) of fever cases in the general population and for 56.6% (95% CI 25.5, 83.2) of fever cases in children <5 years of age, advice or treatment was sought outside the person's home (Table 18). Due to the small number of cases, most comparisons between categories did not reach statistical significance. A diagnostic test from a finger or heel prick was done in 38% (95% CI 22, 57) of cases in the general population and in 33.4% (95% CI 14.1, 60.4) of the cases in children <5 years.

Table 18. Diagnosis, and treatment of persons with fever

Percentage of persons and children under the age of 5 with fever in the 2 weeks preceding the survey for whom advice or treatment was sought, outside the home, and percentage who had blood taken from a finger or heel for testing, according to background characteristics, Papua New Guinea, 2019-2020.

	Persons with fever			Children under age 5 with fever		
Background characteristic	Percentage for whom advice or treatment was sought[1]	Percentage who had blood taken from a finger or heel for testing	Number of persons	Percentage for whom advice or treatment was sought[1]	Percentage who had blood taken from a finger or heel for testing	Number of children
Residence						
Rural	50.7	29.6	103	41.7	24.3	20
Urban	80.3	55.5	31	79.6	47.4	6
	P = 0.0553	P = 0.1904		P = 0.3808	P = 0.4086	
Region						
Southern	65.2	42.2	35	92.9	85.8	5
Highlands	51.2	27.3	49	30.5	7.7	8
Momase	81.2	76.2	24	100.0	100.0	4
Islands	49.2	7.5	26	53.7	9.0	9
	P = 0.2643	P = 0.0038		P = 0.2808	P = 0.0033	
Sex						
Female	69.4	46.3	71	77.2	51.0	14
Male	48.7	27.4	63	35.0	14.9	12
	P =0.0107	P = 0.0372		P = 0.1088	P = 0.2220	
Total	60.3	38.0	134	56.6	33.4	26
(95% CI)	(41.4,76.5)	(22.0, 57.0)		(25.5,83.2)	(14.1, 60.4)	

[1] Includes advice or treatment from sources outside the home.

Most people sought care in health facilities (56.8% in the general population and 56.6% in children <5 years). Health centres were the most frequently visited facility for the general population (26.7%) and children <5 years (24.2%). Other treatment sources were uncommon (Table 19).

Table 19. Source of advice or treatment for children with fever

Percentage of persons and children under age 5 with fever in the 2 weeks preceding the survey for whom advice or treatment was sought from specific sources, Papua New Guinea, 2019-2020

	Percentage for whom advice or treatment was sought from each source:			
	Persons with fever		Children under age 5 with fever	
Source	Among persons with fever	Among persons with fever for whom advice or treatment was sought[1]	Among children with fever	Among children with fever for whom advice or treatment was sought[1]
Public sector				
Health facility	56.8	93.1	56.6	100.0
Hospital	15.5	25.4	14.4	25.4
Health Centre	26.7	43.8	24.2	42.9
Aid Post	16.6	27.2	15.7	27.7
Village Health Volunteer	0.0	0.0	2.3	4.0
Private medical sector				
Pharmacy	1.9	3.0	0.0	0.0
Other private sector				
Store	0.7	1.2	0.0	0.0
Other	0.0	0.0	0.0	0.0
Number	134	115	26	17

[1] Includes advice or treatment from sources outside the home.
Multiple answers were allowed

The most commonly used drugs were antipyretics (33.2%), antimalarials (33.2%) and antibiotics (14.6%) (Table 20). An antimalarial medicine was taken by 33.2% (95% CI 18.8, 51.5) of the fever cases and by 30.8% (95% CI 12.6, 57.9) of cases in children <5 years. The most frequently used antimalarial was the first-line drug artemether-lumefantrine (26.7%), followed by primaquine (1.2%) and Chloroquine (4%). Use of artemisinin monotherapies was uncommon; 31 of the 34 cases (91%) that used artemether tablets or artemether/artesunate injections as a monotherapy also reported taking artemether-lumefantrine.

A total of 30 cases (30.7% of those that reported having a test) reported testing positive for malaria and 37 cases (60.3% of those with a fever for whom advice or treatment was sought

outside home) reported being told by a health worker that they had malaria. An antimalarial was taken in 99.3% of cases where a positive test was reported and by 98.4% who had been told that they had malaria. The first-line treatment artemether-lumefantrine was used by 90.5% of those that reported testing positive and by 87.5% of children <5 years that tested positive. Figure 10 illustrates that only a very small proportion of all potential malaria cases were tested and treated. Antibiotics were taken primarily by those that did not test positive for malaria or were told they had no malaria (Table 20).

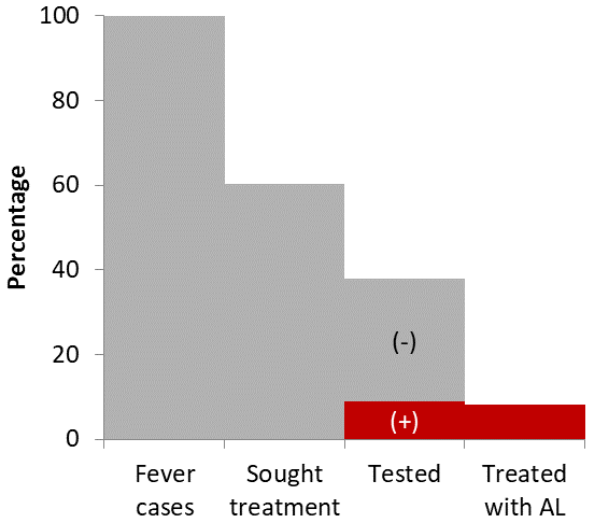


Figure 10. Percentage of fever cases for whom treatment was sought outside home and who were tested and treated with artemether-lumefantrine (AL) in case of a positive test.

Reason for not attending a health facility

Of all the fever cases who did not seek advice or treatment from a health facility, 105 provided a reason. The most frequently cited reasons, i.e. a personal opinion that the illness was not serious or they were feeling better, that it got better or they would wait for it to get more serious before attending a health facility, are displayed among others in Figure 11.

In the words of survey respondents: Many respondents also mentioned that the illness was not serious

"Felt better within the next few days that's why I didn't seek any help from any health facility."
Respondent from Soro village, Southern Highlands Province

In combination with feeling better, many respondents reported relying on home treatment.

"Because after consuming paracetamol I felt better."
Respondent from Lipite 2 village, Chimbu Province

Other main reasons reported by respondents included a lack of money for transport or medication and concerns about the distance of the Health Facility or about transportation.

Or, as one respondent explained:

"The distance to Nuku Health center is too far."
Respondent from Yiriwondi village, West Sepik Province.

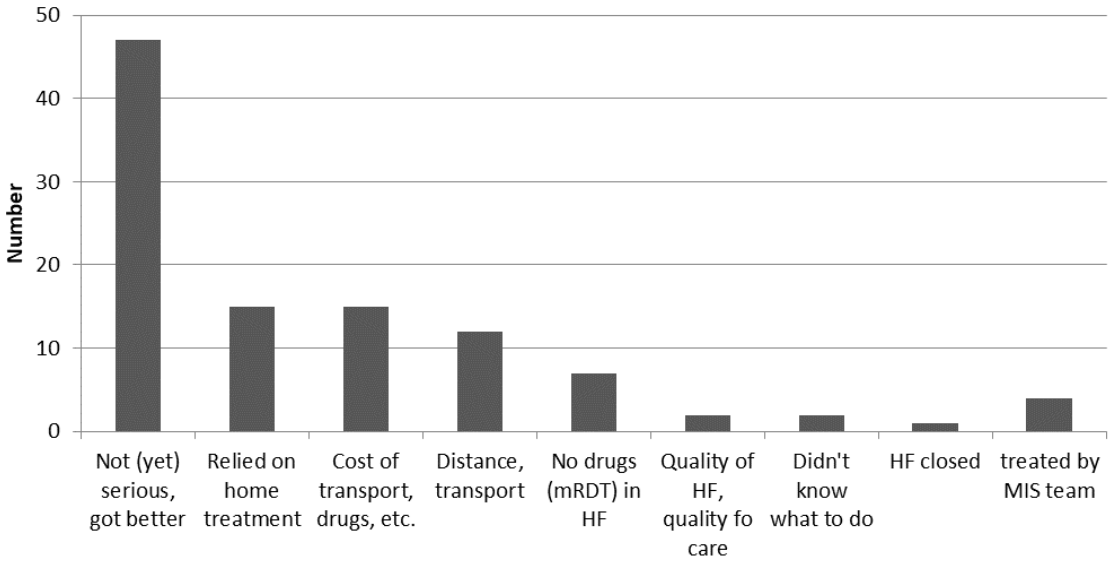


Figure 11. Frequency of reported reasons for not attending a health facility among all 105 persons reporting a reason.

