NATIONAL MALARIA CONTROL PROGRAMME EVALUATION

PAPUA NEW GUINEA

MALARIA INDICATOR SURVEY 2022-2023:

FINAL REPORT ON MALARIA PREVENTION, INFECTION PREVALENCE, AND TREATMENT-SEEKING

JOSEPH G. GIDUTHURI, DIANA TIMBI, MELVIN KUALAWI, CLARA ARE, MICHA MURI, PHILEMON GOI, YANGTA URA, MANUEL HETZEL, WILLIAM POMAT

PAPUA NEW GUINEA INSTITUTE OF MEDICAL RESEARCH

GOROKA

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Authors

Joseph G. Giduthuri[1,2,3] joseph.giduthuri@swisstph.ch
joseph.giduthuri@pngimr.org.pg

Diana Timbi[1,2,3] diana.timbi@pngimr.org.pg
Melvin Kualawi[1] melvin.kualawi@pngimr.org.pg
Clara Are[1] clara.are@pngimr.org.pg
Micha Muri[1] micha.muri@pngimr.org.pg
Philemon Goi[1] philemon.goi@pngimr.org.pg
Yangta Ura[1] yangta.ura@pngimr.org.pg
Manuel W. Hetzel[2,3] manuel.hetzel@swisstph.ch
William Pomat[1] william.pomat@pngimr.org.pg

[1] Papua New Guinea Institute of Medical Research,
Goroka, EHP 441, Papua New Guinea

[2] Swiss Tropical and Public Health Institute,
Kreuzstrasse 2, 4123 Allschwil, Switzerland

[3] University of Basel,
Petersplatz 1, 4003 Basel, Switzerland

A full list of contributors can be found in Appendix H.

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EXECUTIVE SUMMARY

Background

Malaria remains a prevalent issue across Papua New Guinea (PNG), with the exception of its highland regions, where the cooler climate at altitudes above 1600 meters inhibits consistent transmission. The National Malaria Strategic Plan (NMSP) for 2021-2025 has set forth an ambitious goal to eliminate malaria from PNG by 2030. To achieve this, the NMSP outlines objectives to decrease the overall malaria burden by 63% and cut malaria-related deaths by 90% between 2019 and 2025.

Since 2004, the PNG National Malaria Control Programme (NMCP), with financial support from The Global Fund to Fight AIDS, Tuberculosis and Malaria, has been actively distributing insecticide-treated nets (ITNs) across the nation. From the latter part of 2011, the program has also expanded the availability of malaria rapid diagnostic tests (mRDTs) and artemisinin-based combination therapies (ACTs) in healthcare facilities. Furthermore, the NMCP has initiated home-based management of malaria in select regions, complemented by behavior change campaigns to bolster the adoption of both preventive measures and treatment solutions.

Methods

As part of the ongoing thorough assessment of the NMCP, the Papua New Guinea Institute of Medical Research (PNGIMR) undertook a nationwide Malaria Indicator Survey (MIS) from September 2022 to August 2023. This survey aimed to evaluate the coverage of malaria control measures and the prevalence of malaria infections on both national and regional scales. Conducted across 114 villages in all provinces except for Hela province, the survey encompassed 3,029 households, involving a total of 15,435 participants. To diagnose malaria, 12,849 capillary blood samples were collected and analyzed using mRDT and light microscopy techniques.

Results

Across PNG, 58% (95% CI 53.8, 62.0) of all households owned at least one ITN, 46.1% (95% CI 41.4, 50.7) of the population had access to an ITN and 30.7% (95% CI 26.1, 35.8) of household members slept under an ITN the night before the survey. Among children <5 years, 41.9% (95% CI 37.5, 46.3) slept under an ITN (67% among those children living in households that owned at least one ITN). Among pregnant women (15-49 years), 54.4% slept under an ITN (73.6% among those who lived in a household owning at least one ITN). ITN 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, 23.5% reported receiving three doses of Sulphadoxine-pyrimethamine (SP) as intermittent preventative treatment (IPTp) during their last pregnancy. Only 4% 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 microscopy, malaria infection was detected in 3.2% (95% CI 2.0, 5.1) of the population below an altitude of 1600 m, whereas 2% (95% CI 1.0, 4.2) was detected in highland areas at and above 1600 m. In children <5 years of age in villages <1600 m altitude, 4.4% (95% CI 3.2, 6.0) were infected with malaria parasites, whereas only one child (0.7%) was found positive for *P. falciparum* among the villages at 1600 m and above. The provinces with the highest prevalence values were Madang (10.9%), Manus (8.1%), Sandaun (7.3%), New Ireland (6.9%), Enga (6.5%), Chimbu (5%), East Sepik (4.1%), West New Britain (3.9%), Morobe (3.4%), East New Britain (3.2%) and Gulf (3%). In this MIS round, it was found that 7 of 103 surveyed villages showed malaria prevalence rates exceeding 10% and interestingly 4 highland villages reported over 8% *P. falciparum* prevalence. Otherwise, in most of the highland villages, malaria prevalence was generally negligible. Malaria prevalence of over 10% for children under 5 years of age was observed in 16 villages of Southern, Islands and Momase regions.

The target of 1.5% prevalence in children under 5 years of age was not reached on a national or regional level in areas <1600 m altitude where malaria conditions are favorable for transmission. On a provincial level, the target was met in only seven provinces. Prevalence was higher in males than in females and the difference was statistically significant among age groups in the Southern, Islands and Momase regions. Out of 103 surveyed villages, 38 villages reported no malaria infections, and in 68 villages, no infections were detected in children under 5 years of age. 17 villages showed a notable higher prevalence of *P. vivax* in three lowland regions.

A recent fever was reported by 2.5% of all household members and 1.9% had an acute fever on the day of the survey. Anemia was detected in 52.5% of all household members and 3.5% had severe anemia. Anemia was less common in the Highlands Region than in the lowlands and decreased with age. Among children 2-9 years of age, 3% had an enlarged spleen (splenomegaly), specifically in West New Britain contributing up to 78%. However, these were rated 1 on the Hackett grade.

For 54.7% of recent fever cases in the general population and for 47.1% in children <5 years, treatment was sought outside the person's home. The most common source of treatment were health facilities (52.3% in the general population, 33.3% 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 39.6% of cases in the general population and 26.1% of cases in children <5 years. The most used drugs were antimalarials (46.2%), antipyretics (31.4%), and antibiotics (13.4%). Antimalarial was taken in 9% of cases in children <5 years. The most frequently used antimalarial was the first-line treatment artemether-lumefantrine (45.8%). 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 99% and 100% 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 ITN coverage and malaria prevalence by province in five consecutive surveys over the period 2008/09 to 2022/23 are shown on subsequent pages.

Conclusion

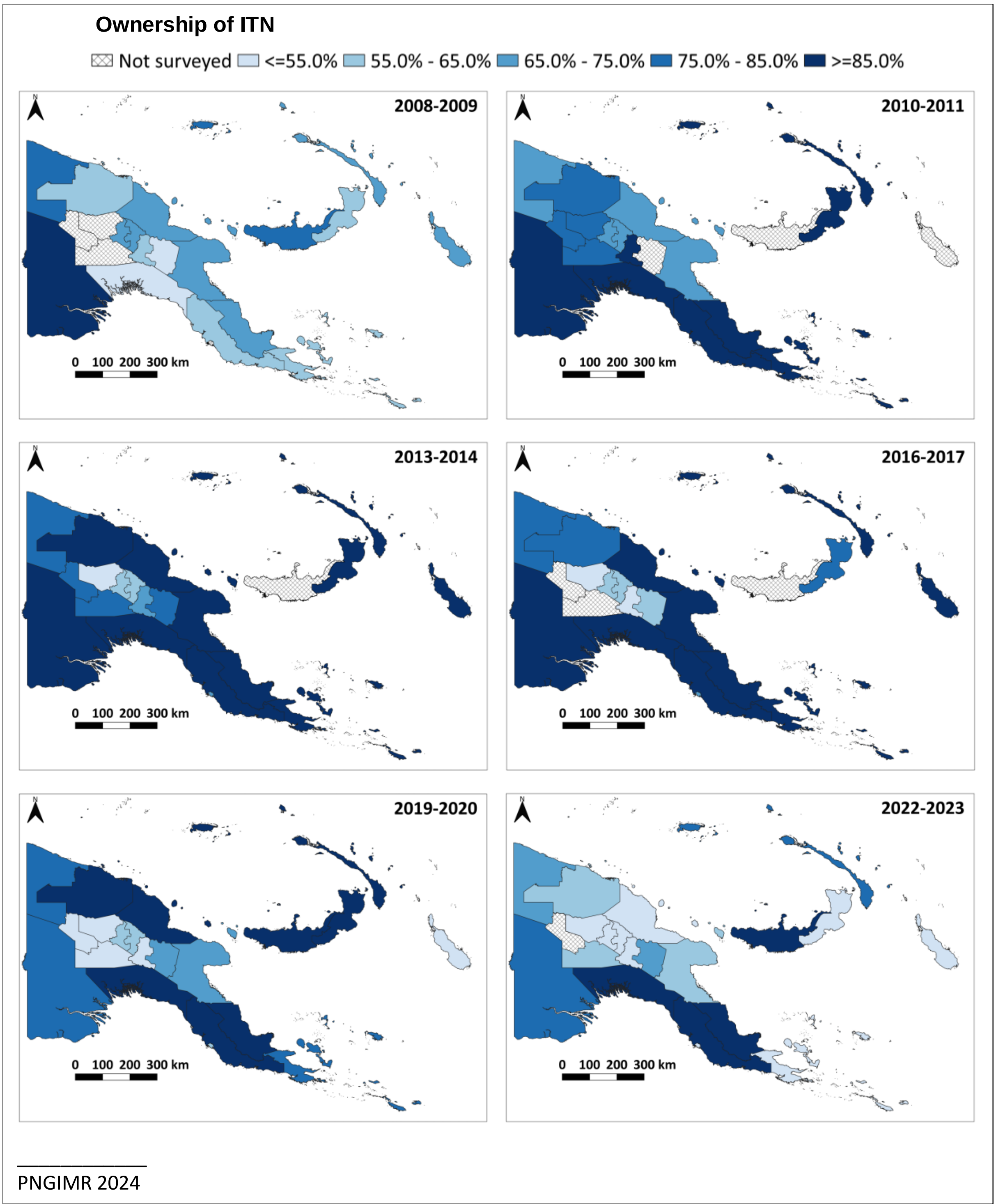
After a resurgence of malaria prevalence observed between 2013/14 and 2016/17, a decrease between 2016/17 and 2019/20 across PNG was noticed. However, in this report we identified that there was an increase in malaria prevalence with microscopy. Simultaneously, trends in ITN coverage show a reduction at national level compared to 2019/20 including 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 2020, and MIS 2023.

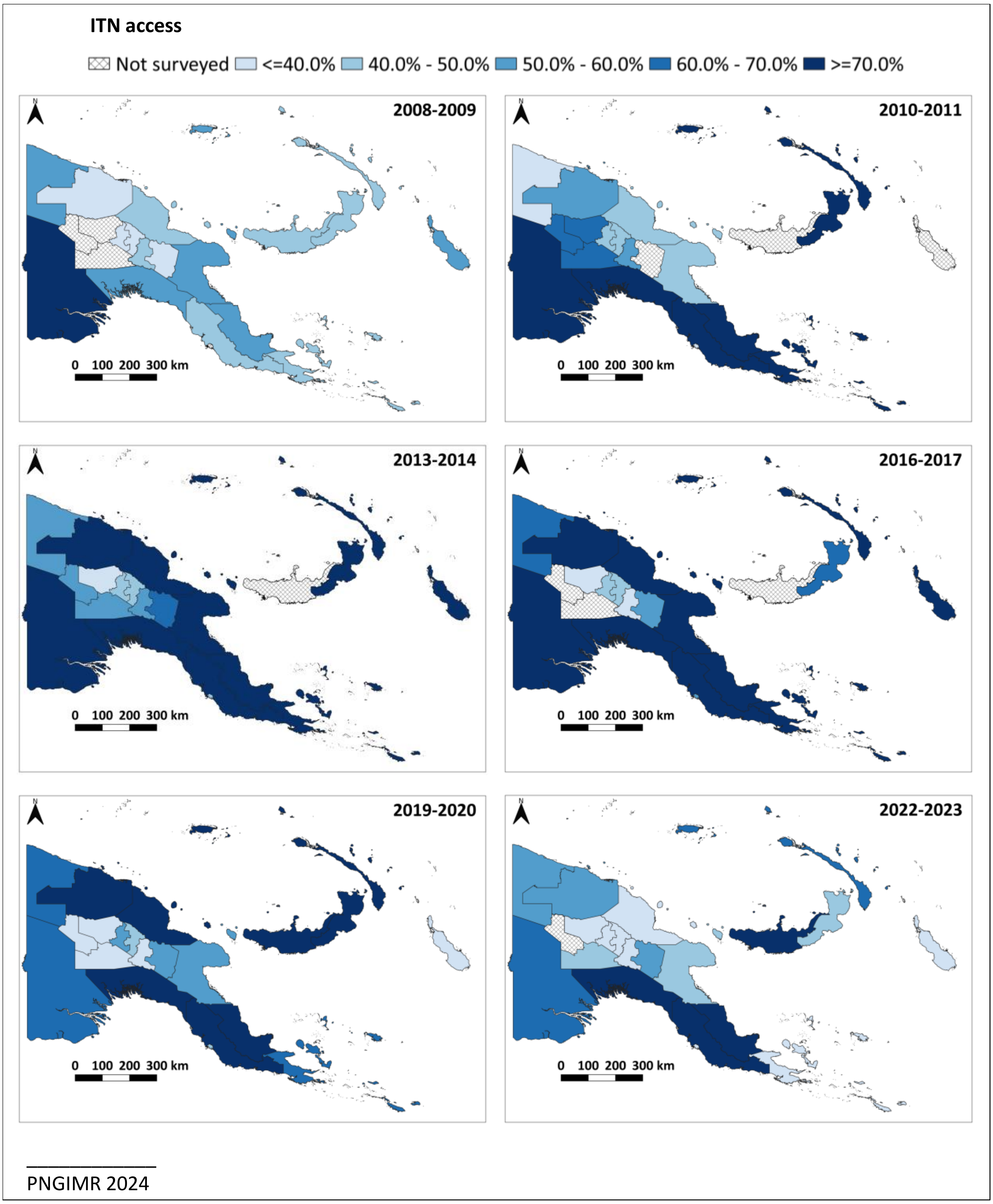
Global Fund Indicator	**MIS 2019/20** (<1600m*)	**Target 2022**	**MIS 2022/23** (<1600m*)
Parasite prevalence: Proportion of children aged 6-59 months with malaria infection (I-5)	2.1% (2.4%)	1.5%	**4.1%** (4.4%)
Proportion of population that slept under an insecticide-treated net the previous night (O-1a)	44% (51%)	60%	**31%** (33%)
Proportion of children under five years old who slept under an insecticide-treated net the previous night (O-1b)	53% (59%)	65%	**42%** (44%)
Proportion of pregnant women who slept under an insecticide-treated net the previous night (O-1c)	54% (60%)	65%	**40%** (42%)
Proportion of population with access to an ITN within their household (O-2)	57% (64%)	75%	**49%** (52%)
Proportion of population using an ITN among the population with access to an ITN (O-3)	76% (79%)	85%	**63%** (64%)
Proportion of households with at least one insecticide-treated net for every two people (O-4.1)	55% (54%)	85%	**33%** (54%)
Proportion of children under five years old with fever in the last two weeks for whom advice or treatment was sought (O-12)	57%	65%	**47%**
Proportion of women who received three or more doses of IPTp in ANC visits during their last pregnancy (O-10)	23% (27%)		**24%** (24%)

* In surveyed sites below 1600m

Trends in ITN ownership, by province, Papua New Guinea (MIS: 2008-09, 2010-11, 2013-14, 2016-17, 2019-20 and 2022-23).
Percent of households own at least one ITN.