Target: The target of 65% of children with a fever in the past two days seeking advice or treatment has not been reached on a national or regional level. Sub-national numbers are difficult to interpret due to the small sample size (Table F1, Appendix F).

Trend: The percentage of fever cases brought to a health facility for treatment has remained almost constant and below 50% since 2009 (Figure 12). While the testing rate steadily increased, still only about half of all cases that attended a health facility were tested. The proportion of those that tested positive and received the first-line treatment increased, yet remains below 100%.

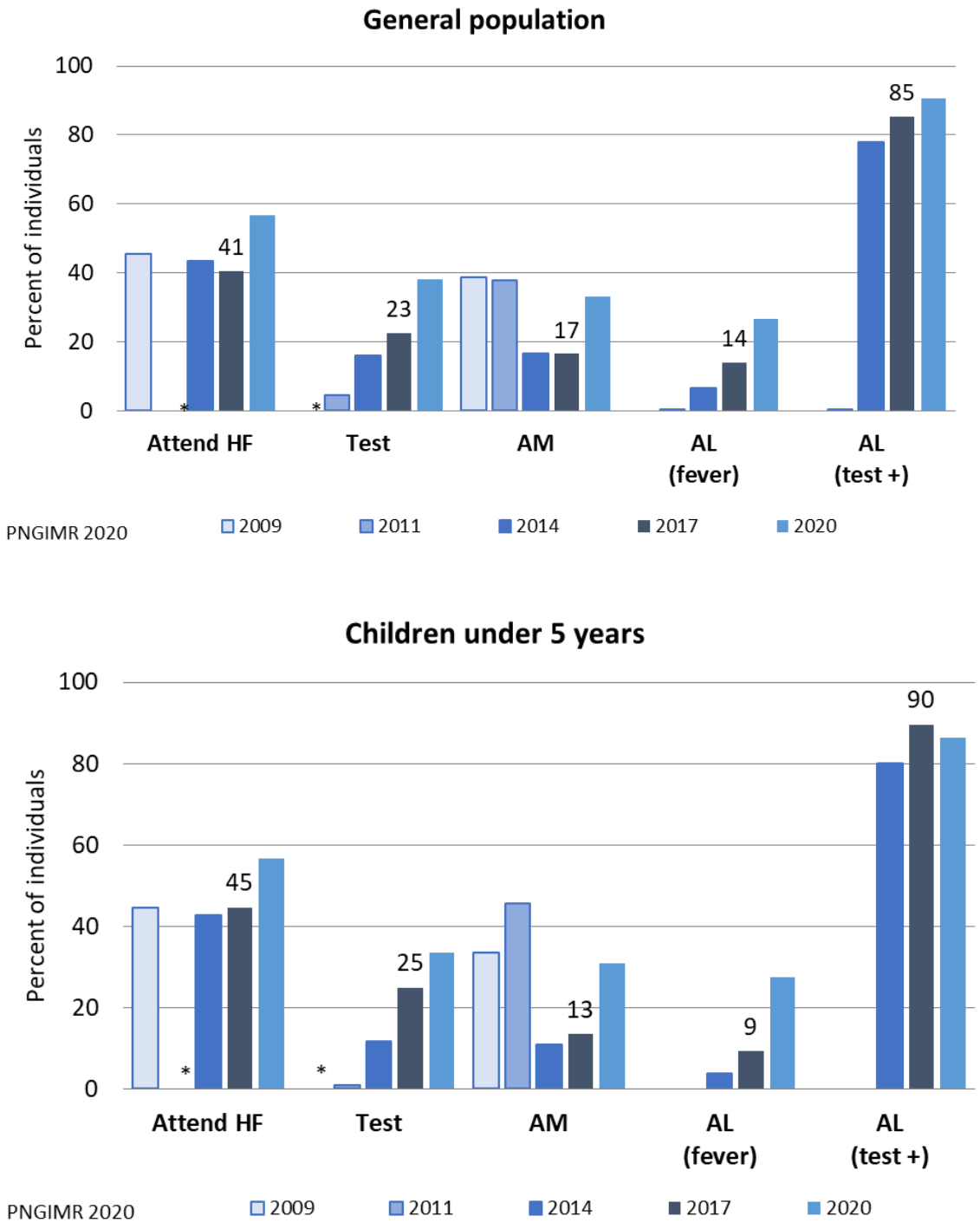


Figure 12. Trends in treatment seeking indicators in the general population and in children <5 years of age. * indicates no data available. National survey results 2009-2020. HF = health facility, AM = antimalarial, AL = artemether-lumefantrine. Source: PNGIMR surveys.

Table 20. Type of antimalarial drugs used

The percentage who took specific drugs among those persons with fever in the 2 weeks preceding the survey, according to background characteristics, Papua New Guinea, 2019-2020

	Percentage of persons who took:									
Background characteristic	Any antimalarial	AL	Prima-quine	SP	Chloroquine	Artemether tablets	Artesunate or artemether injection/IV	Antibiotic	Anti-pyretic	No. persons with fever
Residence										
Rural	20.3	17.1	1.7	0.0	2.6	0.0	0.6	10.4	26.3	103
Urban	60.1	46.7	0.0	1.3	7.1	6.1	6.4	23.5	47.8	31
	P = 0.0104	P = 0.0177				P = 0.0775	P = 0.0592			
Region										
Southern	37.4	32.6	4.3	0.0	4.8	3.1	0.0	24.7	75.0	35
Highlands	11.7	7.6	0.0	1.0	4.1	0.0	0.0	9.9	16.7	49
Momase	72.7	61.7	1.5	0.0	0.0	0.0	11.0	16.7	28.6	24
Islands	30.1	21.5	0.0	0.0	8.7	8.7	0.0	12.2	33.1	26
	P = 0.0012	P < 0.001							P = 0.0387	
Age in years										
<5	30.8	27.5	1.8	0.5	3.3	0.0	0.0	13.7	17.5	26
5+	33.6	26.5	1.0	0.0	4.2	2.4	3.0	14.8	36.5	108
Sex										
Female	37.6	34.9	0.0	0.8	2.0	3.5	0.7	8.4	27.4	71
Male	27.5	16.2	2.6	0.0	6.6	0.0	4.7	22.5	40.6	63
		P = 0.0017	P =0.084					P = 0.0966	P = 0.0799	
Test result										
No malaria	12.8	7.0	1.1	0.56	5.3	2.6	0.5	19.1	37.4	104
Malaria	99.3	90.5	1.3	0	0.0	0.0	8.7	0.0	23.4	30
	P < 0.001	P < 0.001					P = 0.0096			
Clinician diagnosis										
No malaria	8.3	4.4	1.2	0.0	3.9	2.3	0.0	19.4	36.7	97
Malaria	98.4	85.2	1.1	1.6	4.3	0.0	8.9	2.0	24.0	37
	P < 0.001	P < 0.001					P < 0.001	P = 0.0122		
Total	33.2	26.7	1.2	0.4	4.0	2.0	2.4	14.6	33.2	134
95% CI	(18.8, 51.5)	(15.1, 42.7)	(0.3,4.1)	(0.0, 3.5)	(1.4,10.8)	(0.4, 9.1)	(0.6, 10.1)	(8.0, 25.2)	(20.1, 49.6)	

4 DISCUSSION AND RECOMMENDATIONS

Malaria prevalence

After a resurgence of malaria in PNG in the last five years, i.e. a nine fold increase in prevalence between 2013/14 and 2016/17 [11, 27], there are clear signs of a reduction in 2019/20, across PNG. Among the general population and children under five years, prevalence of malaria infection below 1600 m altitude was 7.1% and 9.5% in 2016/17 (diagnosed by light microscopy) [8]. In the 2019/20 MIS, malaria prevalence measured by light microscopy was 2.1% and 2.4%, respectively. The two measurements indicate a renewed decrease in prevalence.

In general, prevalence measured by microscopy was lower in age groups above 5 years of age, confirming the trend observed in previous surveys. Prevalence was markedly higher below <1200 m altitude (2.5%) than above, confirming findings from a recent School Malaria Survey conducted in the Highlands provinces that found very low malaria prevalence in school children[6]. At regional and provincial level, malaria prevalence was highest in the Momase and Islands Regions. The Islands Region also consistently show below-average mosquito net use. In particular, high prevalence rates were observed in East and West New Britain provinces. Pockets of high prevalence at a village level are still observed across the low-lying regions.

The reasons of the previous malaria resurgence in PNG are not yet well understood. One of the suggested factors of this resurgence is a decrease in bio-efficacy of LLINs collected after 2013 (only 17% passed the 80% cut threshold of the World Health Organization test) [12]. At the same time, entomological studies conducted by the PNGIMR have confirmed frequent outdoor biting of local *Anopheles* species and a shift in peak biting to earlier times in the evening [29]. Both behavioural features may contribute to reducing the effectiveness of LLINs. Insecticide resistance, the other major threat to the effectiveness of LLINs, has not yet been detected in PNG [30, 31]. Other possible factors could include: (1) a reduction in the Global Fund support to the PNG malaria control programme after 2013 [32]; (2) a simultaneous decline in PNG public expenditure in the health sector [33]; and (3) a decrease in the availability of artemisinin-based combination treatment and mRDTs across PNG [34], including extended stock-outs in many places.

Lessons from the past clearly show that relaxation of control leads to malaria resurgences in environments that are favourable for malaria transmission, such as most parts of PNG [35, 36]. The findings in this report suggest a deceleration in malaria resurgence observed in PNG since 2015. Still adequate support to the PNG national malaria control programme to continue to re-

[6] Seidahmed O, Jamea S, Kurumop S, Hetzel M, Pomat W. A school survey indicates conducive settings for malaria elimination in the Highlands provinces of Papua New Guinea (Technical Report). Goroka: Papua New Guinea Institute of Medical Research; 2020.

intensify its malaria control efforts is highly needed to stop the resurgence and take the country back on track towards malaria elimination.

Mosquito net coverage

Since the last survey in 2016/17, coverage with mosquito nets, particularly LLINs, has decreased across PNG. The proportion of households with one net per two people has further decreased. Likewise, access and use has declined, indicating that household "saturation" with LLINs has further worsened.

A number of factors, including availability of sufficient LLINs in the household or people's perception of the benefit of using a net, determines LLIN use. In areas, in which ownership and access are low, low use is more likely to be a direct consequence of insufficient availability of nets. In the Highlands provinces, LLIN ownership (49.4%) and access (23.1%) were lowest and lower use than in other areas was therefore expected. On the other hand, as mosquitoes and malaria are less common in the Highlands, then lower use may also be due to a lower perceived benefit of LLIN use. In Bougainville and other provinces, ownership and use of LLINs had dramatically dropped. However, there had been no acquisition of LLINs for more than three years and no round of replacement campaign took place when the MIS was carried out in these provinces.

The difference between LLIN access (the proportion of people who could theoretically use a net) and actual LLIN use is a useful indicator of the approximate behavioural gap which is not a result of insufficient availability but rather due to people choosing not to use an available net. This gap was most notable in the Islands Region (72.5% access, 46.7% use), despite use being higher in this survey than in 2016-17 (38.5%) [37]. In general, adolescent and adult men were less likely to use an LLIN than other household members. In a previous study conducted in PNG, indifference to disease was found to be the main reason underlying low use among individuals who had access to an LLIN [38].

The survey findings suggest alternative methods of behaviour change communication may be necessary to emphasise the dangers of malaria and encourage the use of existing LLINs. Only 5% of interviewed household heads reported having received information on malaria in the past 3 months and most of the information people received originated from health workers. While there may be shortfalls in this particular indicator due to the focus on household heads, it certainly reflects a low coverage with malaria-related behaviour change messages. While in the Islands region this proportion was slightly higher at 10.6%, it did not seem to be sufficient to increase LLIN use in the population. Reaching people with behaviour change messages should take into consideration the availability of the different means of communication in the population (see chapter 3.1.3).

Malaria treatment

Prompt and effective treatment of clinical malaria cases is essential to prevent progression from uncomplicated to severe disease. Effective treatment of infections is also important to eliminate the parasite reservoir in humans and reduce malaria transmission.

Across PNG, the proportion of fever cases brought for treatment at a health facility has increased more than 15% between the MIS 2016/17 and 2019/20. Other treatment sources remain even less common, which reflects the general absence of a private healthcare or drug retail sector outside of major towns. The perceived lack of severity of a febrile illness, long distance and difficult access to health facilities and the poor quality of services provided including a lack of drugs and other supplies have emerged as main reasons preventing people from accessing a health facility.

Together, low health facility attendance and low testing rates lead to about 60% of all potential malaria cases in the community missing the opportunity of proper diagnosis and treatment. If we were to extrapolate the malaria test positivity of approximately 30% reported in this survey to the entire population with a recent fever, then one would expect about 30% of all fevers to be due to malaria, while only 27% of all fever cases received the first-line treatment artemether-lumefantrine. Consequently, 81% of the malarial fevers in the community would not be treated with the recommended first-line antimalarial medicine.

Conclusions

After a resurgence of malaria in PNG between 2013/14 and 2016/17, there are signs of a reduction in 2019/20. Compared to 2016/17, LLIN coverage decreased slightly at the national level but not in communities in low-lying areas. There is a need to evaluate the impact of the change in the distribution strategy of targeting LLINs at areas below 1600m altitude on the malaria situation in PNG.

The PNG Department of Health's vision of a malaria-free PNG by 2030, as articulated in the National Malaria Strategic Plan, will require a better understanding and tackling of factors underlying the previous resurgence of malaria in PNG. In a near-term (2021-2025), PNG aims to reduce malaria morbidity by 63%, decrease morbidity by 90% and eliminate malaria in Bougainville [39].

Malaria control needs to be intensified across endemic and epidemic populations, especially in low-lying areas below 1600m, and should include sufficient funding for vector control, diagnosis, treatment, behaviour change campaigns and operational research. The longer-term goal of malaria elimination by 2030 is still unlikely to be attainable unless more effort and support are put in place to select and target interventions effectively.

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APPENDIX A: SURVEY POPULATION

Table A1. Survey sample

Number of households interviewed by location, and *de facto* household population according to location, age and sex, Papua New Guinea, 2019-2020

Background characteristic		Households			*De facto* population		
		Rural	Urban	Total	Rural	Urban	Total
Province	01 WESTERN	118	30	148	574	158	732
	02 GULF	152	0	152	985	0	985
	03 CENTRAL	110	26	136	713	147	860
	04 NCD	0	134	134	0	989	989
	05 MILNE BAY	125	0	125	631	0	631
	06 ORO	126	0	126	671	0	671
	07 SHP	150	0	150	737	0	737
	08 ENGA	180	0	180	768	0	768
	09 WHP	90	87	177	309	353	662
	10 CHIMBU	167	0	167	821	0	821
	11 EHP	150	27	177	749	98	847
	12 MOROBE	93	60	153	547	432	979
	13 MADANG	120	29	149	539	167	706
	14 E. SEPIK	124	30	154	675	171	846
	15 SANDAUN	120	30	150	713	237	950
	16 MANUS	118	30	148	577	175	752
	17 NEW IRELAND	152	0	152	749	0	749
	18 ENB	98	30	128	533	196	729
	19 WNB	84	30	114	448	156	604
	20 BOUGAINVILLE	150	0	150	605	0	605
	21 HELA	149	0	149	712	0	712
	22 JIWAKA	150	30	180	810	168	978
Region	Southern	631	190	821	3,574	1,294	4,868
	Highlands	1,036	144	1,180	4,906	619	5,525
	Momase	457	149	606	2,474	1,007	3,481
	Islands	602	90	692	2,912	527	3,439
Altitude (m)	<1200m	1,780	429	2,209	9,426	2,828	12,254
	1200 to <1600	270	0	270	1,340	0	1,340
	1600+ m	676	144	820	3,100	619	3,719
Age (years)	<5				1,786	424	2,210
	<1				210	55	265
	1-4				1,576	369	1,945
	5-9				2,197	479	2,676
	10-14				1,788	387	2,175
	15-19				1,344	313	1,657
	20-39				3,963	1,143	5,106
	40+				2,788	701	3,489
Sex	Male				7,063	1,782	8,845
	Female				6,803	1,665	8,468
Total		**2,726**	**573**	**3,299**	**13,866**	**3,447**	**17,313**