Trends in ITN access, by province, Papua New Guinea (MIS: 2008-09, 2010-11, 2013-14, 2016-17, 2019-20 and 2022-23).
Percent of people with access to an ITN within their household.



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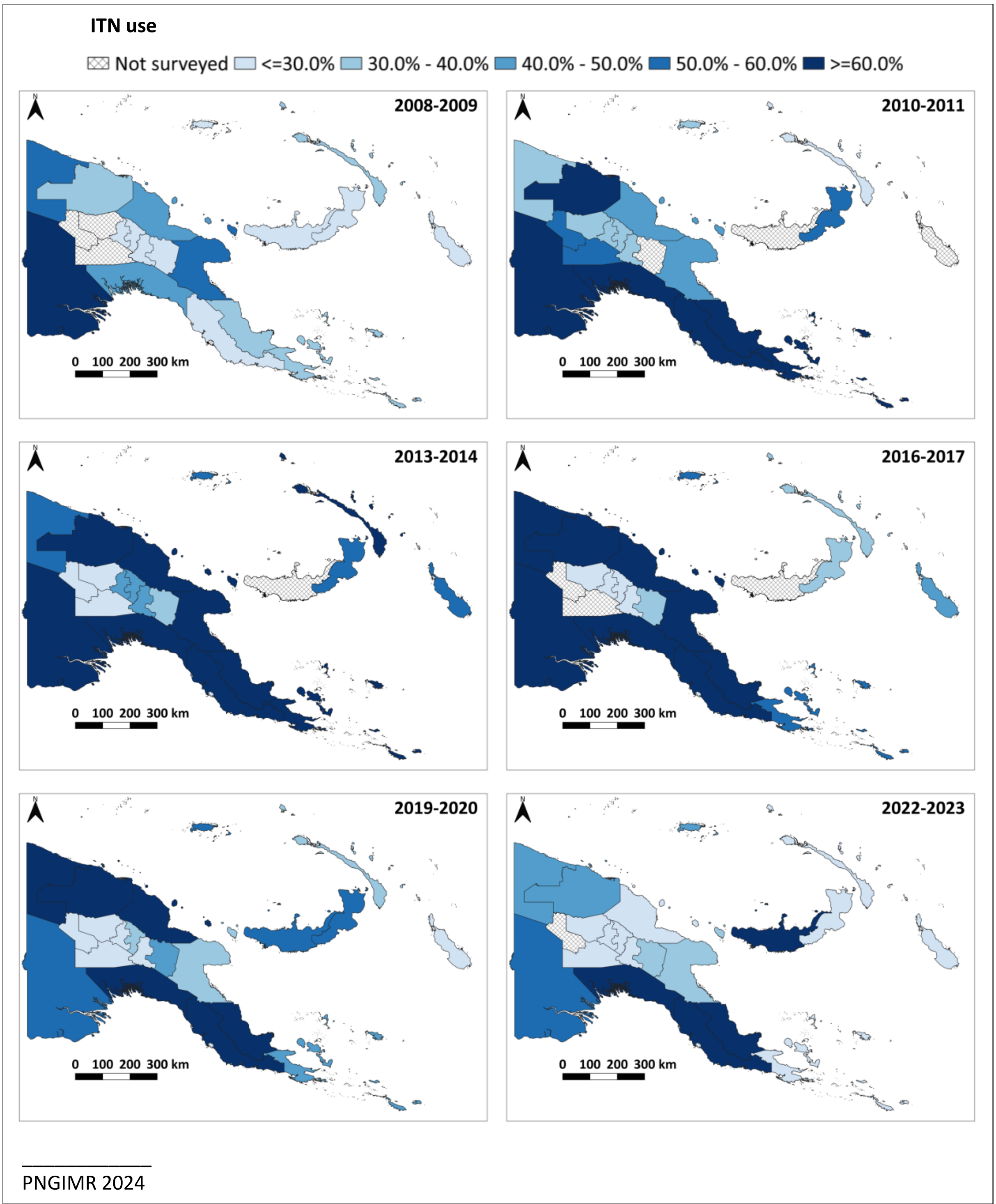
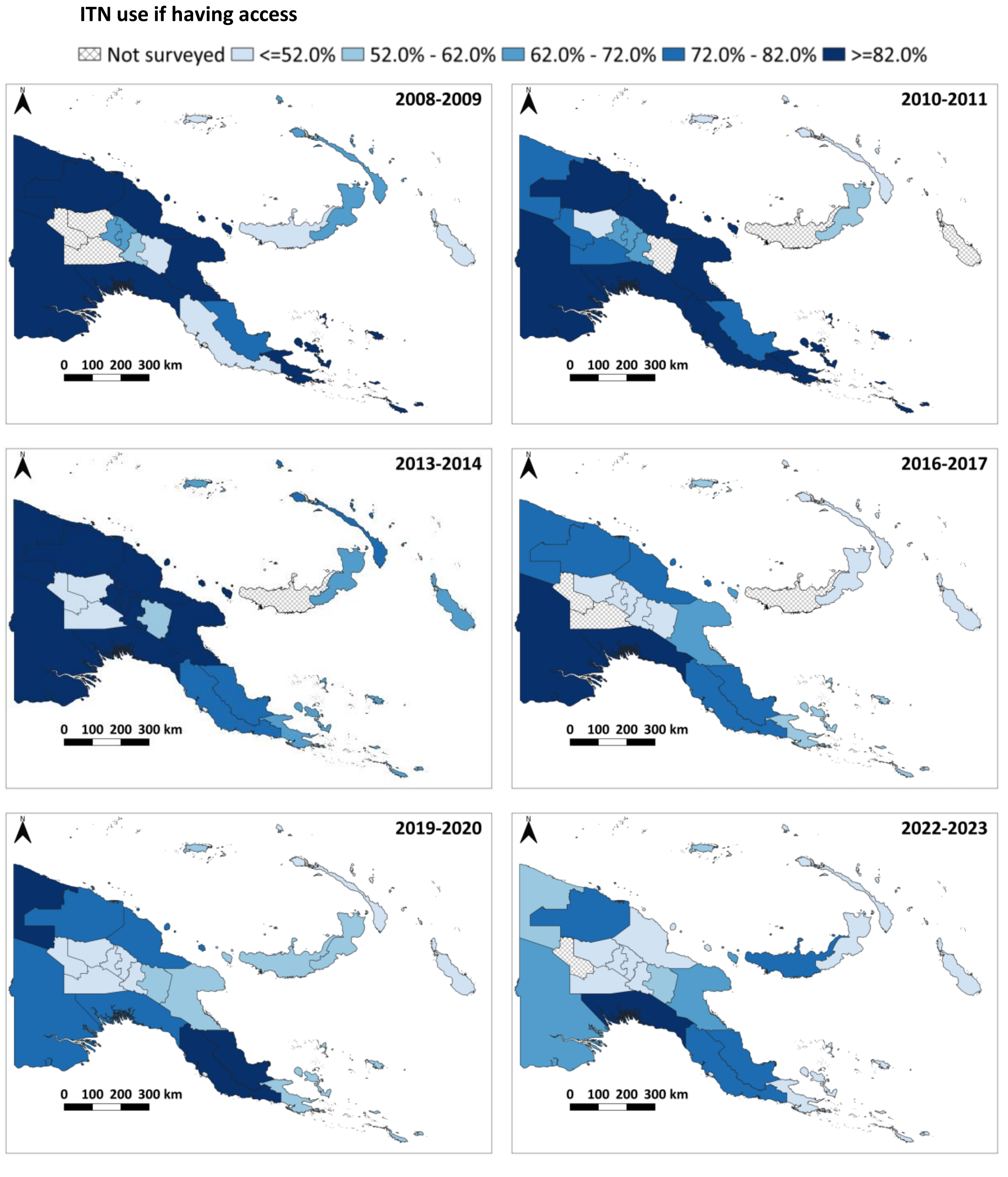
Trends in ITN use, by province, Papua New Guinea (MIS: 2008-09, 2010-11, 2013-14, 2016-17, 2019-20 and 2022-23).
Percent of people using an ITN the night before the survey.

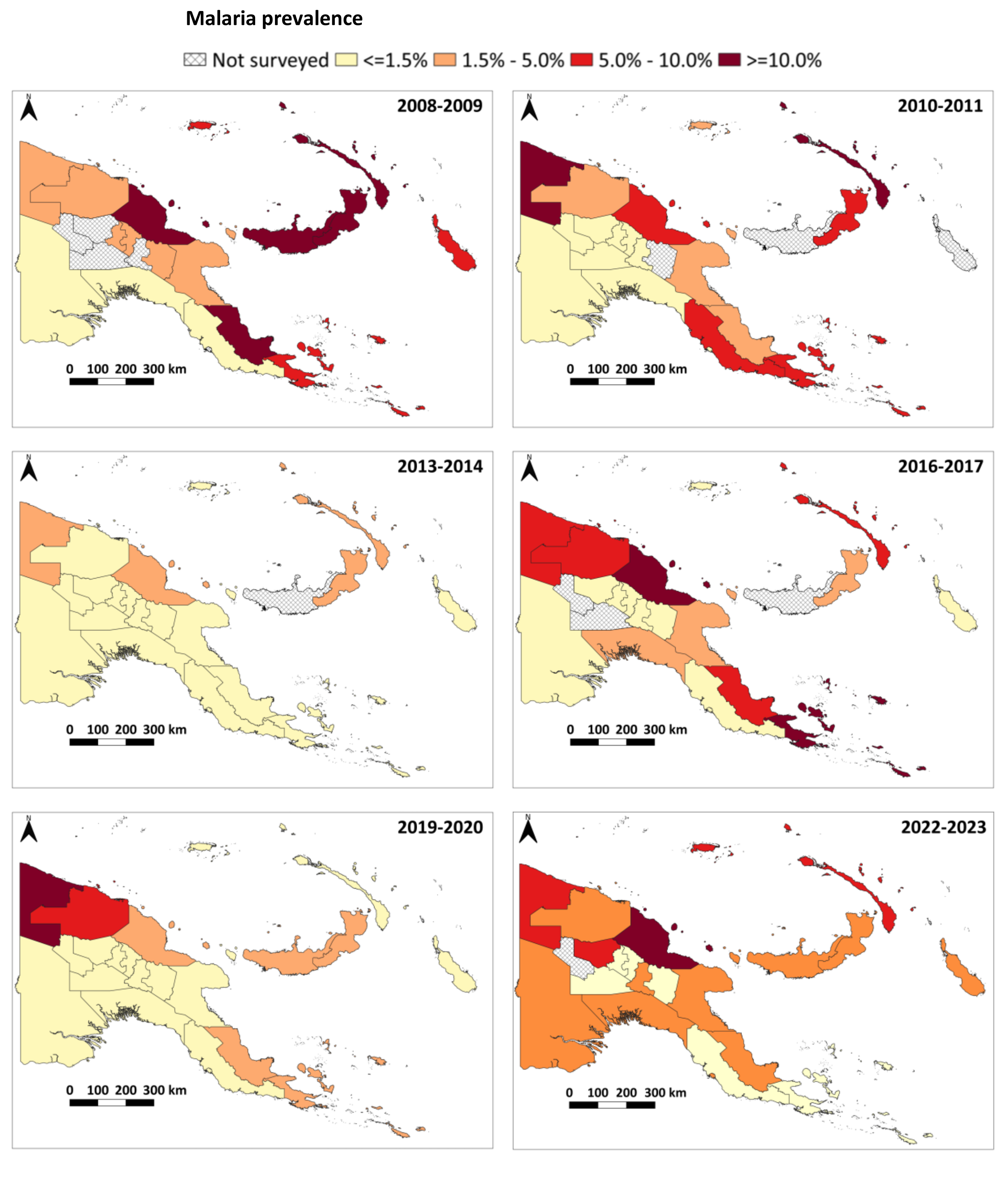


Trends in ITN use among those with access, by province, Papua New Guinea (MIS: 2008-09, 2010-11, 2013-14, 2016-17, 2019-20 and 2022-23).
Percent of people with access to ITN using an ITN the night before the survey.



PNGIMR 2024

Trends in malaria prevalence, by province, Papua New Guinea (MIS: 2008-09, 2010-11, 2013-14, 2016-17, 2019-20 and 2022-23).
Percent of people infected with *Plasmodium* parasites (any species), by light microscopy.



PNGIMR 2024

CONTENTS

LIST OF TABLES

ABBREVIATIONS

ACT	Artemisinin-based Combination Therapy
AL	Artemether-Lumefantrine
AM	Anti-Malarial
APLMA	Asia Pacific Leaders Malaria Alliance
CI	Confidence Intervals
EHP	Eastern Highland Province
ENB	East New Britain
GPS	Global Positioning System
Hb	Heamoglobin
HF	Health Facility
INDEPTH	International Network for the Demographic Evaluation of Populations and Their Health
IPTp	Intermittent Preventive Treatment during Pregnancy
IRB	Institutional Review Board
ITN	Insecticide Treated Net
LLIN	Long-Lasting Insecticidal Net
LM	Light Microscopy
MIS	Malaria Indicator Survey
MRAC	Medical Research Advisory Committee
mRDT	Malaria Rapid Diagnostic Test
NCD	National Capital District
NDOH	National Department of Health
NHIS	National Health Information System
NMCP	National Malaria Control Programme
P.f.	Plasmodium falciparum
P.m.	Plasmodium malariae
P.v.	Plasmodium vivax
PNG	Papua New Guinea
PNGIMR	Papua New Guinea Institute of Medical Research
RAM	Rotarians Against Malaria
SDG	Sustainable Development Goal
SHP	Southern Highland Province
Swiss TPH	Swiss Tropical and Public Health Institute
UNICEF	United Nations Children Fund
WHO	Work Health Organization
WHP	Western Highland Province
WNB	West New Britain

1 INTRODUCTION

1.1 The PNG National Malaria Control Programme

In Papua New Guinea (PNG), malaria is a major public health issue, historically endemic in most regions except for high-altitude areas over 1600 m, where low temperatures prevent stable local transmission, though occasional epidemics have occurred [1, 2]. The disease is caused by four human pathogenic parasites - *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, and *Plasmodium ovale* - transmitted through a variety of *Anopheles* mosquitoes, each uniquely adapted to different ecological niches [3].