APPENDIX B: MOSQUITO NET COVERAGE

Table B1. Household ownership of mosquito nets

Percentage of households with at least one mosquito net (treated or untreated) and long-lasting insecticidal net (LLIN); average number of nets and LLINs per household; and percentage of households with at least one net and LLIN per two persons who stayed in the household last night, according to background characteristics, Papua New Guinea, 2019-2020

	Percentage of households with at least one mosquito net			Average number of nets per household			
Province[1]	Any mosquito net	LLIN[2]	Percentage of households with at least two LLIN	Any mosquito net	LLIN	Percentage of households with at least one LLIN for every two persons who stayed in the household last night	Number of households with at least one person who stayed in the household last night
01 WESTERN	77.7	77.7	58.8	1.9	1.9	59.1	148
02 GULF	97.4	97.4	88.8	4.0	4.0	66.4	150
03 CENTRAL	94.9	94.9	92.6	3.3	3.3	73.6	136
04 NCD	64.9	55.2	45.5	2.1	1.7	52.7	134
05 MILNE BAY	82.4	82.4	64.8	2.5	2.5	61.8	125
06 ORO	99.2	99.2	86.5	3.0	3.0	63.2	126
07 SHP	32.7	28.7	16.7	0.6	0.5	32.6	150
08 ENGA	62.2	42.2	31.7	1.5	1.0	72.4	180
09 WHP	66.7	65	46.9	1.4	1.3	69.3	176
10 CHIMBU	49.1	48.5	32.3	1.1	1.1	59.3	167
11 EHP	70.6	70.6	49.7	1.7	1.7	57.6	177
12 MOROBE	71.2	70.6	60.1	2.2	2.2	53.7	153
13 MADANG	100	100	83.2	2.3	2.3	57	149
14 E. SEPIK	89.6	89	71.4	2.8	2.8	60	151
15 SANDAUN	78	77.3	71.3	2.3	2.3	46.6	150
16 MANUS	97.3	97.3	90.5	3.5	3.5	76.4	148
17 NEW IRELAND	90.1	88.8	67.1	2.4	2.4	65.9	152
18 ENB	89.1	89.1	79.7	2.6	2.6	63.2	128
19 WNB	91.2	91.2	71.9	2.4	2.3	49	114
20 BOUGAINVILLE	50	42	32.7	1.1	0.9	68.3	150
21 HELA	19.5	19.5	8.1	0.3	0.3	34.5	149
22 JIWAKA	60	58.3	37.8	1.4	1.3	41	180

[1]Provincial figures are unweighted proportions.
[2] Green shading indicates that Global Fund target of **85%** was reached

Table B2. Access to an LLIN

Percentage of the *de facto* population with access to an LLIN in the household, by province, Papua New Guinea, 2019-2020

Province	Percentage of the *de facto* population with access to an LLIN[1,2]
01 WESTERN	64.2
02 GULF	87.2
03 CENTRAL	87.0
04 NCD	43.7
05 MILNE BAY	69.4
06 ORO	87.9
07 SHP	19.8
08 ENGA	36.7
09 WHP	58.0
10 CHIMBU	38.6
11 EHP	58.2
12 MOROBE	57.0
13 MADANG	85.0
14 E. SEPIK	76.3
15 SANDAUN	65.2
16 MANUS	89.8
17 NEW IRELAND	75.5
18 ENB	77.6
19 WNB	74.4
20 BOUGAINVILLE	37.0
21 HELA	13.6
22 JIWAKA	42.4

[1] Percentage of *de facto* household population who could sleep under an LLIN if each LLIN in the household were used by up to two people.

[2] Green shading indicates that Global Fund target of **75%** was reached.

Table B3. Use of mosquito nets by persons in the household

Percentage of the *de facto* household population who slept the night before the survey under a mosquito net (treated or untreated) and under a long-lasting insecticidal net (LLIN); and among the *de facto* household population in households with at least one LLIN, percentage who slept under a LLIN the night before the survey, according to background characteristics, Papua New Guinea, 2019-2020

	Household population			Household population in households with at least one LLIN	
Province	Percentage who slept under any mosquito net last night	Percentage who slept under an LLIN last night[1]	Number of persons	Percentage who slept under an LLIN last night	Number of persons
01 WESTERN	57.5	57.5	732	75.0	561
02 GULF	78.4	78.4	985	80.0	965
03 CENTRAL	78.8	78.5	860	83.4	809
04 NCD	29.4	25.1	989	46.5	533
05 MILNE BAY	47.2	47.2	631	56.9	524
06 ORO	86.4	86.4	671	87.6	662
07 SHP	14.5	14.5	737	49.8	215
08 ENGA	22.4	13.0	768	33.7	297
09 WHP	15.9	15.9	662	25.6	410
10 CHIMBU	20.6	20.6	821	44.4	381
11 EHP	40.5	40.5	847	54.6	628
12 MOROBE	40.5	40.0	979	58.2	674
13 MADANG	78.1	78.1	706	78.1	706
14 E. SEPIK	67.1	67.1	846	75.7	750
15 SANDAUN	62.6	61.6	950	82.1	713
16 MANUS	53.3	53.3	752	54.5	736
17 NEW IRELAND	36.1	36.1	749	40.2	671
18 ENB	52.3	52.3	729	58.6	650
19 WNB	50.3	50.3	604	55.0	553
20 BOUGAINVILLE	14.9	14.9	605	35.2	256
21 HELA	1.3	1.3	712	7.0	129
22 JIWAKA	30.1	30.1	978	51.2	574

[1] Green shading indicates that Global Fund target of **60%** was reached.

Table B4. Use of mosquito nets by children

Percentage of children under age 5 who, the night before the survey, slept under a mosquito net (treated or untreated) and under a long-lasting insecticidal net (LLIN); and among children under age 5 in households with at least one LLIN, percentage who slept under a LLIN the night before the survey, according to background characteristics, Papua New Guinea, 2019-2020

	Children under age 5 in all households			Children under age 5 in households with at least one LLIN	
Province	Percentage who slept under any mosquito net last night	Percentage who slept under an LLIN last night[1]	Number of children	Percentage who slept under an LLIN last night	Number of children
01 WESTERN	65.2	65.2	112	84.9	86
02 GULF	81.9	81.9	127	85.2	122
03 CENTRAL	82.0	82.0	100	90.1	91
04 NCD	36.3	28.2	124	51.5	68
05 MILNE BAY	60.6	60.6	71	72.9	59
06 ORO	94.3	94.3	88	95.4	87
07 SHP	22.4	22.4	58	68.4	19
08 ENGA	31.8	16.5	85	56	25
09 WHP	30.5	30.5	82	45.5	55
10 CHIMBU	33.0	33.0	97	72.7	44
11 EHP	51.6	51.6	97	65.8	76
12 MOROBE	52.7	51.8	112	72.5	80
13 MADANG	85.4	85.4	96	85.4	96
14 E. SEPIK	74.8	74.8	107	85.1	94
15 SANDAUN	69.1	67.6	139	90.4	104
16 MANUS	66.7	66.7	90	66.7	90
17 NEW IRELAND	44.3	44.3	106	49	96
18 ENB	67.0	67.0	97	73.9	88
19 WNB	63.8	63.8	80	69.9	73
20 BOUGAINVILLE	24.1	24.1	108	52	50
21 HELA	4.0	4.0	101	13.3	30
22 JIWAKA	41.4	41.4	133	62.5	88

[1] Green shading indicates that Global Fund target of **65%** was reached.

Note: Due to the small number of samples, mosquito net use in pregnant women was not calculated by province.