The turning point in PNG's battle against malaria began with significant financial backing from the Global Fund to Fight AIDS, Tuberculosis and Malaria (The Global Fund), which started supporting the National Malaria Control Programme (NMCP) in 2004. This support catalyzed a series of national campaigns that provided insecticide-treated nets (ITN) to households since 20025 and scaled up the availability of malaria rapid diagnostic tests (mRDT) and artemisinin-based combination therapy (ACT) across health facilities nationwide since late 2011 [4, 5]. These measures were complemented by home-based management of malaria programmes in selected areas of the country and behavior change campaigns, aimed to improve coverage and uptake of interventions.

Integral to the NMCP's success has been its operational framework, characterized by a partnership-centric approach involving National and Provincial Departments of Health, non-governmental organizations, the private sector, and academic and research institutions. Under the Global Fund malaria grant for the period 2021 to 2023, Rotarians Against Malaria (RAM) acted as sole principal recipient in charge of all programme components incl. ITN distribution, home-based malaria management and nationwide behavior-change communication, as well as monitoring and evaluation.

The National Malaria Strategic Plan (2021-2025) encapsulates PNG's ambitious vision of achieving a malaria-free status by 2030 [6]. The plan sets forth short-term aims to significantly reduce malaria-related morbidity by 63% and mortality by 90% between 2019 and 2025 and aims to eliminate malaria transmission in specific regions like Bougainville. This vision aligns with the broader goal of the Asia Pacific Leaders Malaria Alliance (APLMA) to eliminate malaria in the region by the same year [7].

A detailed monitoring and evaluation system is part of the Global Fund's grants. The Papua New Guinea Institute of Medical Research (PNGIMR) has been contracted to independently evaluate the NMCP effectiveness and impact. This evaluation provides scientific evidence of PNG's advancements in implementing control measures and reducing the malaria burden. Additionally, the Swiss Tropical and Public Health Institute (Swiss TPH) has provided technical and scientific support to this evaluation process. PNGIMR's evaluation measures key outcome and impact indicators against targets set in the Global Fund grant performance framework, following standardized methodological approaches. Moreover, it aims to deliver precise, current data on various aspects of PNG's changing malaria epidemiology and the provision of malaria-related services. PNGIMR's evaluation encompasses a range of data-gathering methods to concurrently monitor changes in intervention coverage, as well as trends in malaria morbidity [8].

1.2 PNG Malaria Indicator Surveys

Epidemiological studies conducted by the PNGIMR through various Malaria Indicator Surveys have provided a comprehensive understanding of the changing malaria landscape in Papua New Guinea over the years. The reports of the past five MIS conducted between 2008-09 and 2019-20 revealed shifts in malaria prevalence intervention coverage, reflecting the overall impact of control measures in light of funding variations and possibly other contextual developments.

The first MIS in 2008-09, conducted after the initial nation-wide distribution of ITNs by the National Department of Health (NDOH) marked a critical phase in malaria control, with the prevalence of malaria in villages below 1600 m altitude recorded at 11%. This period saw the initiation of substantial control efforts with ITNs, funded by the Global Fund, prior to the large-scale implementation of RDT-testing and before introducing ACT. The subsequent MIS in 2010-11 indicated that the distribution of ITNs had led to a notable decrease in malaria prevalence across different age groups and regions. The survey also highlighted the widespread use of ITNs, supporting their role in reducing malaria transmission.

By the time of the 2013-14 MIS, these efforts had led to a significant reduction in malaria prevalence, dropping to less than 1% in lower altitude areas [9]. This period also saw a marked decrease in the incidence of test-confirmed malaria cases in sentinel surveillance sites. Incidence of test-confirmed cases in sentinel surveillance sites dropped by 85-90% immediately after the first country-wide distribution of ITN 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]. The 2016-17 MIS presented a concerning resurgence in malaria prevalence, increasing to 9.5% in areas below 1600 m altitude. This increase coincided with reduced funding for malaria control, a decrease in the availability of ACT and mRDTs across PNG [12]. Additionally, the effectiveness of ITNs distributed post-2013 was questioned due to their reduced bio-efficacy against local *Anopheles* vectors [13].

The most recent 2019-20 MIS report further elaborated on these challenges, indicating a continued struggle to maintain the gains achieved in the earlier years. The survey underscored the need for sustained funding, effective intervention strategies, and continuous monitoring of vector behavior and resistance patterns to ensure the effective management of malaria in PNG. The fluctuating trends in malaria prevalence and net usage observed at national and regional levels across these surveys highlight the dynamic nature of malaria epidemiology in the region, influenced by a complex interplay of environmental, socio-economic, and health system factors [14].

The 2022-23 MIS for PNG is critically important in the continuous fight against malaria. This survey is crucial for assessing the current malaria situation, particularly considering the resurgence seen in recent years and the challenges identified in the 2019-20 MIS report. It provides important data on the impact of current malaria control strategies in terms of infection prevalence, on intervention coverage including the ownership, access, and use of ITNs, and it helps in identifying areas where intervention efforts need to be intensified. Additionally, the 2022-23 MIS is instrumental in informing policymaking, optimizing resource allocation, and developing future strategies for malaria control and elimination in PNG, ensuring they are informed by the most recent and accurate data.

1.3 Objectives of the Malaria Indicator Survey

The 2022-2023 MIS was designed to evaluate the extent of malaria control intervention coverage across the population and the prevalence of malaria infections across all age groups, in alignment with the targets set in the Global Fund grant performance framework. Additionally, the survey aimed to generate national and regional estimates of these outcomes, facilitating comparisons with data from surveys conducted in prior years. Estimates below the regional level can not necessarily be considered representative for the respective administrative unit due to a small number of observations per unit. Key objectives included assessing the current prevalence of malaria and evaluating the impact of existing malaria control strategies.

1.4 Map of PNG with survey villages

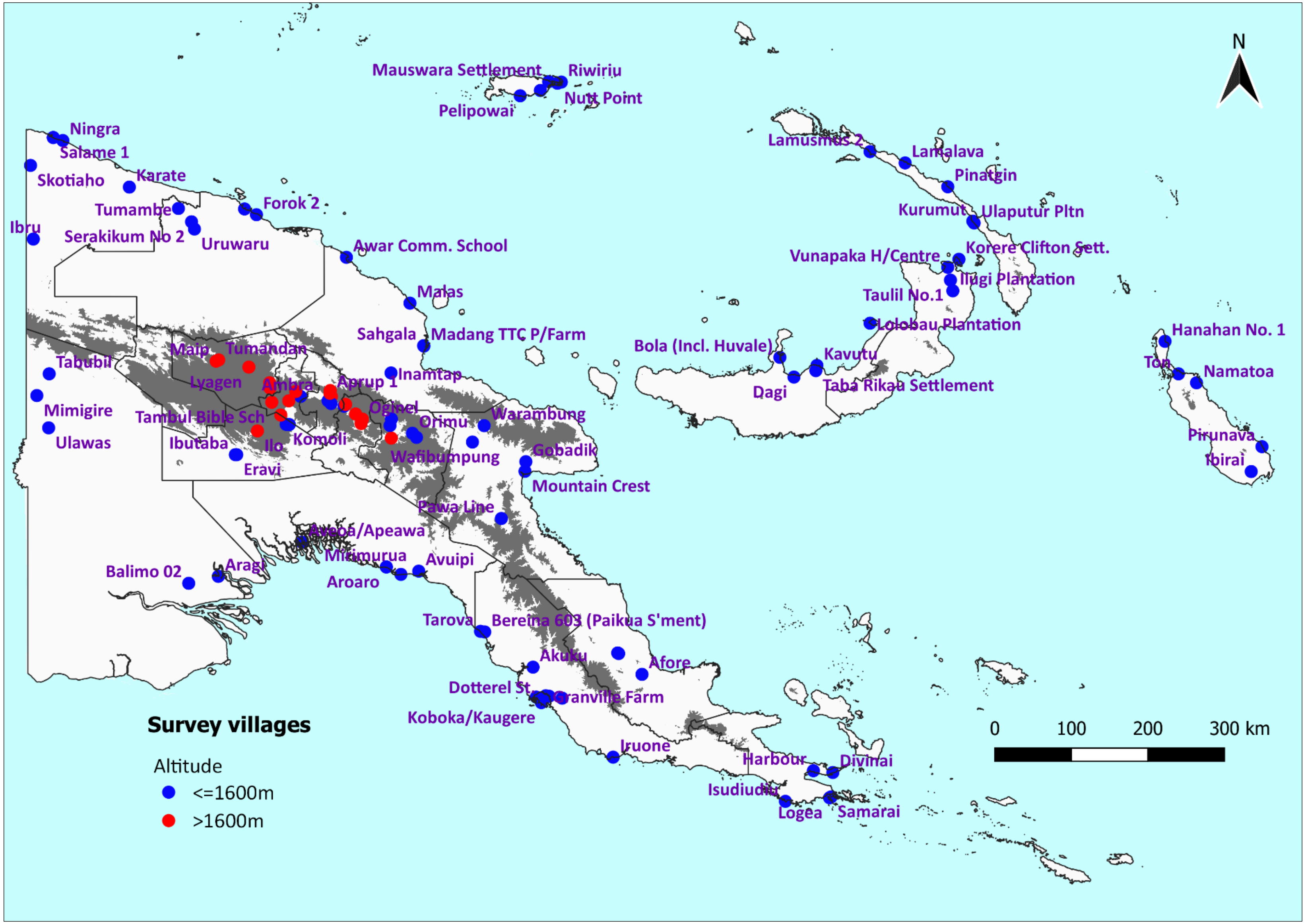


Figure 1: Map of Papua New Guinea showing provincial borders and the location of survey villages in two altitudinal strata

2 METHODOLOGY

2.1 Sample design

The design for the 2022-23 Malaria Indicator Survey (MIS) mirrored the protocols of preceding surveys (2013/14, 2016/17 and 2019/20) to evaluate the National Malaria Control Program (NMCP) [13]. All these surveys were implemented by the PNGIMR. A province-stratified, multi-stage sampling strategy was used, drawing from the 2011 National Census village ("census units") database as the sampling frame[1]. Stata 16.1 (Stata Corp LLP, College Station, TX, USA) software facilitated the random selection of five villages from each province, with an equivalent number of backup villages identified, excluding the initially selected. Accessibility issues due to logistical or security concerns warranted the use of backup villages.

Upon entering each chosen village, a detailed household list was conducted by the survey team leader with the help of local representatives. Subsequently, up to 30 households were randomly selected through a tablet-based Random Number Generator application. Within these households, interviews were conducted with heads of households, women between 15-49 years, and individuals associated with recent illness episodes, while all household members were eligible for capillary blood sampling. This methodological approach ensured a thorough and representative analysis of malaria prevalence and coverage of control interventions across various provinces and demographic segments.

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 [15] 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 ODK (an open-source mobile data collection platform) 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 ITNs, exposure to behavior 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 later treatment seeking behavior, 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 hemoglobin (Hb) and malaria testing was recorded alongside the results of the Hb measurement, the mRDT test result and the Hackett grade reflecting 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 Malaria and anemia testing

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 (Parascreen® Pf. HRP2/pLDH Test, Zephyr Biomedicals) was performed and a microcuvette sample was prepared to measure Hb levels using a handheld HemoCue Hb 201+ analyzer (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 [16]. Participants with a persistent fever, diagnosed with malaria through RDT, and treated with ACT within the preceding two weeks, were recommended for health facility referral. Moreover, participants testing RDT positive and showing either a hemoglobin level below 8 g/dl or signs of severe malaria were categorized as severe cases and referred to the nearest health facility immediately.

Malaria diagnosis by light microscopy was performed at the PNGIMR in Madang following established procedures [16, 17]. 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 2022-23 MIS was conducted across 21 of PNG's 22 provinces, navigating through substantial challenges such as security concerns and logistical difficulties. This undertaking began in the wake of the country's general national elections, a period marked by heightened tensions. Notably, the survey in Hela province was not conducted due to a security emergency in the region. In Oro province of the Southern region, the survey team successfully completed the fieldwork in three villages. However, due to a robbery attempt on their vehicle, they were compelled to return to the PNGIMR headquarters in Goroka. Overcoming these challenges, the PNGIMR effectively completed the survey in 103 villages within the four regions of the country. The MIS in PNG typically requires a longer duration to complete compared to similar surveys in other countries. This extended timeframe is primarily due to operational considerations in a setting with logistical and security challenges.

The survey spanned from September 2022 to August 2023 and was conducted by four trained PNGIMR field teams operating simultaneously in different locations. Each field team was comprised of at least one nursing officer, one or more scientific officers, and one or two research assistants. Comprehensive training was provided to all team members, covering the project background, survey protocol and methods, survey instruments, and blood sample collection techniques for the nursing officers.

Before starting the survey in a specific province, provincial health authorities were briefed about the survey's scope, selected sites, and schedule. A local health officer was requested to accompany the survey team. Upon arrival at a survey village, the team engaged with local village leaders or councilors to explain the survey's purpose and procedures. With the community's consent and assistance from the village leader or councilor, the team leader compiled a list of households and conducted random sampling using a random number table. The geographical locations and elevations of the villages were recorded using a hand-held GPS device (Garmin). On average, the survey teams spent 3 to 5 days in each village.

2.5 Data management and analysis

All data were collected electronically using the 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 project ODK Central server at the Swiss TPH in Allschwil, Switzerland, using the available local mobile phone network (Digicel PNG). ODK form and data management were led by PNGIMR with authorized PNGIMR investigators having unrestricted access to the uploaded data. The datasets were downloaded directly from the ODK Central server and exported to Stata/SE 16.1 (StataCorp LLC, College Station, TX, USA) for analysis.

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 equaled the weights of the households to which an individual belonged.

Mosquito net ownership and use indicators were calculated following standard procedures [19]. The proportion of the population with access to an ITN was calculated by dividing the number of ITN sleeping spaces (assuming two per ITN) 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 an ITN" was calculated by dividing the number of people using an ITN 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 [20].

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) [21]. 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 earlier 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 anemia following the world health organization (WHO) definitions including age-specific cut-offs and altitude correction [22].

Binary variables were compared using χ^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. 2108) and the Medical Research Advisory Committee (MRAC) of the PNG National Department of Health (MRAC No. 21.05).

Prior to beginning 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 taken to conduct the survey in the 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 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 give 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 the use of health services and other health behaviors 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 includes 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 conducted in 103 villages located in 21 provinces. Of these villages, 74 (71.8%) were located below 1200 m altitude, 10 (9.7%) between 1200 and 1599 m, and 19 (18.4%) at 1600 m or above (Figure 1). Of the total villages surveyed, 90 (87.4%) of villages are in rural areas, and 13 (12.6%) villages are in an urban locality. All urban sites were from the lowest altitude category and located in the towns of Port Moresby, Lae, Madang, Balimo, Lorengau, Alotau and Kimbe.

The survey was completed in 3,029 households comprising a total *de jure* population of 16,156 usual residents. The *de facto* population of individuals present in the household the night before the survey amounted to 15,435.

> The *de jure* population is all persons who are usual residents of the selected households, whether 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, 10.6% were children below 5 years of age and 50.8% were female. The survey also included 110 women aged 15-49 years who reported to be pregnant. A total of 158 household members (incl. 16 children <5 years) had experienced a febrile illness episode in the past 2 weeks.

Details of the distribution of surveyed households and of the survey population by location, altitude, age group, and sex are 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 shows a substantial number of children and a high birth rate. As the age increases, the pyramid narrows quickly, which suggests a lower life expectancy and higher mortality rates at younger ages. The study population was predominantly youthful, with a substantial proportion of the population under 15 years of age (35.6%, Table A1). Sex distribution was relatively balanced in youth but shows a slight increase in females over males in older age groups.

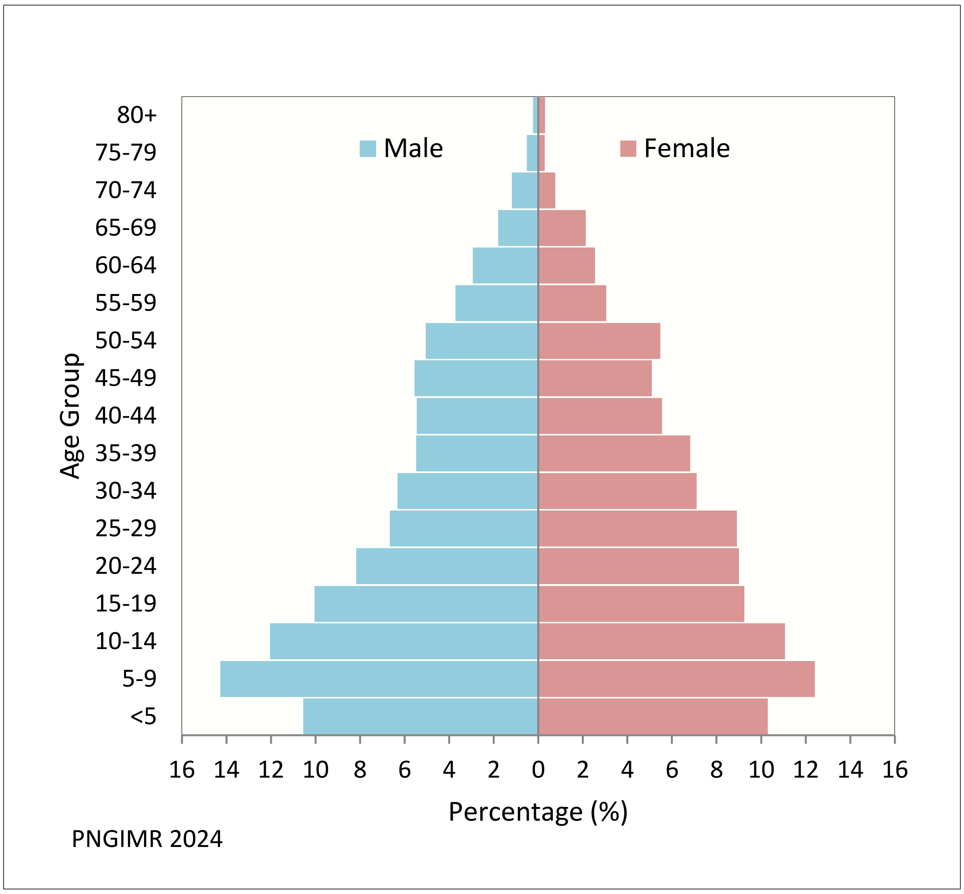


Figure 2. Study population pyramid
Percent distribution of the household population by sex and five-year age group

3.1.2 Drinking water sources

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

Across PNG, significant differences were seen in the sources of household drinking water between rural and urban areas. The data from the surveyed households revealed a predominant reliance on unimproved water sources in rural regions, with 53.0% of households depending on surface water such as rivers, streams, lakes, and ponds. In contrast, urban areas showed a higher access to improved water sources, with 25.2% of households having water piped directly into the dwelling and 39.6% using neighborhood or public taps. The use of protected wells was notably minimal in urban areas (0.6%) compared to rural areas (4.0%). Additionally, a sizable part of rural households (22.7%) relied on water tanks or rainwater, slightly less than the 29.1% in urban areas (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, 2022-2023

	Residence[1]		
Characteristic	Rural	Urban	Total
Main source of drinking water			
Improved source			
Piped into dwelling	1.0	25.2	4.2
Piped into neighborhood / public tap	5.2	39.6	9.8
Protected well (public/private)	4.0	0.6	3.6
Water tank/rainwater	22.7	29.1	23.6
Unimproved source			
Open well (public/private)	14.1	3.6	12.7
Surface water (river, stream, lake, pond, etc.)	53.0	2.0	46.1
Other source	0.0	0.0	0.0
Number of households	2648	381	3029

[1] Weighted proportion

3.1.3 Sanitation services

Improved toilet facilities include toilets of the following types: own or shared pit latrines with slab, owned or shared flush toilet and composting toilets[2].

A stark contrast in sanitation infrastructure was noticed between rural and urban settings in the survey. The most common toilet facilities that were used across PNG were open pit latrines, which were used by 55.7% of households. In urban settings, improved sanitation facilities, such as flush toilets, are more commonly available, with 22.4% of urban households having their own flush toilet, compared to a mere 2.1% in rural households. Additionally, shared flush toilets are used by 11.1% of urban households, indicating a higher level of sanitation infrastructure in urban centers. (Table 2). Conversely, rural areas show a heavy reliance on unimproved sanitation options. A striking 58.1% of rural households use their own open pit latrine, and 16.5% share one, compared to 40.3% and 8.4%, respectively, in urban areas. Open defecation,

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

a critical public health concern, is reported by 12.2% of rural households, highlighting a significant challenge in rural sanitation practices.

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, 2022-2023

	Residence[1]		
Type and location of toilet/latrine facility*	Rural	Urban	Total
Improved sanitation			
Shared pit latrine with slab	2.5	2.1	2.4
Own pit latrine with slab	8.7	10.6	8.9
Shared flush toilet	0.7	11.1	2.1
Own flush toilet	2.1	22.4	4.8
Unimproved sanitation			
Shared open pit latrine	16.5	8.4	15.4
Own open pit latrine	58.1	40.3	55.7
Closet over sea/river	1.0	9.9	2.2
Open defecation (no facility/bush/field)	12.2	2.5	10.9
Number of households	2648	381	3029

[1] Weighted proportion
* Multiple answers were allowed

Unsafe water, inadequate sanitation, and poor hygiene practices are major contributors to the global health burden, resulting in approximately 1.4 million deaths annually, with diarrheal diseases accounting for 71.4% of these fatalities. An estimated 385,000 of these deaths are children under the age of five [23]. In 2022, 2.2 billion still lacked access to safely managed drinking water, including 115 million people drinking surface water. Data from this MIS broadly confirms findings in a recent report by WHO and UNICEF, that found PNG to be one of the countries in East Asia and the Pacific without safely managed national drinking water coverage, the country with the lowest proportion of access to basic drinking water services and with insufficient progress towards achieving SDG 6 (clean water and sanitation) [24].

Compared to the last MIS in 2019-20, the water supply and sanitation situation has remained largely unchanged, particularly in rural settings. Most rural households in PNG remain without access to safe water and improved sanitation facilities, which are crucial for preventing contact with human waste and reducing the transmission of waterborne diseases such as typhoid, cholera, and others. Achieving the United Nations Sustainable Development Goal 6, which aims to ensure availability and sustainable management of water and sanitation for all, remains a critical concern [25].

3.1.4 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 (Table 3). 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.

In terms of lighting, a majority of rural households rely on solar power (54.3%) and battery lanterns (27.8%), compared to urban areas where electricity is the predominant source of lighting (62.8%). Solar power, though significantly used in urban areas (27.8%), still lags the rural adoption rate. The use of candles, lanterns/lamps, and other traditional lighting methods is minimal across both settings. Compared to the previous MIS in 2019-20, rural electrification has remained largely unchanged (11.3% in 2019-20).

Flooring material varies greatly between rural and urban residences. Earth or sand flooring are more common in rural areas (27.7%) than in urban areas (3.9%), while wood flooring dominates in both environments, more so in urban areas (66.8%) compared to rural (45.9%). Polished wood and cement or tiles are more prevalent in urban settings, indicating better housing quality.

Outer wall materials also show a clear urban-rural divide. Bamboo or pitpit and sago palm leaves are predominantly used in rural areas, reflecting traditional building materials, whereas urban households are more likely to use wood, plywood, Masonite/Fibro, cement, bricks, and iron sheets, suggesting more durable construction.

Roofing materials further underscore these differences, with thatched grass and sago palm leaves more common in rural homes, while corrugated iron is the primary choice for both rural (51.6%) and urban (90.9%) households, indicating its widespread acceptance as a durable roofing material. Cooking fuel choices reveal a reliance on firewood in rural areas (86.5%), with urban households also using it significantly (61.1%). Urban areas show a higher diversity in cooking fuels, including electricity (22.0%) and gas, which are almost non-existent in rural settings.

This comprehensive overview of housing characteristics in the survey sample underscores the notable contrasts in living conditions between rural and urban areas, reflecting the broader challenges in infrastructure and access to modern amenities. The data highlights the urgent need for targeted interventions to improve housing quality and access to basic services across the country, especially in rural areas. Table 4 provides details on possession of selected durable household goods, means of transport and livestock. In terms of household effects, there is a notable disparity in ownership between rural and urban areas. While mobile phones are widely owned across both settings (71.6% in rural and 85.9% in urban areas), urban households have significantly higher ownership of televisions (36.8% compared to 10.8% in rural areas) and refrigerators (28.7% in urban areas versus 4.0% in rural areas). Radios are common in both rural and urban settings, with a slight difference in ownership (20.6% in rural vs. 21.6% in urban).

Table 3. Housing characteristics

Percent distribution of households by housing characteristics, according to residence, Papua New Guinea, 2022-2023

	Residence[1]		
Housing characteristic	Rural	Urban	Total
Lighting			
None	1.4	0.0	1.2
Candle	0.3	0.0	0.2
Lantern/lamp	0.8	1.9	1.0
Battery lantern	27.8	7.5	25.1
Solar power	54.3	27.8	50.8
Electricity	15.4	62.8	21.7
Pressure lamp/ Coleman	0.1	0.0	0.1
Other	0.0	0.0	0.0
Flooring material			
Earth/sand	27.7	3.9	24.5
Palm/bamboo/grass	20.5	1.9	18.0
Wood	45.9	66.8	48.7
Polished wood	3.4	18.4	5.4
Cement/tiles	2.6	9.0	3.4
Other	0.0	0.0	0.0
Outer wall material			
Bamboo / pitpit	52.2	2.3	45.5
Sago, palm leaves	15.3	2.7	13.6
Wood	19.3	33.5	21.2
Plywood	2.1	9.6	3.1
Masonite/Fibro	4.2	24.3	6.9
Cement or bricks	0.2	9.1	1.4
Iron sheets	6.8	18.5	8.4
Other	0.1	0.0	0.1
Roofing material			
Thatched grass	21.2	0.2	18.4
Sago palm leaves	26.7	6.9	24.1
Corrugated iron	51.6	90.9	56.8
Wood planks	0.6	2.0	0.8
Cement	0.0	0.0	0.0
Other	0.0	0.0	0.0
Cooking fuel			
Firewood	86.5	61.1	83.1
Small twigs/tree branches/coconut shell	11.1	9.6	10.9
Kerosene	0.3	1.2	0.5
Gas	0.0	0.7	0.1
Electricity	1.4	22.0	4.2
Other	1.1	6.6	1.8
Number of households	**2,648**	**381**	**3,029**

[1] Weighted proportion

When it comes to means of transport, bicycles, motorbikes, and cars/trucks are more commonly owned in urban areas, reflecting better economic status or possibly the greater need for such transport in more densely populated areas. Interestingly, dugout canoes and boats with motors are also more prevalent in urban areas, suggesting that waterways are an important mode of transport across the country.

Ownership of farm animals shows significant differences, with rural households more likely to own chickens (31.0%), pigs (38.5%), and goats and sheep (7.9%), indicating a reliance on subsistence farming and livestock rearing. Urban households, on the other hand, have markedly lower rates of livestock ownership, with chickens (7.2%) and pigs (1.8%) being the most notable examples. The presence of cassowaries and cows is minimal across both settings, but slightly higher in rural areas.

Table 4. Household possessions

Percentage of households possessing various household effects, means of transportation, and livestock/farm animals, according to residence, Papua New Guinea, 2022-2023.

	Residence[1]		
Possession	Rural	Urban	Total
Household effects			
Radio	20.6	21.6	20.7
Television	10.8	36.8	14.3
Mobile phone	71.6	85.9	73.5
Non-mobile telephone	0.4	0.8	0.4
Refrigerator	4.0	28.7	7.3
Means of transport			
Bicycle	6.5	9.0	6.9
Motorbike	0.4	0.5	0.4
Car/truck	2.9	11.8	4.1
Dugout, canoe (without motor)	11.1	18.3	12.1
Boat with a motor	2.4	4.9	2.7
Ownership of farm animals[1]			
Chicken	31.0	7.2	27.8
Cassowaries	0.7	0.0	0.6
Goats and sheep	7.9	0.3	6.9
Pigs	38.5	1.8	33.6
Cows	0.911	0.2	0.820
Number of households	**2,648**	**381**	**3,029**

[1] Weighted proportion

Data from Table 4 reflecting the varying lifestyles, economic opportunities, and possibly the infrastructural differences between urban and rural settings of PNG. The higher ownership of modern appliances and means of transport in urban areas contrasts with the rural reliance on livestock and traditional means of transport, underscoring the diverse socio-economic conditions across the country.