APPENDIX C: PARASITE PREVALENCE

Table C1. Prevalence of malaria (age-standardized) by province

Percentage of persons classified as having malaria, by mRDTs and light microscopy, Papua New Guinea, 2019-2020

Province	Malaria prevalence using RDT[1]		Malaria prevalence according to microscopy					
	RDT positive	Number of persons	Any species	*P. falciparum*	*P. vivax*	*P. malariae*	Mixed *P.f.* & *P.v.*	Number of persons
01 WESTERN	2.3	566	0.5	0.5	0.0	0.0	0.0	566
02 GULF	4.7	850	1.1	0.7	0.5	0.0	0.1	849
03 CENTRAL	0.8	623	1.3	0.8	0.8	0.0	0.2	621
04 NCD	0.0	708	0.2	0.0	0.2	0.0	0.0	703
05 MILNE BAY	4.6	564	2.2	1.2	1.0	0.0	0.0	562
06 ORO	4.1	559	3.7	0.8	2.6	0.3	0.0	554
07 SHP	0.3	673	0.0	0.0	0.0	0.0	0.0	663
08 ENGA	0.4	476	0.5	0.0	0.5	0.0	0.0	474
09 WHP	0.2	503	0.0	0.0	0.0	0.0	0.0	503
10 CHIMBU	0.0	597	0.0	0.0	0.0	0.0	0.0	599
11 EHP	0.3	641	0.0	0.0	0.0	0.0	0.0	632
12 MOROBE	1.5	826	0.4	0.1	0.2	0.0	0.0	817
13 MADANG	8.6	759	2.5	1.9	0.5	0.0	0.0	747
14 E. SEPIK	15.1	768	8.6	6.7	2.3	0.0	0.5	764
15 SANDAUN	13.6	733	10.6	8.9	1.7	0.1	0.1	732
16 MANUS	2.5	613	0.1	0.1	0.0	0.0	0.0	613
17 NEW IRELAND	6.3	576	1.4	0.8	0.6	0.0	0.0	576
18 ENB	8.4	536	2.9	2.0	0.6	0.3	0.0	541
19 WNB	14.0	471	1.6	1.3	0.0	0.3	0.0	465
20 BOUGAINV.	1.2	566	0.3	0.0	0.3	0.0	0.0	565
21 HELA	0.4	551	0.0	0.0	0.0	0.0	0.0	551
22 JIWAKA	0.4	761	0.0	0.0	0.0	0.0	0.0	761

mRDT = malaria Rapid Diagnostic Test

Table C2. Prevalence of malaria in children <5 years of age, by province

Percentage of children between 6 months and 5 years of age classified as having malaria, by mRDTs and light microscopy, Papua New Guinea, 2019-2020

Province	Malaria prevalence using RDT		Malaria prevalence according to microscopy					
	RDT positive	Number of children	Any species	P. falciparum	P. vivax	P. malariae	Mixed P.f. & P.v.	Number of persons
01 WESTERN	2.4	83	0.0	0.0	0.0	0.0	0.0	83
02 GULF	2.9	102	1.9	1.0	1.0	0.0	0.0	103
03 CENTRAL	0.0	65	1.5	0.0	1.5	0.0	0.0	65
04 NCD	0.0	87	0.0	0.0	0.0	0.0	0.0	83
05 MILNE BAY	3.2	63	0.0	0.0	0.0	0.0	0.0	63
06 ORO	11.7	60	10.0	0.0	10.0	0.0	0.0	60
07 SHP	0.0	51	0.0	0.0	0.0	0.0	0.0	51
08 ENGA	0.0	31	0.0	0.0	0.0	0.0	0.0	31
09 WHP	0.0	54	0.0	0.0	0.0	0.0	0.0	54
10 CHIMBU	0.0	50	0.0	0.0	0.0	0.0	0.0	50
11 EHP	0.0	62	0.0	0.0	0.0	0.0	0.0	63
12 MOROBE	0.0	81	0.0	0.0	0.0	0.0	0.0	78
13 MADANG	2.1	96	1.1	1.1	0.0	0.0	0.0	93
14 E. SEPIK	15.2	79	10.1	5.1	6.3	0.0	1.3	79
15 SANDAUN	22.6	106	17.0	13.2	3.8	0.0	0.0	106
16 MANUS	2.9	69	0.0	0.0	0.0	0.0	0.0	69
17 NEW IRELAND	11.0	73	4.1	2.7	1.4	0.0	0.0	73
18 ENB	15.2	66	3.1	1.5	0.0	1.5	0.0	65
19 WNB	14.0	50	2.0	2.0	0.0	0.0	0.0	50
20 BOUGAINVILLE	0.0	92	0.0	0.0	0.0	0.0	0.0	92
21 HELA	0.0	55	0.0	0.0	0.0	0.0	0.0	55
22 JIWAKA	1.0	105	0.0	0.0	0.0	0.0	0.0	102

mRDT = malaria Rapid Diagnostic Test

Table C3. Prevalence of malaria infection in children <5 years of age, by sex

Percentage of children between 6 months and 5 years of age classified by light microscopy as having malaria, in villages <1600 m altitude and overall, by sex, Papua New Guinea, 2019-2020

	Malaria prevalence according to RDT[1]		Malaria prevalence according to microscopy[1]					
Background characteristic	RDT positive	Number of children	Any species	*P. falciparum*	*P. vivax*	*P. malariae*	Mixed *P.f.* & *P.v.*	Number of persons
Altitude <1600 m								
Sex								
Female	4.9	641	1.8	1.1	0.8	0.000	0.0	689
Male	4.7	696	3.0	2.2	0.8	0.073	0.1	635
	P = 0.94		P = 0.23	P = 0.16	P = 0.91	P = 0.4	P = 0.4	
Overall								
Sex								
Female	4.3	769	1.5	0.9	0.6	0.000	0.0	764
Male	4.0	811	2.6	1.9	0.7	0.063	0.1	804
	P = 0.89		P = 0.16	P = 0.1	P = 0.87	P = 0.35	P = 0.35	

[1]Weighted

Table C4. Prevalence of malaria by village (raw data)

Percentage of persons and children < 5 years classified in two tests as having malaria, by survey village, Papua New Guinea, 2019-2020

Background characteristic		Malaria prevalence							
		According to RDT[1]		According to microscopy					
Province	Village name	RDT positive	Number of persons	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of persons
WESTERN	AWABA	1.46	137	0	0.0	0.0	0.0	0.0	138
WESTERN	Bisuaka (Saguanso)	1.8	111	0	0.0	0.0	0.0	0.0	111
WESTERN	Gusiore	4.55	110	2.75	2.8	0.0	0.0	0.0	109
WESTERN	KIMAMA	0	95	0	0.0	0.0	0.0	0.0	95
WESTERN	Tabubil	3.54	113	0	0.0	0.0	0.0	0.0	113
GULF	BEMA	0	134	0	0.0	0.0	0.0	0.0	132
GULF	IRIMUKU	0	183	0	0.0	0.0	0.0	0.0	185
GULF	Mapaio	1.35	148	0	0.0	0.0	0.0	0.0	148
GULF	Miaru	21.82	165	6.1	4.3	2.4	0.0	0.6	164
GULF	Morovamu	0.91	220	0.45	0.0	0.5	0.0	0.0	220
CENTRAL	Kapari	0	115	0	0.0	0.0	0.0	0.0	115
CENTRAL	Madevate Settlement	0	104	0	0.0	0.0	0.0	0.0	104
CENTRAL	Poba Abala	3.1	129	4.69	3.1	2.3	0.0	0.8	128
CENTRAL	Toule Comm. School	0	131	0.76	0.0	0.8	0.0	0.0	131
CENTRAL	Upulima Block	0.69	144	0.7	0.0	0.7	0.0	0.0	143
NCD	Coot St.	0	98	0	0.0	0.0	0.0	0.0	94
NCD	Dogura Rd.	0	200	0	0.0	0.0	0.0	0.0	198
NCD	Sabama S'mnt - Kilakila Agr.	0	102	0	0.0	0.0	0.0	0.0	102
NCD	Sabama S'mnt	0	171	0	0.0	0.0	0.0	0.0	172
NCD	Vadavada S'mnt - Tutu	0	137	0.73	0.0	0.7	0.0	0.0	137
MILNE BAY	Awaiama	9.77	133	6.02	4.5	1.5	0.0	0.0	133
MILNE BAY	Bedauna	6.59	91	4.4	1.1	3.3	0.0	0.0	91
MILNE BAY	DCA Gurney Airport	2	50	0	0.0	0.0	0.0	0.0	49
MILNE BAY	Gameta	0	135	0	0.0	0.0	0.0	0.0	135
MILNE BAY	Hagita	3.87	155	1.95	0.0	2.0	0.0	0.0	154
ORO	Ahora	1.01	99	0	0.0	0.0	0.0	0.0	99
ORO	Founa	8.29	193	11.58	2.6	8.4	0.5	0.0	190
ORO	Tombata	4.94	81	1.28	1.3	0.0	0.0	0.0	78
ORO	Totogata	1.67	60	0	0.0	0.0	0.0	0.0	60
ORO	Ururu	0.79	126	0.79	0.0	0.8	0.0	0.0	127
SHP	Andua	0	150	0	0.0	0.0	0.0	0.0	150
SHP	Kaweri	0	112	0	0.0	0.0	0.0	0.0	111
SHP	Lipite 2	1.64	122	0	0.0	0.0	0.0	0.0	116
SHP	Soro	0	151	0	0.0	0.0	0.0	0.0	149