3.2 Malaria prevention: mosquito net coverage

This chapter provides results on the population coverage with insecticide-treated nets (ITNs)[3]. Mosquito net coverage was assessed for all households (N = 3,029) and use was assessed for all *de facto* household members (N = 15,435).

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 ITN within their household (O-2)	**75%**
Proportion of population using an ITN among the population with access to an ITN (O-3)	**85%**
Proportion of households with at least one insecticide-treated net for every two people (O-4.1)	**65%**

3.2.1 Mosquito net ownership

Across PNG, 58.0% (95% CI 53.8, 62.0) of households owned at least one ITN, with 46.1% (95% CI 41.4, 50.7) having at least two ITNs, and an average of 1.5 (95% CI 1.3, 1.6) nets per household. The percentage of households with at least one ITN for every two persons who stayed in the household the night before the survey was 32.7% (95% CI 29.5, 36.1) (Table 5 & Table B1, Appendix B).

In rural versus urban residences, the percentage of households with at least one mosquito net or ITN is significantly higher in rural areas (61.4%) compared to urban areas (35.9%), with a p-value < 0.05, indicating a statistically significant difference in net ownership between these settings. Similarly, the presence of at least two ITNs in rural households (48.6%) compared to urban (29.7%) also shows a difference but not statistically significant.

[3] Though insecticide-treated nets distributed through Global Fund supported campaigns are Long-Lasting Insecticidal Nets (LLINs), in this report, the term "ITN" is used to keep it consistent with the Global Fund's performance framework terminology.

Regionally, the proportion of households with at least one mosquito net or ITN is relatively consistent across the Southern, Highlands, Momase, and Islands regions. In terms of households possessing at least two ITNs, Southern and Islands have similar ownership over 48%, while Momase and Highlands are slightly lower at 42.8% and 45%. The average number of nets per household is similar across all regions, ranging from 1.4 in Momase and Highlands to 1.7 in Southern. The percentage of households with at least one ITN for every two persons varies, with Momase having the highest at 37.4% and Highlands having the lowest at 27.4%. The p-values ($P > 0.05$) suggest that the differences in net ownership among these regions are not statistically significant.

The altitude analysis presents a substantial difference in ITN ownership. Households located at altitudes below 1600 meters have significantly higher rates of any mosquito net or ITN ownership (61.3%) and at least two ITNs (49.6%) compared to those at or above 1600 meters (36.2% for any net, 22.8% for at least two ITNs), with p-values < 0.001 across these comparisons. This suggests a robust statistical significance in net ownership favoring lower altitudes.

The ownership rates of at least one mosquito net or ITN are highest in the second wealth quintile (66.9%) and lowest in the highest quintile (43.5%). The second quintile also leads with the highest percentage of households having at least two ITNs (51.4%), and the highest quintile has the lowest (34.7%). The average number of nets per household generally decreases as wealth increases, with the middle three quintiles maintaining a higher average of 1.7 nets, while the lowest and highest quintiles have fewer nets. Moreover, the proportion of households with at least one ITN per two persons also tends to decrease with increasing wealth with high statistical significance.

Table 5. Household ownership of mosquito nets

Percentage of households with at least one mosquito net (treated or untreated) and insecticide-treated net (ITN); average number of nets and ITNs per household; and percentage of households with at least one net and ITN per two persons who stayed in the household the night prior to the survey, according to background characteristics, Papua New Guinea, 2022-2023

Background characteristics	Percentage of households with at least one mosquito net: Any mosquito net	Percentage of households with at least one mosquito net: ITN	Percentage of households with at least two ITN	Average number of nets per household: Any mosquito net	Average number of nets per household: ITN	Percentage of households with at least one ITN for every two persons*	Number of households with at least one person*
Residence							
Rural	61.4	61.4	48.6	1.5	1.5	34.4	2,648
Urban	35.9	35.9	29.7	1.1	1.1	22.0	381
	P = 0.016	P = 0.016	P = 0.089	P = 0.203	P = 0.204	P = 0.198	
Altitude							
<1600m	61.3	61.3	49.6	2.1	2.1	54.4	2,473
≥1600m	36.2	36.2	22.8	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	59.6	59.6	49.6	1.7	1.7	35.2	804
Highlands	56.0	56.0	45.0	1.4	1.4	27.4	891
Momase	57.0	57.0	42.8	1.4	1.4	37.4	581
Islands	62.0	62.0	48.1	1.6	1.6	34.4	753
	P = 0.813	P = 0.813	P = 0.763	P = 0.732	P = 0.731	P = 0.252	
Wealth Quintiles							
Lowest	55.1	55.1	42.9	1.3	1.3	33.5	608
Second	66.9	66.9	51.4	1.7	1.7	42.0	607
Middle	62.5	62.5	48.4	1.7	1.7	36.9	672
Fourth	61.3	61.3	48.3	1.7	1.7	27.2	545
Highest	43.5	43.5	34.7	1.2	1.2	24.2	596
	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P = 0.009	
Total	**58.0**	**58.0**	**46.1**	**1.5**	**1.5**	**32.7**	**3,029**
(95% CI)	(53.8,62.0)	(53.8,62.0)	(41.4,50.7)	(1.3, 1.6)	(1.3, 1.6)	(29.5,36.1)	

* who stayed in the household last night

Target: The 75% target of household ownership of at least one LLIN was not reached on a national level but provincial estimates in seven of 21 surveyed provinces exceeded the target. The highland provinces except EHP and SHP, Madang, ENB, NCD and Bougainville had estimates below the national average. (Table B1, Appendix B).

Trend: Following an already significant decrease between 2016/16 and 2019/20, household ownership of ITNs has again declined significantly in the 2022/23 survey compared to 2019/20. Similarly, there have been subsequent decreases in the average number of ITNs per household, indicating a reduction in net density within net-owning households. (Figure 3).

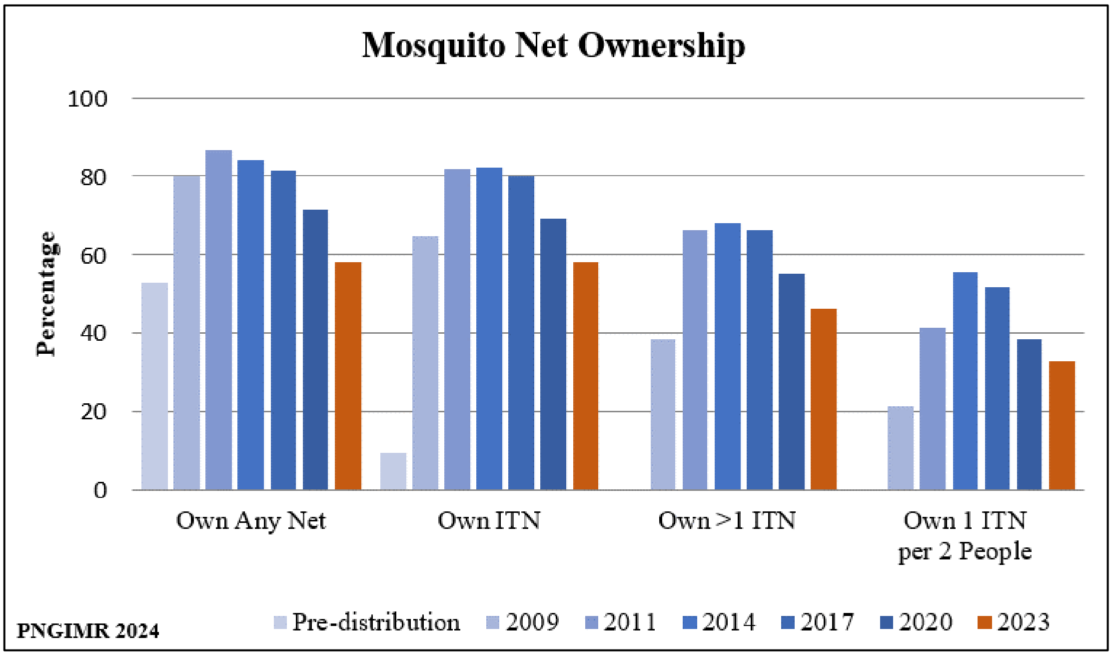


Figure 3. Trend in ownership of mosquito nets.
Pre-distribution estimate and national survey results 2009-2023.
Data source: PNGIMR surveys

3.2.2 Mosquito net access

In this context, access to an ITN is defined as the percentage of the *de facto* household population who could sleep under an ITN if each ITN 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.

Overall, 48.6% (95% CI 44.9, 52.3) of the de facto population in PNG had access to an ITN (Table 6). In rural areas, over half of the population (51.3%) had access to an ITN, significantly higher than in urban areas (31.1%), with a p-value of 0.04 showing a statistically significant difference between rural and urban access rates.

The ITN access by altitude indicates a similar trend, with 51.9% of the population living below 1600 meters having access to an ITN, compared to only 27.2% at or above this altitude ($p < 0.001$), reflecting different distribution strategies in higher altitude areas. Regionally, the percentages vary slightly but not significantly, with the Southern region at 51.2%, Highlands at 45.3%, Momase at 49.3%, and Islands at 51.6%.

Out of the 21 provinces surveyed, two provinces had ITN access rates that were close to the national average. Nine provinces had ITN access rates that were lower than the national average. The remaining provinces, totaling nine, had ITN access rates that exceeded the national average. (Table B2, Appendix B).

Using these numbers, an “access gap” can be calculated, which reflects the number of people requiring additional ITNs[4]. In analyzing the "Access to ITN gap" across Papua New Guinea, based on 2021 population estimates by the National Statistics Office PNG, 2023, it is crucial to consider regional variations in ITN access and the specific needs for malaria prevention. Table 7 outlines the percentage of the population with access to ITNs, those without access ("access gap"), and the estimated number of ITNs needed to bridge this gap, assuming two people per ITN.

While the Southern, Momase, and Islands regions show significant gaps in ITN access, needing 1.8 million more nets to meet the population's needs, the Highlands region presents a unique case. Although calculations suggest a need for over 1.2 million ITNs to bridge the access gap (i.e. cover the entire population), the programmatic distribution of ITNs has been limited to specific risk groups. A different ITN distribution approach is justified by low to nonexistent malaria transmission in the Highlands [26], rendering the identified gap in ITN coverage less critical for intervention efforts in this specific region, and increasingly limited funding for malaria control (Table 7).

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

Table 6. Access to an ITN

Percentage of the de facto population with access to an ITN in the household, according to background characteristics, Papua New Guinea, 2022-2023

Background characteristics	Percentage of the *de facto* population with access to an ITN[1]
Residence	
Rural	51.3
Urban	31.1
	P = 0.04
Altitude	
<1600m	51.9
>=1600m	27.2
	P < 0.001
Region	
Southern	51.2
Highlands	45.3
Momase	49.3
Islands	51.6
	P = 0.635
Total	**48.6**
95% CI	(44.9,52.3)

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

Table 7. Access to ITN gap

Population with access to an ITN, "gap" of people without access, and number of ITNs required to fill the "access gap" based on two people per ITN

Region	Population*	Percent with access to an ITN	Population with access to an ITN	Access gap	Number of ITNs required
Southern	2,412,736	51.2	1,234,114	1,178,622	589,311
Highlands	4,566,398	45.3	2,068,578	2,497,820	1,248,910
Momase	3,040,584	49.3	1,498,096	1,542,488	771,244
Islands	1,761,841	51.6	909,286	852,555	426,277
Total	**11,781,559**	**48.6**	**5,724,660**	**6,056,899**	**3,028,450**

* Population Estimates of Papua New Guinea in 2021 by National Statistics Office PNG, 2023.

3.2.3 Mosquito net use

Table 8 provides a detailed analysis of mosquito net usage among the *de facto* household population. Across PNG, 30.7% (95% CI 26.1, 35.8) of the population slept under an ITN the night before the survey. In households owning at least one ITN, 51.6% (95% CI 43.8, 59.4) used an ITN. All the nets observed during the survey were ITNs which is a reflection that untreated nets have become less common after multiple rounds of free ITN distributions.

The data indicates a significant age-related disparity in ITN usage. The youngest age group (<1 year) showed the highest usage, with 54.6% sleeping under an ITN overall, and 80.3% in households owning at least one ITN. However, usage declined sharply with increasing age, dropping to 28.1% among those aged 20 and above, with only 49.1% in ITN-owning households, and these differences are statistically significant (P<0.001). This trend is consistent among those in households with at least one ITN, where usage rates decrease with age, highlighting a potential gap in protection for older children and adults.

Gender differences in ITN usage are also evident with 32.0% of females and 29.4% of males using an ITN the previous night (53.4% of females and 49.8% of males in households owning at least one ITN). These differences, though less pronounced than those by age, are statistically significant (P = 0.019 and P = 0.014, respectively).

A comparison between rural and urban areas reveals that rural residents had higher ITN usage (31.6%) than urban residents (24.5%). However, in households owning at least one ITN, urban residents showed a higher percentage of usage (60.2%) compared to their rural counterparts (50.8%). While these differences are not statistically significant, they indicate a trend of better adherence to ITN use in urban compared to rural households in spite of poorer access in urban areas (31% vs 51%, Table 6). Conversely, rural household members appeared to more often not use an ITN even if one was available.

The data shows a significant difference in mosquito net usage by altitude. Households below 1600 meters had much higher usage rates (33.3%) compared to those at or above 1600 meters (13.1%). This trend is consistent in households owning at least one ITN, with 53.1% usage below 1600 meters and only 34.5% at higher altitudes (P<0.001 and P<0.015, respectively). Lower use at higher altitudes reflects both the lower ITN ownership (Table 5) and more frequent non-use even when an ITN was available.

The Southern region had the highest usage of ITNs (43.2% overall and 69.4% in households owning at least one ITN), while the Highlands showed the lowest (19.7% overall and 35.0% in households owning at least one). The Momase and Islands regions fall in between, though notably, ITN use in ITN-owning households remained very low in Southern region (45.6%). These regional differences are statistically significant (P<0.001). Setting-specific strategies to improve vector control coverage, including ITN usage, are important particularly in areas with endemic malaria transmission.

A statistically significant association between socio-economic status (wealth quintiles) and ITN use was found. People in the lowest and highest wealth quintiles were least likely to use an ITN (27.1% and 18.4%, respectively), while usage was highest in the second and third quintiles overall (P<0.001). In households owning at least one ITN, these differences were much less pronounced and not statistically significant (P = 0.096), suggesting that different levels of usage between people in socio-economic strata are more strongly influenced by ITN ownership than by a choice not to use available nets. A lower overall use in the highest wealth quintile may also be due to these households being more often located in urban areas, where net ownership is lower, partly due to less intensive distribution strategies.

Table B3 in Appendix B describes the use of mosquito nets by *de facto* household population by province. ITN use by the general population was below the national average in the Highlands provinces except in Eastern Highland Province, NCD, New Ireland, Madang, and Bougainville. As the survey was not powered to assess indicators at the province level, these data points are only indicative and not necessarily representative of the entire province.

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 a insecticide-treated net (ITN); and among the *de facto* household population in households with at least one ITN, the percentage who slept under an ITN the night before the survey, according to background characteristics, Papua New Guinea, 2022-2023

	Household population			Household population in households with at least one ITN	
Background characteristic	Percentage who slept under any mosquito net last night	Percentage who slept under an ITN last night	Number of persons	Percentage who slept under an ITN last night	Number of persons
Age					
<5	41.9	41.9	1,630	67.0	1,023
5-9	34.7	34.7	2,083	56.5	1,317
10-14	32.1	32.1	1,780	50.6	1,148
15-19	27.5	27.5	1,502	44.2	949
20+	28.1	28.1	8,440	49.1	4,852
	P<0.001	P<0.001		P<0.001	
Sex					
Female	32.0	32.0	7,840	53.4	4,710
Male	29.4	29.4	7,595	49.8	4,579
	P = 0.019	P = 0.019		P = 0.014	
Residence					
Rural	31.6	31.6	13,512	50.8	8,386
Urban	24.5	24.5	1,923	60.2	903
	P = 0.313	P = 0.313		P = 0.19	
Altitude					
<1600m	33.3	33.3	12,775	53.1	8,326
>=1600m	13.1	13.1	2,660	34.5	963
	P<0.001	P<0.001		P<0.015	

Region					
Southern	43.2	43.2	4,111	69.4	2,752
Highlands	19.7	19.7	4,579	35.0	2,150
Momase	35.9	35.9	2,936	62.8	1,676
Islands	30.2	30.2	3,809	45.6	2,711
	P<0.001	P<0.001		P<0.001	
Wealth Quintiles					
Lowest	27.1	27.1	2,879	44.7	1,673
Second	42.3	42.3	2,978	58.6	2,029
Middle	38.4	38.4	3,581	59.0	2,304
Fourth	28.8	28.8	2,935	49.9	1,864
Highest	18.4	18.4	3,056	41.9	1,413
	P<0.001	P<0.001		P = 0.096	
Overall	**30.7**	**30.7**	**15,435**	**51.6**	**9,289**
(95% CI)	(26.1, 35.8)	(26.1, 35.8)		(43.8, 59.4)	

Table 9 highlights the percentage of the *de facto* household population that had access to an ITN, the percentage who slept under an ITN the night before the survey, and the percentage who slept under an ITN among those with access, categorized by region.

Overall, the percentage of the population who had access to an ITN was comparable between geographical regions, ranging from 45.3% to 51.6%. However, the percentage who used an ITN the previous night among those with access to an ITN differed substantially between regions (range 43.6% to 85.7%).

In the Southern region, 85.7% of those with access used an ITN. Similarly, in the Momase region, where ITN use among those with access was 72.8%, indicating generally strong adherence to ITN use recommendations in both regions, as long as people had access to an ITN.

In the Highlands region, usage at 43.6% was the lowest, and was likely a reflection of low perceived malaria risk in many highland areas, which is generally supported by routine clinical data [26] and low prevalence (see chapter 3.4).

In the Islands Region, on the other hand, where malaria transmission remains endemic, only 58.5% of the population used an ITN among those with access. These figures indicate consistently poor adherence to ITN use recommendations in this region in line with previous observations of a pervasive indifferent attitude towards regular mosquito net use [27]. Tailored strategies are required to improve vector control coverage in this region, possibly beyond focusing merely on ITNs.

Table 9. Use of ITN among those with access

Percentage population who slept the night before the survey under a insecticide-treated net (ITN) among the *de facto* household population that had access to an ITN within their household, Papua New Guinea, 2022-2023

Background characteristic	Percentage of the *de facto* population with access to an ITN[1]	Percentage who slept under an ITN last night	Number of persons	Number of persons with access to an ITN	Number of persons who slept under an ITN last night	Percentage who slept under an ITN among those with access[2]
Region						
Southern	51.2	43.8	4,111	2,103	1,801	**85.7**
Highlands	45.3	20.0	4,579	2,074	904	**43.6**
Momase	49.3	35.9	2,936	1,447	1,053	**72.8**
Islands	51.6	27.9	3,809	1,966	1,150	**58.5**
Overall	**48.6**	**30.7**	**15,435**	**7,500**	**4,745**	**63.3**

[1] Percentage of the *de facto* household population that could sleep under an ITN if each ITN 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].

Table 10 provides a detailed analysis of mosquito net usage among the *de facto* household population under the age of 5 years. Overall, 41.9% (95% CI 37.5, 46.3) of children under 5 years slept under an ITN the night before the survey, with a significantly higher use of 67.0% (95% CI 58.7, 74.3) among children in households owning an ITN (Table 10).

A slightly higher percentage of male children (42.9%) slept under an ITN compared to female children (40.8%), also in households owning at least one ITN, though these differences are not statistically significant (P = 0.543 and P = 0.255, respectively).

Children in rural areas had a higher rate (43.4%) of sleeping under an ITN than children in urban areas (30.2%), with a difference that did not reach statistical significance (P = 0.065). However, in households with access to an ITN, urban children had a slightly higher usage rate (71.1%) compared to rural children (66.1%), though this difference was not statistically significant (P = 0.668).

Altitude shows a significant association with ITN usage, with 44.4% of children below 1600m sleeping under an ITN, compared to only 21.8% at or above 1600m (P < 0.001). Among those with access to an ITN, children at lower altitudes also had a higher usage rate (67.5%) compared to those at higher altitudes (60.0%), though the difference was not statistically significant (P = 0.373).

The Southern region showed the highest usage of ITNs in children under 5 (57.1%), reaching 80.2% among those in households owning an ITN. In Momase region, use by children was lower than in Southern (46.8%), though in children living in households owning a net, usage by 80.0% indicate the same level of adherence to ITN use in case one is available. The Highlands had the lowest usage overall (29.3%), and among those in households owning an ITN (51%). In the Islands regions, use by children under 5 remained at only 39.3% overall and 59.0% among children in households owning an ITN. Southern and Momase regions have comparable use among those with access. The regional differences were statistically significant (P < 0.001).

Table 10. Use of mosquito nets by children

Percentage of the *de facto* household children under-5 population who slept the night before the survey under a insecticide-treated net (ITN) among the *de facto* household population that has access to an ITN within their household, Papua New Guinea, 2022-2023

	Children under age 5 in all households			Children under age 5 in households with at least one ITN	
Background characteristic	Percentage who slept under any mosquito net last night	Percentage who slept under an ITN last night	Number of children	Percentage who slept under an ITN last night	Number of children
Sex					
Female	40.8	40.8	816	64.5	512
Male	42.9	42.9	814	69.5	511
	P = 0.543	P = 0.543		P = 0.255	
Residence					
Rural	43.4	43.4	1,435	66.1	937
Urban	30.2	30.2	195	71.1	86
	P = 0.065	P = 0.065		P = 0.668	
Altitude					
<1600m	44.4	44.4	1,386	67.5	936
>=1600m	21.8	21.8	244	60.0	87
	P < 0.001	P < 0.001		P = 0.373	
Region					
Southern	57.1	57.1	457	80.2	332
Highlands	29.3	29.3	423	51.0	195
Momase	46.8	46.8	317	80.0	182
Islands	39.3	39.3	433	59.0	314
	P < 0.001	P < 0.001		P = 0.001	
Wealth quintile					
Lowest	39.8	39.8	299	66.2	188
Second	56.7	56.7	338	74.6	243
Middle	43.2	43.2	402	62.7	269
Fourth	38.5	38.5	309	64.6	190
Highest	30.4	30.4	282	66.2	133
	P = 0.059	P = 0.059		P = 0.589	
Overall	**41.9**	**41.9**	**1,630**	**67.0**	**1,023**
(95% CI)	(37.5, 46.3)	(37.5, 46.3)		(58.7, 74.3)	

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

Figure 4 illustrates regional and age-related differences in the proportion of ITN users across genders. The Southern and Momase regions exhibit high and consistent ITN usage across all age groups and genders, with the Southern region showing slightly lower usage among males aged 20 and above. In contrast, the Highlands region displays lower overall ITN usage, with a marked decline in usage as age increases, particularly among males. The Islands region shows moderate ITN usage, with higher rates among younger children and generally higher usage among females compared to males. These disparities highlight the need for targeted interventions to improve ITN coverage, especially in regions and demographics with lower usage rates. In overall, female household members were significantly more likely to use an ITN than their male counterparts ($P < 0.05$).

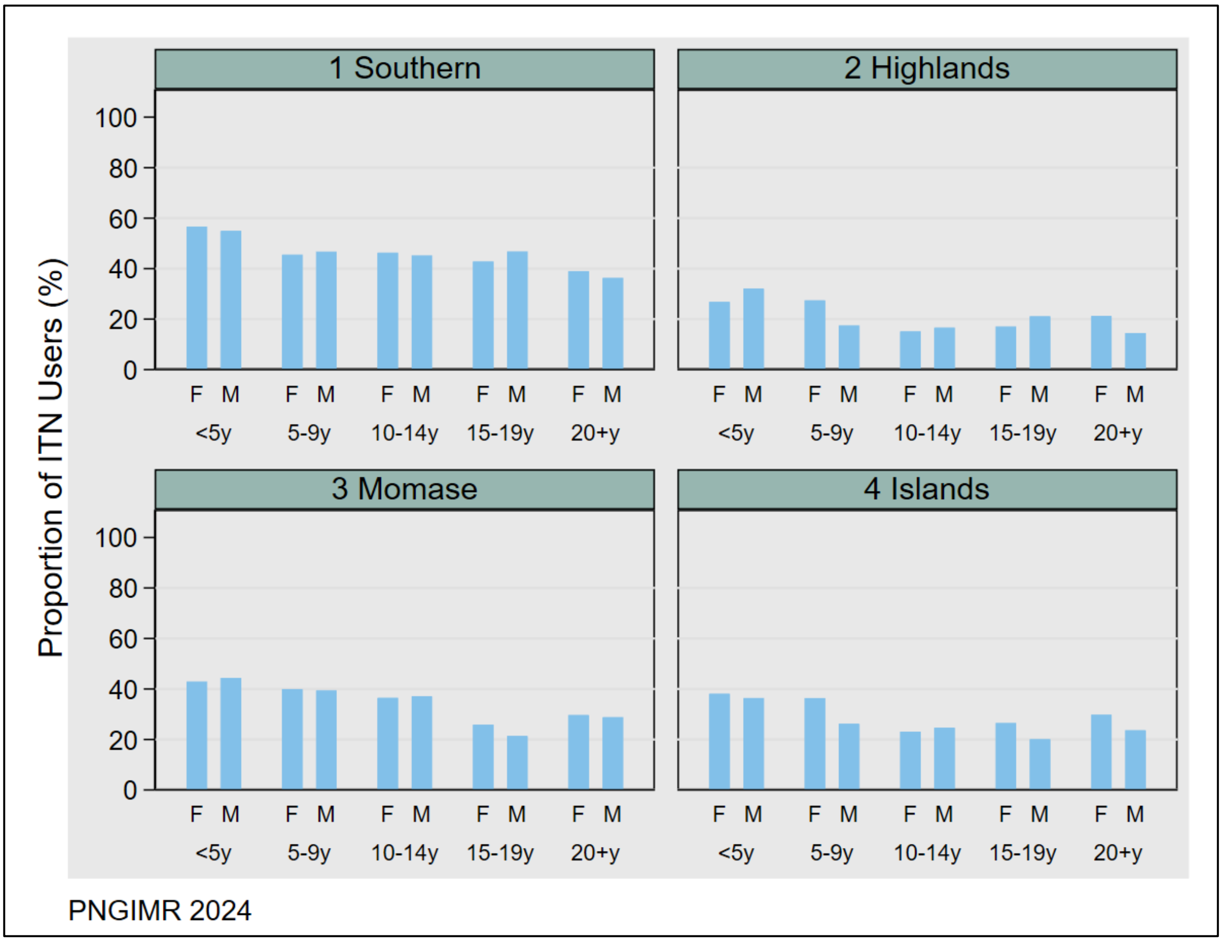


Figure 4. Use of mosquito nets according to sex and age group by region

Survey locations in the 21 provinces showed varying levels of ITN usage among children under 5 years, with some provinces significantly below the national averages. Notably, NCD, Milne Bay, SHP, Enga, and WHP have the lowest percentages of children sleeping under an ITN in all households. Similarly, SHP, Enga, WHP, ENB, and Bougainville are below the national average for ITN usage among children in households that own at least one ITN, highlighting areas where targeted interventions to increase ITN usage could be particularly beneficial (Table B4, Appendix B). As the survey was not powered to assess indicators at the province level, these data points are only indicative and not necessarily representative of the entire province.

Among 110 surveyed women who reported to be pregnant, 39.7% (95% CI 23.7, 58.2) slept under an ITN, while 54.3% (95% CI 31.3, 75.6) used an ITN in households owning an ITN. The power of stratified analyses is limited by the small number of surveyed pregnant women resulting in most comparisons not reaching statistical significance (Table 11).

Comparisons between pregnant women in urban and rural areas are compromised by the small number of observations from urban areas (N=8). Findings of an association of higher altitude and lower ITN use, though not statistically significant, broadly reflects the findings from the general population.

Different to findings from the general population, pregnant women living in the Islands region were not the least likely to use an ITN. In fact, ITN use among pregnant women was higher in the Islands than in Momase and the Highlands, suggesting that there may be some level of awareness of the vulnerability of pregnant women also in the Islands region. Regional differences almost reached statistical significance (P=0.052).

A stratification of ITN use by educational background of surveyed pregnant women indicates that women having more than secondary education reported the highest ITN usage (46.2%) and women with no formal education the lowest (27.6%), though the differences between strata were not statistically significant.

The association of ITN use with wealth quintiles did not reflect the same patterns as observed in the general population, with women in the lowest quintile having the highest percentage of ITN usage (53.4%). Differences between wealth quintiles were not statistically significant.