Table C4. Prevalence of malaria by village (raw data)

Percentage of persons and children < 5 years classified in two tests as having malaria, by survey village, Papua New Guinea, 2019-2020

Background characteristic		Malaria prevalence							
		According to RDT[1]		According to microscopy					
Province	Village name	RDT positive	Number of persons	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of persons
SHP	Utupia	0	138	0	0.0	0.0	0.0	0.0	137
ENGA	Irelya T/Up Miss/Sch & A/P	0	108	0.93	0.0	0.9	0.0	0.0	108
ENGA	Kanamanda	0	89	0	0.0	0.0	0.0	0.0	90
ENGA	Kusi	1.02	98	0	0.0	0.0	0.0	0.0	97
ENGA	Kundis	0	65	0	0.0	0.0	0.0	0.0	65
ENGA	Mukrumanda	0	64	0	0.0	0.0	0.0	0.0	62
ENGA	Takaipos	1.92	52	1.92	0.0	1.9	0.0	0.0	52
WHP	Kimininga Police Barracks	0	104	0	0.0	0.0	0.0	0.0	104
WHP	Kuk Research	1.23	81	0	0.0	0.0	0.0	0.0	81
WHP	PULUMONG	0	77	0	0.0	0.0	0.0	0.0	77
WHP	Wanka	0	75	0	0.0	0.0	0.0	0.0	75
WHP	Wania	0	77	0	0.0	0.0	0.0	0.0	77
WHP	Yakismanda.1	0	89	0	0.0	0.0	0.0	0.0	89
CHIMBU	Gembogl Stn	0	103	0	0.0	0.0	0.0	0.0	103
CHIMBU	Karaweri H/Sch	0	52	0	0.0	0.0	0.0	0.0	52
CHIMBU	Kendine H/C	0	99	0	0.0	0.0	0.0	0.0	98
CHIMBU	Ofu	0	67	0	0.0	0.0	0.0	0.0	67
CHIMBU	Solida	0	147	0	0.0	0.0	0.0	0.0	150
CHIMBU	Urumil	0	129	0	0.0	0.0	0.0	0.0	129
EHP	Broken Hill	0	75	0	0.0	0.0	0.0	0.0	75
EHP	Lahamenegu	0	141	0	0.0	0.0	0.0	0.0	136
EHP	Lodopulo	0.71	141	0	0.0	0.0	0.0	0.0	140
EHP	Muritoka	0.59	170	0	0.0	0.0	0.0	0.0	170
EHP	Sikinumuga	0	66	0	0.0	0.0	0.0	0.0	64
EHP	WIHANONI	0	48	0	0.0	0.0	0.0	0.0	47
MOROBE	Ambuasutz	0.6	168	0	0.0	0.0	0.0	0.0	166
MOROBE	Hagona	4.4	159	1.28	0.6	0.6	0.0	0.0	156
MOROBE	Karanas No.2	0.69	145	0	0.0	0.0	0.0	0.0	143
MOROBE	Marafau	0.61	163	0	0.0	0.0	0.0	0.0	162
MOROBE	Uni Tech-Sogeri Drive	1.05	191	0.53	0.0	0.5	0.0	0.0	190
MADANG	Awam	2.1	143	0	0.0	0.0	0.0	0.0	137
MADANG	Buru (Bur)	13.64	154	3.29	2.0	1.3	0.0	0.0	152
MADANG	Kulili Plantation	1.43	140	0	0.0	0.0	0.0	0.0	140
MADANG	Kwanje	17.45	149	7.38	6.0	1.3	0.0	0.0	149
MADANG	Sagalau	7.51	173	1.18	0.6	0.6	0.0	0.0	169
ESP	Mansu/Mapau-Y C Street	5.37	149	2.67	2.0	0.7	0.0	0.0	150

Table C4. Prevalence of malaria by village (raw data)

Percentage of persons and children < 5 years classified in two tests as having malaria, by survey village, Papua New Guinea, 2019-2020

Background characteristic		Malaria prevalence							
		According to RDT[1]		According to microscopy					
Province	Village name	RDT positive	Number of persons	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of persons
ESP	Nindiko	47.49	179	27.27	24.4	4.6	0.0	1.7	176
ESP	Sarapa	6.92	159	4.4	3.8	0.6	0.0	0.0	159
ESP	Yenigo	0.7	143	0	0.0	0.0	0.0	0.0	142
ESP	Yawik	7.97	138	7.3	1.5	6.6	0.0	0.7	137
WSP	AMINI	20.14	139	17.99	14.4	3.6	0.7	0.7	139
WSP	Paiawa	21.33	150	22	20.7	1.3	0.0	0.0	150
WSP	Tomontonik	15.04	133	9.77	9.0	0.8	0.0	0.0	133
WSP	Top Tower	3.35	179	1.12	0.6	0.6	0.0	0.0	178
WSP	Yiriwondi	10.61	132	6.82	3.0	3.8	0.0	0.0	132
MANUS	Bundralis	5.77	104	0	0.0	0.0	0.0	0.0	104
MANUS	Lawes	4.13	121	0	0.0	0.0	0.0	0.0	121
MANUS	Nyada	0	125	0	0.0	0.0	0.0	0.0	125
MANUS	Tamat DPI Stn	2.29	131	0.76	0.8	0.0	0.0	0.0	131
MANUS	Tingou	0.76	132	0	0.0	0.0	0.0	0.0	132
NIP	Hilalon Plantation	3.19	94	2.13	1.1	1.1	0.0	0.0	94
NIP	Lavali	0.74	135	0.74	0.0	0.7	0.0	0.0	135
NIP	Purunkom	9.43	106	2.83	2.8	0.0	0.0	0.0	106
NIP	Tandis	12.2	123	0.81	0.0	0.8	0.0	0.0	123
NIP	UGANA	5.93	118	2.54	1.7	0.9	0.0	0.0	118
ENB	Kabakaul	2.03	148	0.68	0.7	0.0	0.0	0.0	148
ENB	Milim Sub District Office	28.57	28	3.85	3.9	0.0	0.0	0.0	26
ENB	Napapar No.2 Village	6.25	112	0	0.0	0.0	0.0	0.0	113
ENB	Rusty/Wiltane Platation	11.01	109	5.5	1.8	2.8	0.9	0.0	109
ENB	Sahalil	10.79	139	8.28	5.5	1.4	1.4	0.0	145
WNB	Galilo	10.88	147	2.84	2.8	0.0	0.0	0.0	141
WNB	Kulungi	3.23	93	2.17	1.1	0.0	1.1	0.0	92
WNB	Malalimi	12.5	80	2.5	2.5	0.0	0.0	0.0	80
WNB	Mixed Settlement	24.5	151	0	0.0	0.0	0.0	0.0	152
AROB	BTHA	0.9	111	0	0.0	0.0	0.0	0.0	110
AROB	Iokomori	4	100	0	0.0	0.0	0.0	0.0	100
AROB	Kurai	0	99	0	0.0	0.0	0.0	0.0	99
AROB	Mituai	0	134	0	0.0	0.0	0.0	0.0	134
AROB	Rumba SDA	1.64	122	0.82	0.0	0.8	0.0	0.0	122
HELA	Andawana	0	100	0	0.0	0.0	0.0	0.0	100
HELA	Page	0.83	120	0	0.0	0.0	0.0	0.0	120
HELA	Pai	0	130	0	0.0	0.0	0.0	0.0	130
HELA	Poroloma	0	101	0	0.0	0.0	0.0	0.0	101

Table C4. Prevalence of malaria by village (raw data)

Percentage of persons and children < 5 years classified in two tests as having malaria, by survey village, Papua New Guinea, 2019-2020

Background characteristic		Malaria prevalence							
		According to RDT[1]		According to microscopy					
Province	Village name	RDT positive	Number of persons	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of persons
HELA	SEBIBA	1	100	0	0.0	0.0	0.0	0.0	100
JIWAKA	Avi Market	0	145	0	0.0	0.0	0.0	0.0	145
JIWAKA	Domil	0	107	0	0.0	0.0	0.0	0.0	107
JIWAKA	Goldop	0	152	0	0.0	0.0	0.0	0.0	151
JIWAKA	Kurumul Tea/Coffee	0	129	0	0.0	0.0	0.0	0.0	132
JIWAKA	Police Residence	0	98	0	0.0	0.0	0.0	0.0	96
JIWAKA	Yambedop 1	3.08	130	0	0.0	0.0	0.0	0.0	130

APPENDIX D. PERFORMANCE OF mRDT AND MALARIA PREVALENCE BY mRDT

This Appendix presents performance and prevalence results of malaria infection in the general population assessed in household members above 6 months of age using malaria rapid diagnostic test (RDT). The results are presented overall and by type of positive result represented by the respective test-line (i.e., "only *Plasmodium falciparum* [*Pf*]", "*Pf* or mixed infection of *Pf*" or "non-*Pf*"). Hence, mRDT results reported here for 13,920 individuals are NOT the gold standard and should be interpreted with caution. The microscopy results are presented above in Section 3.4. Village-level mRDT results are presented in Appendix C.