Table 11. Use of mosquito nets by pregnant women

Percentage of pregnant women aged 15-49 years who, the night before the survey, slept under a mosquito net (treated or untreated) and a insecticide-treated net (ITN); and among pregnant women age 15-49 in households with at least one ITN, the percentage who slept under an ITN the night before the survey, according to background characteristics, Papua New Guinea, 2022-2023

	Among pregnant women aged 15-49 in all households			Among pregnant women aged 15-49 in households with at least one ITN	
Background characteristic	Percentage who slept under any mosquito net last night	Percentage who slept under an ITN last night	Number of pregnant women	Percentage who slept under an ITN last night	Number of pregnant women
Residence					
Rural	37.8	37.8	102	52.3	71
Urban	69.8	69.8	8	80.7	6
	P = 0.182	P = 0.182		P = 0.285	
Altitude					
<1600m	41.7	41.7	94	54.5	71
>=1600m	17.6	17.6	16	50.0	6
	P = 0.123	P = 0.123		P = 0.766	
Region					
Southern	73.5	73.5	26	76.2	24
Highlands	28.9	28.9	53	44.5	26
Momase	39.5	39.5	16	51.9	13
Islands	63.4	63.4	15	67.1	14
	P = 0.052	P = 0.052		P = 0.360	
Education					
No education	27.6	27.6	25	36.1	16
Primary	57.0	57.0	29	63.5	23
Secondary	33.1	33.1	43	50.1	29
More than secondary	46.2	46.2	13	85.2	9
	P = 0.258	P = 0.258		P = 0.174	
Wealth quintile					
Lowest	53.4	53.4	21	73.6	16
Second	21.1	21.1	14	24.9	10
Middle	48.2	48.2	28	61.8	22
Fourth	32.7	32.7	25	49.0	17
Highest	43.4	43.4	22	62.6	12
	P = 0.531	P = 0.531		P = 0.351	
Total	**39.7**	**39.7**	**110**	**54.3**	**77**
(95% CI)	(23.7,58.2)	(23.7,58.2)		(31.3,75.6)	

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

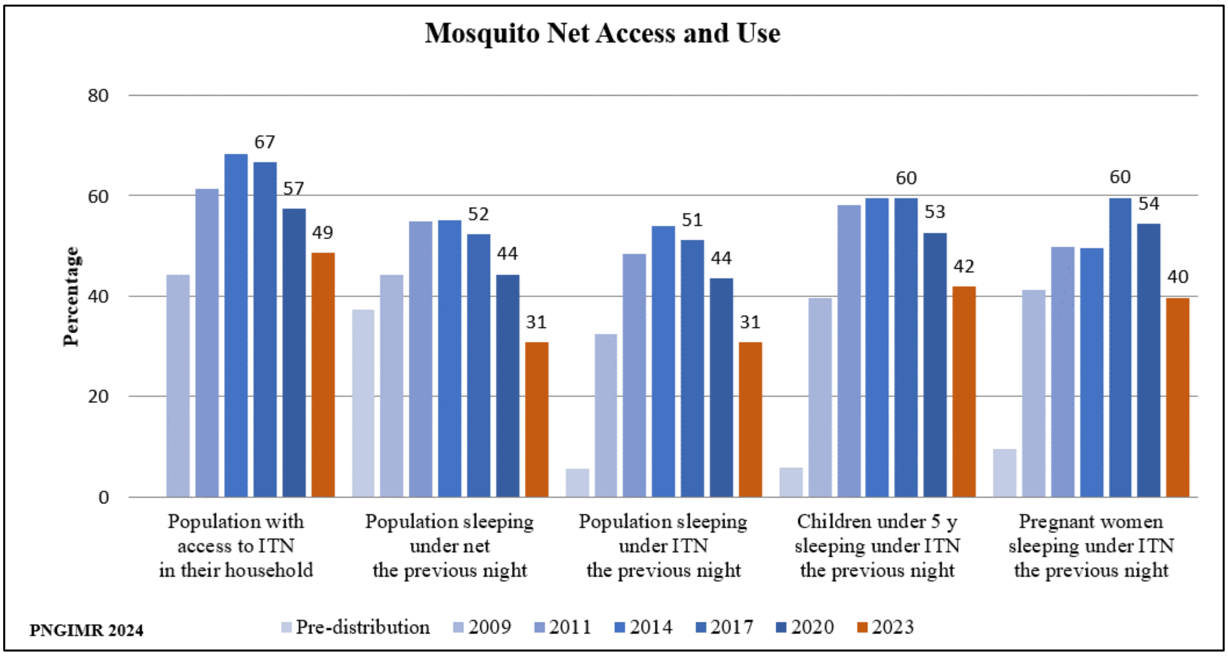


Figure 5. Trends in access to and use of mosquito nets

Pre-distribution estimate and national survey results 2009-2023.

Data source: PNGIMR surveys.

Targets: On a national level, the targets of 75% ITN access, 60% ITN use among all age groups, 65% use in children <5 years and pregnant women, and 85% use among those with access were missed both in the general population and in households owning at least one ITN. The overall ITN usage target for all age groups was missed the surveyed villages in 17 provinces; the target was reached in Gulf, Oro, Central and WNB provinces (Appendix B). ITN use in children <5 years was similar to that of the general population: in the survey villages in five of 21 provinces including Western, Gulf, Oro, Central and WNB provinces, ITN use was above 65%.

Trend: Between the MIS in 2016-17 and 2022-23, there has been a steady decline in access to and usage of ITNs among the general population, children under 5 years of age, and pregnant women. This trend marks a shift from the period up until 2016-17, during which the access and usage initially increased and then remained stable (Figure 5).

3.3 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.

Overall, across the 423 women surveyed, 45.4% (95% CI 37.4, 53.6) had received at least one dose of IPTp with SP, 41.7% (95% CI 33.9-49.9) received two or more doses, and 23.5% (95% CI 17.2-31.3) received three or more doses (Table 12).

Women living in urban areas reported higher IPTp coverage compared to their rural counterparts, though the differences were not statistically significant ($P > 0.05$).

There was difference in IPTp coverage by altitude, with women living in villages at or above 1600 meters reporting lower coverage with two or more doses and three or more doses of IPTp. Similarly, differences between regions were observed, though neither the differences between altitude categories, nor between regions were statistically significant ($P > 0.05$).

Education level was associated with IPTp coverage, with women having more than secondary education (N=12) showing the highest coverage rates (83.3% for one or more doses, 77.1% for two or more doses, and 45.4% for three or more doses). On the other hand, women without education (N=46) were least likely to have completed at least one (27.1%), two or more (25.9%), or three or more doses of IPT (14.4%), indicating a positive correlation between education level and IPTp uptake. The differences between education levels were statistically significant for receiving one or more doses and two or more doses ($P < 0.05$).

The socioeconomic status of the household in which a woman was living was also significantly associated with IPTp coverage ($P < 0.05$). Coverage was highest among women in the highest wealth quintile and lowest in the lowest quintile. The differences between wealth quintiles were statistically significant for receiving one or more doses and two or more doses.

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

Percentage of women aged 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 2022-2023

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	57.2	52.7	38.7	34
Rural	44.4	40.7	22.3	389
	P = 0.514	P = 0.559	P = 0.447	
Altitude				
<1600m	45.3	42.1	24.4	354
>=1600m	46.4	37.8	15.8	69
	P = 0.929	P = 0.744	P = 0.316	
Region				
Southern	43.5	39.8	22.2	131
Highlands	50.1	46.5	24.2	130
Momase	37.9	34.5	23.4	55
Islands	42.4	37.7	24.4	107
	P = 0.595	P = 0.589	P = 0.992	
Education				
No education	27.1	25.9	14.4	46
Primary	43.9	39.2	21.8	157
Secondary	49.5	46.6	27.5	208
More than secondary	83.3	77.1	45.4	12
	P = 0.012	P = 0.032	P = 0.55	
Wealth quintile				
Lowest	20.4	18.1	12.7	89
Second	42.1	39.5	25.4	88
Middle	39.7	36.4	16.6	116
Fourth	63.5	60.6	43.7	75
Highest	72.4	67.4	34.0	55
	P = 0.001	P = 0.002	P = 0.077	
Total	**45.4**	**41.7**	**23.5**	**423**
(95% CI)	(37.4,53.6)	(33.9,49.9)	(17.2,31.3)	

* Weighted proportion

3.4 Malaria prevention: exposure to malaria messages

Table 13 provides the percentage of household heads exposed to malaria messages over the three months prior to the survey, categorized by background characteristics. Overall, 4.0% of household heads reported exposure to malaria messages, with a 95% confidence interval of 2.2% to 7.2%. Rural areas showed a higher exposure rate (4.5%) compared to urban areas (0.5%), with a statistically significant difference (P < 0.001). By altitude, household heads below 1600 meters had a higher exposure (4.3%) than those at or above 1600 meters (2%), although this difference is not statistically significant (P = 0.165). Regional differences are also evident, with household heads in the Southern region having the highest exposure (8.3%) and Momase the lowest (1.5%), a statistically significant variation (P = 0.027).

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, 2022-2023

Background characteristic	Information from any source[1]	Number of household heads
Residence		
Rural	4.5	2,648
Urban	0.5	381
	P < 0.001	
Altitude		
<1600m	4.3	2,474
>=1600m	2.0	555
	P = 0.165	
Region		
Southern	8.3	804
Highlands	3.3	891
Momase	1.5	581
Islands	2.1	753
	P = 0.027	
Total	**4.0**	**3,029**
(95% CI)	(2.2,7.2)	

[1] Weighted proportion

Figure 6 describes various sources of malaria messages and their respective percentages among household heads. Health workers are the primary source, with nearly 40% of household heads receiving information from them. However, it is not possible to establish whether this exposure occurred during a health facility visit or outreach activities. Net distribution programs are the second most significant source, reaching around 30%. Other notable sources include friends, research institutions, community meetings, radio, NGOs, and news, though these account for smaller percentages. The prominence of health workers and net distribution highlights the critical role of direct health interventions in disseminating malaria information.

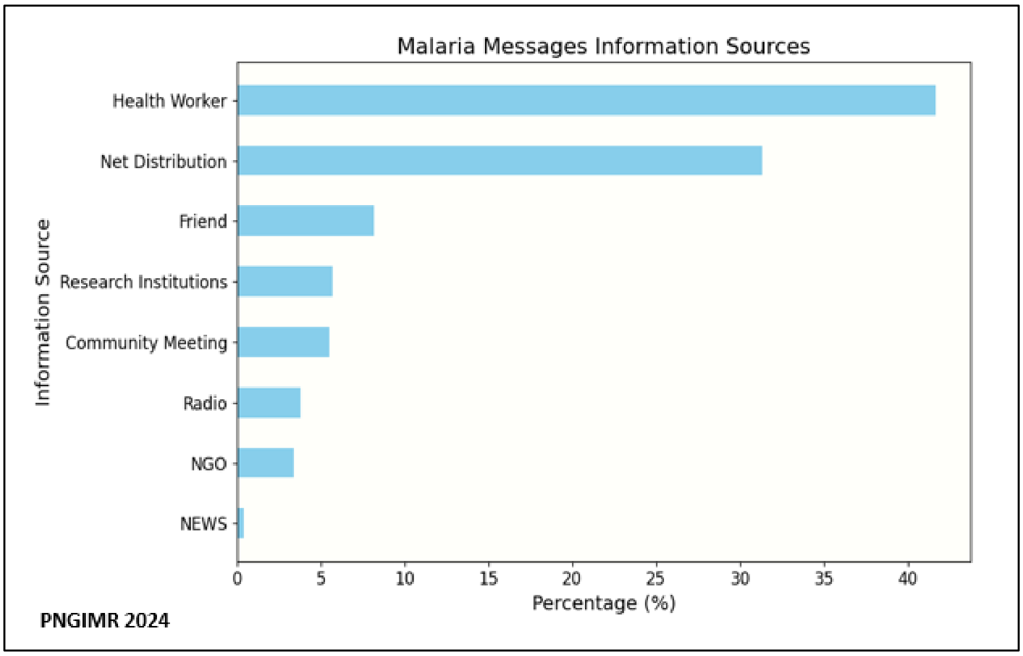


Figure 6. Sources of malaria information among household heads who received information in the past 3 months. (More than one answer was allowed.)

3.5 Prevalence of malaria infection

This chapter presents the prevalence of malaria infection in the general population, assessed in household members over 6 months of age. Two tests were used to assess malaria infection: light microscopy and mRDT.

The microscopy results are presented both overall and by *Plasmodium* species: *P. falciparum* (*P.f.*), *P. vivax* (*P.v.*), *P. malariae,* and mixed infections of *P.f.* and *P.v.* To ensure comparability with previous MIS, prevalence as determined by microscopy should be considered as the most accurate measurement of a current infection.

It is expected that malaria prevalence differs between mRDT and microscopy results. Microscopic detection of malaria parasites depends on observing stained parasites under a microscope indicating a current infection. In contrast, mRDTs detect a parasite antigen present in the blood. Certain antigens, particularly HRP2, may persist in the blood for several weeks after an infection was cleared and no live parasites remain in a person's blood. Therefore, mRDT results (provided in the appendix) should be interpreted cautiously as they may include past infections and hence false-positive result. Province and village-level results using microscopy and mRDT are available 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%**

Results were available for 12,849 mRDT tests and 12,638 blood slides for light microscopy. The detailed results of the mRDT tests are available in Appendix C.

Table 14 presents the prevalence of malaria infection by light microscopy among individuals above 6 months of age. The overall malaria prevalence in the population was 3.1% (95% CI 2.0, 4.8). *P. falciparum* was the most prevalent species at 2.5%, followed by *P. vivax* at 0.7%. *P. malariae* and mixed infections each accounted for 0.2% of the infections. No *P. ovale* infections were found.

In areas situated below 1600 meters, the overall malaria prevalence was 3.2% (95% CI 2.0, 5.1), with *P. falciparum* being the predominant species at 2.6%. *P. vivax* accounts for 0.7% of infections, while both *P. malariae* and mixed infections of *P.f.* & *P.v.* are relatively rare, each constituting 0.2% of cases. In surveyed areas at or above 1600 meters, infections with malaria were less common, with an overall prevalence of 2.0% (95% CI 0.9, 4.2), including 1.5% infections with *P. falciparum,* 0.5% with *P. vivax,* and 0.2% with both *P. malariae* and mixed infections.