The mRDT brand used in this survey, i.e. CareStart™ Malaria HRP2/pLDH (Pf/pan) Combo Test, detects both the P. falciparum-specific, histidine-rich protein-2 (HRP-2), that can persist in the blood for up to a month after parasite clearance, and the pan malaria-specific antigen (pLDH) which detect all malaria parasites but relatively short-lived after treatment [24-26]. In areas highly endemic for P. falciparum, or with recent introduction or scale-up of effective treatment, the persistence of the antigen may lead to higher malaria prevalence estimates by RDTs as compared to microscopy.

1) Performance of malaria RDT brand

To evaluate diagnostic test performance, two measures are usually used to verify the accuracy of RDT: sensitivity and specificity. The two formula used in calculation of the two measures are shown below:

Sensitivity = Total of true positive results detected by microscopy and RDT / total of positive results detected by RDT (true positive + false positive)

Specifity = Total of true negative results detected by microscopy and RDT / total of negative results detected by RDT (true negative + false negative)

Table D1 shows a crosstab of the results of RDT brand CareStart™ with the light microscopy as a gold standard. Apparently, the sensitivity of RDT brand is low 73.2%, while the diagnostic kit shows a high specificity 97.3%.

Table D1. Crosstab of results of malaria RDT brand (CareStart™ Malaria HRP2/pLDH (Pf/pan) Combo Test) with the results of light microscopy, MIS 2019/20, PNG

		RESULTS BY MICROSCOPY		
		negative	positive	Total
RESULTS BY RDT	negative	13,188	74	13,262
		97.25%	26.81%	95.84%
	positive	373	202	575
		2.75%	73.19%	4.16%
	Total	13,561	276	13,837
		100%	100%	100%

2) Prevalence of malaria using mRDT

Below 1600 m altitude, 5.95% (95% CI 4.34, 8.12) of people tested positive with mRDTs. In highland areas at 1600 m and above, only 0.51% (95% CI 0.3, 0.87) of the population tested positive. On a national level, mRDTs with *Pf* only were more common than positive results with a "*Pf* or mixed" or non-*Pf* result in areas below 1600m, while non-*Pf* infections were more common in highland areas (Table D2).

Children <5 years living in areas <1600 m altitude, 4.81% (95% CI 3.16, 7.25) tested positive using mRDTs, while only one malaria infection was found in the 243 children surveyed in highland villages at 1600 m and above (Table D3).

Malaria prevalence was the highest in Islands Region (10.4%) and lowest in the Highlands Region (0.3%) (Table D4). Only one infection was found in villages between 1200 and 1600 m altitude but due to the population distribution in PNG [1] the survey sample at these altitudes was small. Overall, infections were slightly less common in urban than in rural areas.

Table D2. Prevalence of malaria using mRDTs

Percentage of persons above 6 months of age classified by mRDT as having malaria, in villages <1600 m altitude, ≥1600 m altitude, and overall, Papua New Guinea, 2019-2020

	Number				Malaria prevalence according to mRDT[1] (%)			
Altitude	negative	positive	failed*	tested	*Pf*	non-*Pf*	*Pf* or mixed	All
<1600 m (95% CI)	10,684	571	16	11,271	2.93 (1.83,4.64)	1.64 (1.26,2.13)	1.39 (0.89,2.15)	5.95 (4.34,8.12)
≥1600 m (95% CI)	2,655	10	3	2,668	0.08 (0.02,0.25)	0.33 (0.18,0.59)	0.1 (0.04,0.27)	0.51 (0.3,0.87)
Overall (95% CI)	**13,339**	**581**	**19**	**13,939**	**2.37** (1.49,3.75)	**1.38** (1.08,1.77)	**1.14** (0.74,1.75)	**4.88** (3.59,6.61)

[1]Age-standardized and weighted.
*Failed tests were not repeated and not included in the calculation of prevalence

Table D2. Prevalence of malaria in children <5 years of age using mRDTs

Percentage of children between 6 months and 5 years of age classified by mRDTs as having malaria, in villages <1600 m altitude, ≥1600 m altitude, and overall, Papua New Guinea, 2019-2020

	Totals				Malaria prevalence according to mRDT[1] (%)			
Altitude	negative	positive	failed*	tested	*Pf*	non-*Pf*	*Pf* or mixed	All
<1600 m (95% CI)	1258	79	1	1,338	2.34 (1.19,4.55)	1.49 (0.85,2.58)	0.98 (0.52,1.86)	4.81 (3.16,7.25)
≥1600 m (95% CI)	242	1	0	243	0	0	0.57 (0.12,2.60)	0.57 (0.12,2.60)
Overall (95% CI)	**1500**	**80**	**1**	**1,581**	**1.98** (1.02,3.83)	**1.26** (0.73,2.17)	**0.92** (0.50,1.67)	**4.16** (2.78,6.19)

[1]Age-standardized and weighted.
*Failed tests were not repeated and not included in the calculation of prevalence

Table D3. Prevalence of malaria infection by background characteristics

Percentage of persons above 6 months of age classified by light microscopy as having malaria, according to background characteristics, Papua New Guinea, 2019-2020

Background characteristic	Totals			Malaria prevalence according to mRDT				
	negative	positive	failed*	Pf %	Non-Pf %	Mixed/Pf %	All %	Obs
Altitude (m)								
<1200	9,544	570	13	3.5	2.0	1.7	7.1	10,114
1200 to 1599	1,140	1	3	0.1	0.0	0.0	0.1	1,141
1600+	2,655	10	3	0.1	0.3	0.1	0.5	2,665
Residence								
Rural	10,819	503	19	2.2	1.3	1.3	4.9	11,322
Urban	2,520	78	0	2.8	1.6	0.5	4.8	2,598
Region								
Southern	3,763	107	2	0.9	1.4	0.5	2.9	3,870
Highlands	4,190	12	7	0.1	0.2	0.1	0.3	4,202
Momase	2,793	293	2	4.2	2.4	2.6	9.2	3,086
Islands	2,593	169	8	6.7	2.1	1.6	10.4	2,762
Age in years								
<5	1,500	80	1	2.0	1.3	0.9	4.2	1,580
<1	42	0	0	0.0	0.0	0.0	0.0	42
1-4	1,458	80	1	2.0	1.3	1.0	4.3	1,538
5-9	2,068	150	2	3.5	2.8	1.9	8.2	2,218
10-14	1,572	92	4	2.7	1.7	1.9	6.1	1,664
15-19	1,098	70	3	3.8	2.0	1.9	7.6	1,168
20-39	4,145	124	5	2.2	0.8	0.8	3.8	4,269
40+	2,956	65	4	1.3	0.8	0.5	2.6	3,021
Sex								
Female	7,187	281	11	2.4	1.3	0.9	4.6	7,468
Male	6,152	300	8	2.3	1.5	1.4	5.3	6,452
Women 15-49 years								
Not pregnant	3,478	96	7	2.0	0.9	0.8	3.7	3,574
Pregnant	171	6	0	4.4	0.1	0.0	4.5	177

*Failed tests were not repeated and not included in the calculation of prevalence.

From the 114 villages surveyed, there were no malaria infections detected in 46 villages and no infections detected in children <5 years in 87 villages. Villages in which infections were found

exclusively in older children or adults may be less likely to have ongoing local transmission. For example, in the Highlands Region, malaria infected individuals were found in only nine villages, however, the infections among children were only found in one village, suggesting imported cases rather than local transmission in most villages (Table C3, Appendix C).

At the other end of the spectrum, fifteen villages with prevalence values >10% were found in all regions, except in the Highlands. In West Sepik and West New Britain Provinces, most of the surveyed villages had >10% prevalence in adults and similar values in young children (up to 47.8% in children <5 years in the West Sepik village of Amini). In the other non-Highlands provinces, there appeared to be pockets of high prevalence in children and adults, some villages with infections only in older children and adults, and some villages with no infections at all (Table C2, Appendix C).

In children below five years of age living in the villages surveyed <1600 m altitude, there was no statistically significant difference between the overall prevalence in female (4.91%) and male (4.72%) children ($P > 0.05$) (Table C4, Appendix C). In women aged 15-49 years, the difference in prevalence between women reporting to be pregnant and non-pregnant women was not statistically significant (Table D4).

Infections with P. falciparum -- including both Pf only and Mixed/Pf -- was the dominant positive result on both a national- and regional-level (Tables D1-D3). However, individual villages with a notably higher prevalence of non-Pf than P. falciparum were found in the following provinces: Western (1), Gulf (1), Milne Bay (2), Oro (1), Enga (2), WHP (1), EHP (1), Morobe (2), Madang (3), East Sepik (1), Manus (1), New Ireland (2), East New Britain (1), West New Britain (1), and Hela (1). In almost all of these villages, the non-falciparum dominance was higher in children <5 years than P. falciparum (Appendix C).

APPENDIX E: MORBIDITY INDICATORS BY PROVINCE

Table E1. Fever, anaemia, severe anaemia, and splenomegaly

Percentage of persons with reported fever, acute fever, haemoglobin below the WHO threshold for anaemia and severe anaemia, and splenomegaly, according to background characteristics, Papua New Guinea, 2019-2020

Province	Reported fever	Number of persons	Acute fever[1]	Number of persons	Anaemia[2]	Severe anaemia[2]	Number of persons	Splenomegaly[3]	Number of children
01 WESTERN	0.8	566	1.3	566	72.5	9.9	566	0.0	149
02 GULF	1.3	849	0.2	849	48.4	2.5	849	0.0	205
03 CENTRAL	2.6	621	0.6	621	60.2	3.2	621	0.0	152
04 NCD	1.8	703	0.2	703	62.3	3.8	703	0.0	156
05 MILNE BAY	1.9	562	1.2	562	62.8	2.7	562	0.0	133
06 ORO	0.2	554	1.2	554	86.9	2.9	554	0.0	161
07 SHP	0.5	663	4.1	663	44.2	0.4	663	0.0	126
08 ENGA	0.3	474	0.3	474	15.9	0.4	474	0.0	63
09 WHP	2.5	503	0.9	503	39.0	1.0	503	0.0	112
10 CHIMBU	0.4	597	0.5	597	47.5	2.1	597	0.0	153
11 EHP	4.4	632	1.1	632	34.0	0.7	632	0.0	133
12 MOROBE	1.8	817	2.9	817	67.0	2.9	817	0.0	202
13 MADANG	4.4	747	3.8	747	91.3	19.4	747	0.0	226
14 E. SEPIK	2.4	764	1.4	764	84.5	5.3	764	2.1	168
15 SANDAUN	7.4	732	1.2	732	74.7	5.3	732	1.0	196
16 MANUS	4.2	613	0.7	613	74.4	2.2	613	0.0	154
17 NEW IRELAND	4.7	576	4.4	576	76.4	4.9	576	0.0	166
18 ENB	4.6	541	0.9	541	74.7	8.8	541	19.7	174
19 WNB	1.5	464	0.8	464	17.2	0.7	464	0.7	115
20 BOUGAINVILLE	0.0	565	5.1	565	65.1	6.7	565	0.0	138
21 HELA	0.5	551	0.4	551	26.8	0.8	551	0.0	121
22 JIWAKA	1.4	761	0.1	761	33.5	2.0	761	0.0	201

[1] Acute fever was defined as axillary temperature >37.5°C

[2] Anaemia and severe anaemia were defined according to WHO recommendations, which include age-specific cut-offs and altitude corrections (WHO 2011).

[3] Splenomegaly was defined as a palpable spleen (i.e. Hackett grade 1 to 5) in children aged 2-9 years.

APPENDIX F: TREATMENT SEEKING BY PROVINCE

Table F1. Diagnosis, and treatment of persons with fever

Percentage of persons and children under age 5 with fever in the 2 weeks preceding the survey for whom advice or treatment was sought, outside the home, and percentage who had blood taken from a finger or heel for testing, according to background characteristics, Papua New Guinea, 2016-2017.

	Persons with fever			Children under age 5 with fever		
Background characteristic	Percentage for whom advice or treatment was sought[1]	Percentage who had blood taken from a finger or heel for testing	Number of persons	Percentage for whom advice or treatment was sought[1]	Percentage who had blood taken from a finger or heel for testing	Number of children
01 WESTERN	11.2	11.2	11	0.0	0.0	3
02 GULF	34.8	6.3	14	0.0	0.0	2
03 CENTRAL	87.4	30.3	22	75.3	33.2	9
04 NCD	48.7	28.6	14	62.7	23.1	3
05 MILNE BAY	100.0	100.0	6	100.0	100.0	1
06 ORO	27.1	18.4	30	27.4	10.2	10
08 ENGA	33.3	0.0	3	100.0	0.0	1
09 WHP	12.0	12.0	6	n/a	n/a	0
10 CHIMBU	0.0	0.0	1	0.0	0.0	1
11 EHP	34.7	0.0	5	0.0	0.0	1
12 MOROBE	100.0	83.3	3	100.0	100.0	1
13 MADANG	38.8	21.1	80	40.3	18.4	12
14 E. SEPIK	19.0	14.3	24	24.7	16.5	13
15 SANDAUN	27.8	13.7	13	56.2	56.2	5
16 MANUS	80.1	80.1	2	0.0	0.0	1
17 NEW IRELAND	79.3	47.9	9	100.0	50.0	2
18 ENB	49.4	32.7	16	41.1	29.8	5
20 BOUGAINVILLE	59.0	22.2	13	100.0	33.8	3

[1] Includes advice or treatment from sources outside the home.

APPENDIX G: IMPLEMENTATION TIMELINE OF MIS 2019-2020

Province	start date	end date	surveyed villages	FORM 2 (H/hold interv.)	FORM 2.1 (Treatm. seeking)	FORM 3 (Preval. quest.)	FORM 5 (Women's quest.)
Eastern Highlands	22/10/2019	28/11/2019	6	177	27	642	134
Madang	21/11/2019	19/12/2019	5	149	50	761	91
Morobe	22/11/2019	16/12/2019	5	153	17	826	181
Chimbu	26/11/2019	19/12/2019	6	167	17	600	85
Milne Bay	13/02/2020	12/03/2020	5	125	11	564	96
National Capital District	17/02/2020	13/03/2020	5	134	11	708	113
New Ireland	19/02/2020	15/03/2020	5	152	37	576	33
Jiwaka*	04/03/2020	27/05/2020	6	180	8	766	69
Southern Highlands*	18/03/2020	06/06/2020	5	150	40	673	188
Central*	19/03/2020	29/05/2020	5	136	26	623	122
East Sepik	20/05/2020	16/06/2020	5	154	15	768	149
Northern	22/05/2020	18/06/2020	5	126	12	560	8
Manus	07/06/2020	09/07/2020	5	148	9	613	115
East New Britain	09/06/2020	10/07/2020	5	128	9	543	120
West Sepik	16/06/2020	14/07/2020	5	150	37	733	137
Western	22/06/2020	26/07/2020	5	148	6	567	63
Gulf	26/06/2020	09/08/2020	5	152	15	850	191
Western Highlands	06/07/2020	13/08/2020	6	177	6	503	62
AR Bougainville	14/07/2020	08/08/2020	5	150	16	566	165
Hela	05/08/2020	21/08/2020	5	149	21	551	93
Enga	17/08/2020	04/09/2020	6	180	0	476	84
West New Britain	30/09/2020	11/10/2020	4	114	16	473	76
All	22/10/2019	11/10/2020	114	3,299	406	13,942	2,375

***** The red asterisk indicates provinces in which the MIS implementation was affected by the country lockdown in 2020 due to Covid-19.

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