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, 2022-2023

	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	**3.2**	**2.6**	**0.7**	**0.2**	**0.2**	**10,553**
(95% CI)	(2.0, 5.1)	(1.6, 4.2)	(0.4, 1.1)	(0.1, 0.7)	(0.1, 0.4)	
≥1600 m	**2.0**	**1.5**	**0.5**	**0.2**	**0.2**	**2,076**
(95% CI)	(0.9, 4.2)	(0.7, 3.0)	(0.7, 1.4)	(0.1, 0.6)	(0.03, 0.9)	
Overall	**3.1**	**2.5**	**0.7**	**0.2**	**0.2**	**12,629**
(95% CI)	(2.0, 4.8)	(1.6, 3.8)	(0.4, 1.0)	(0.1, 0.6)	(0.1, 0.4)	

[1]Age-standardized and weighted

Table 15 shows the prevalence of malaria infection among children aged 6 months to 5 years, as determined by light microscopy. Overall, the malaria prevalence among children under 5 years across all altitudes was 4.1% (95% CI 3.0, 5.5). *P. falciparum* accounted for 2.2% of cases, *P. vivax* for 2.1%, *P. malariae* for 0.1%, and mixed infections for 0.3%.

In areas below 1600 meters, the malaria prevalence among children under 5 years was 4.4% (95% CI 3.2, 5.9), with 2.3% for both *P. falciparum* and *P. vivax*, 0.2% for *P. malariae*, and 0.4% for mixed infections of *P.f.* & *P.v.* In areas at or above 1600 meters altitude, the malaria prevalence is significantly lower at 0.7%, attributed solely to P. falciparum. There were no recorded cases of *P. vivax*, *P. malariae*, or mixed infections in this altitude category.

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, 2022-2023

	Malaria prevalence according to microscopy[1]					
Altitude	Any species	*P. falciparum*	*P. vivax*	*P. malariae*	Mixed *P.f.* & *P.v.*	Number of children
<1600 m	**4.4**	**2.3**	**2.3**	**0.2**	**0.4**	**1,172**
(95% CI)	(3.8, 6.0)	(1.5, 3.7)	(1.4, 3.7)	(0.03, 0.7)	(0.1, 1.2)	
≥1600 m	**0.7**	**0.7**	**0.0**	**0.0**	**0.0**	**61**
(95% CI)	(0.1, 4.9)	(0.1, 4.9)				
Overall	**4.1**	**2.2**	**2.1**	**0.1**	**0.3**	**1,233**
(95% CI)	(3.0, 5.5)	(1.4, 3.4)	(1.2, 3.4)	(0.03, 0.7)	(0.1, 1.1)	

[1]Weighted

Table 16 presents the prevalence of malaria by background characteristics of the survey participants. According to microscopy results, malaria prevalence varies significantly by altitude, with the highest prevalence found below 1200 meters (4%), followed by regions above 1600 meters (2.0%), and the lowest in the 1200-to-1599-meter range (0.6%). The predominant species is *P. falciparum* at all altitudes, followed by *P. vivax*. These altitude-based differences are statistically significant for any species, *P. falciparum* and *P. vivax* (all P < 0.005).

In rural areas, malaria prevalence was higher (3.2%) compared to urban areas (2.2%), though the differences are only statistically significant for *P. malariae* (P = 0.037) and mixed infections.

Momase region exhibited the highest prevalence (7.3%) and Southern region the lowest (1.5%). These regional differences are statistically significant (P < 0.001).

Age-based analysis indicates that younger children, particularly those under 5 years old, have higher malaria prevalence (4.1%), with a significant portion due to *P. falciparum* (2.2%) and *P. vivax* (2.1%). Prevalence decreases with age, with the lowest rates observed in individuals aged 40 and above (1.9%). These age-related trends are statistically significant (P = 0.005 for overall prevalence).

The differences in malaria prevalence between males and females are minimal and not statistically significant. While pregnant women have a lower prevalence (1.4%) compared to non-pregnant women (2.8%), this difference is also not statistically significant (P = 0.352).

Figure 7 illustrates the disparities in malaria prevalence across the regions and age groups by gender. In the Southern and highlands regions, malaria prevalence is low across all age groups with not much gender differences. The Momase region, however, has higher prevalence rates, especially among adolescents aged 10-19, with females showing slightly higher rates than males (p = 0.005). In the Islands region, prevalence is notably high among children under 5, with females generally having higher rates, though the gender differences are not statistically significant (p = 0.309).

Figure 8 illustrates the distribution of *P. falciparum* and *P. vivax* malaria across different regions and age groups. All regions reported higher prevalence of *P. falciparum* compared to *P. vivax*. The Momase region bears the highest burden for both *P. falciparum* and *P. vivax.* Among different age groups, adolescents aged 10-19 reported higher malaria prevalence, particularly for *P. falciparum.* In the Momase and Islands regions, children under 5 reported a higher prevalence of *P. vivax* than *P. falciparum*.

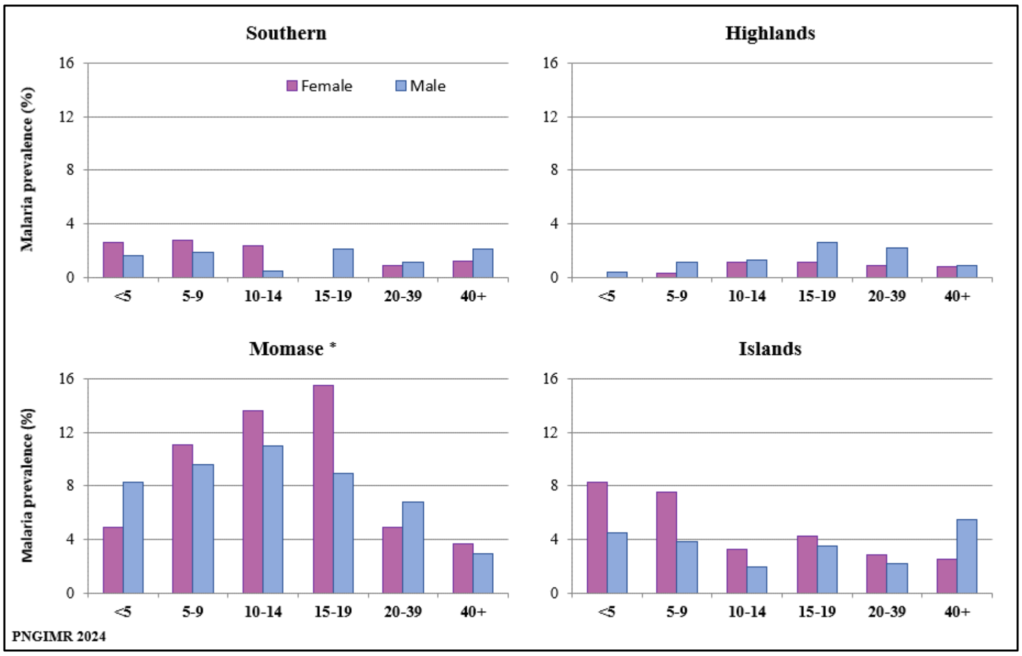


Figure 7. Malaria prevalence by age group, sex and region
Statistically significant differences are indicated by * ($p < 0.05$).

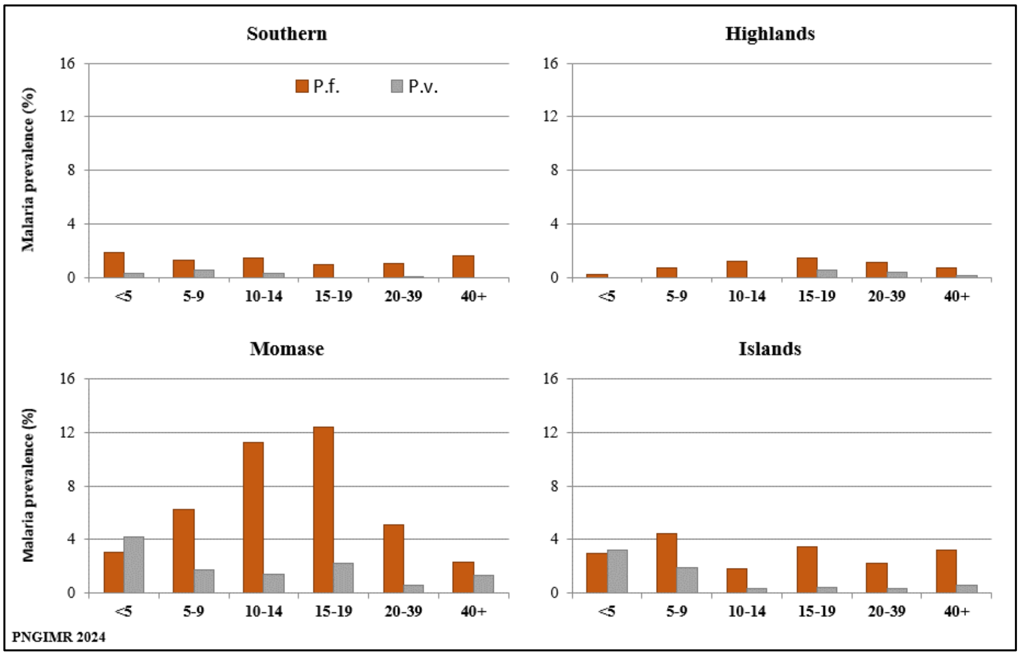


Figure 8. Species-specific malaria prevalence by age group, and region

The mRDT results indicate a higher overall prevalence of malaria compared to microscopy, particularly in regions with higher LM prevalence. Prevalence was notably lower at intermediate altitudes, in urban areas, and in the Highlands, likely due to lower transmission rates and reduced likelihood of false-positive RDT results from past infections. Detailed mRDT results are available in Appendix D (Table D4).

Table 16. Prevalence of malaria by background characteristics*

Percentage of persons classified in two tests as having malaria, using light microscopy and mRDTs, Papua New Guinea, 2022-2023.

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	4.0	3.2	0.9	0.2	0.2	9,245	8.3	9,412
1200 to 1599	0.6	0.6	0.03	0.0	0.0	1,308	0.2	1,312
1600+	2.0	1.5	0.5	0.2	0.2	2,076	3.9	2,131
	P = 0.014	P = 0.033	P = 0.006	P = 0.472	P = 0.365		P < 0.001	
Residence								
Rural	3.2	2.5	0.7	0.2	0.2	11,081	6.9	11,322
Urban	2.2	2.0	0.2	0.03	0.03	1,557	1.8	2,598
	P = 0.352	P = 0.574	P = 0.132	P = 0.037	P = 0.029		P=0.645	
Region								
1 Southern	1.5	1.3	0.1	0.1	0.0	3,424	5.0	3,533
2 Highlands	1.1	0. 9	0.2	0.1	0.1	3,494	1.6	3,554
3 Momase	7.3	5.8	1.6	0.5	0.5	2,521	12.5	2,539
4 Islands	3.8	2.9	1.0	0.2	0.2	3,190	8.7	3,223
	P < 0.001	P < 0.001	P < 0.001	P = 0.02	P = 0.002		P < 0.001	
Age in years								
<5	4.1	2.2	2.1	0.1	0.3	1,224	4.2	1,580
5-9	4.2	2.7	0.9	0.7	0.2	1,754	8.2	2,218
10-14	4.3	3.9	0.5	0.5	0.2	1,369	9.9	1,664
15-19	4.2	4.0	0.7	0.1	0.6	1,043	8.0	1,168
20-39	2.6	2.2	0.3	0.0	0.1	3,770	5.6	4,269
40+	1.9	1.5	0.4	0.0	0.0	3,469	3.6	3,021
	P = 0.005	P = 0.057	P = 0.018	P = 0.091	P = 0.005		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 mRDTs, Papua New Guinea, 2022-2023.

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	3.1	2.4	0.6	0.3	0.1	6,764	5.9	7,468
Male	3.1	2.5	0.8	0.1	0.2	5,865	6.6	6,452
	P = 0.932	P = 0.895	P = 0.168	P = 0.049	P = 0.491		P=0.063	
Women 15-49 years								
Not pregnant	2.8	2.3	0.4	0.0	0.0	3,479	5.7	3,574
Pregnant	1.4	1.4	0.0	0.0	0.0	91	2.0	177
	P = 0.352	P = 0.468	P = 0.655	P = 0.859	P = 0.826		P = 0.794	

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

[1]mRDT = malaria Rapid Diagnostic Test

Appendix C Table C1 presents the age-standardized malaria prevalence, using light microscopy and mRDT. Provincial prevalence estimates should be interpreted with caution as the limited number of surveyed villages per province may not be representative for the entire province. Nevertheless, the results provide an indication of the malaria situation in the province and may provide the basis for further investigations. Madang has the highest malaria prevalence at 10.9%, followed by Sandaun at 7.3%, and Manus at 8.1%. These provinces are significantly affected by *P. falciparum*, with Madang reporting 8.7% and Sandaun 7.2%. Despite being a Highlands province, Enga shows high prevalence at 6.5%, with significant contributions from both *P. falciparum* (4.4%) and *P. vivax* (2.6%). On the other hand, provinces such as Central, Milne Bay, SHP, EHP, and Jiwaka report zero or near-zero malaria prevalence. Western and Gulf provinces exhibit moderate malaria prevalence, primarily driven by *P. falciparum*, while provinces like Bougainville and WHP report lower prevalence rates. Mixed infections are relatively rare across all provinces.

Appendix C Table C4 describes the raw malaria prevalence data by village. According to microscopy results, there were 13 villages with zero prevalence for specific malaria species, indicating no detected cases of *P. falciparum, P. vivax, P. malariae*, or mixed infections. Additionally, 19 villages have a malaria prevalence of less than 5%, while 8 villages show a prevalence of less than 10%. Western and Central provinces have multiple villages with low prevalence, whereas Madang and Eastern Sepik provinces have several villages with higher prevalence, highlighting the need for targeted malaria control efforts in these areas.

Appendix C Table C3 details the prevalence of malaria infection in children under 5 years of age. Rural areas exhibit a higher malaria prevalence (4.4%) compared to urban areas (1.8%), with *P. falciparum* and *P. vivax* being the primary species detected in rural settings. Regionally, the Islands and Momase regions show the highest malaria prevalence among children, at 7.4% and 7%, respectively. The Southern region has a moderate prevalence of 2.6%, while the Highlands report the lowest prevalence at 0.2%. These regional differences are statistically significant ($P < 0.001$ for overall prevalence).

Gender-wise, the prevalence of malaria in female children is 3.7%, while male children have a slightly higher prevalence of 4.4%. *P. falciparum* is more prevalent in female children (2.7%) compared to males (1.7%), whereas *P. vivax* is more prevalent in males (3.0%) compared to females (1.1%). These gender differences in malaria prevalence are not statistically significant overall, though *P. vivax* shows a slightly significant difference ($P = 0.045$).

In children under 5 years of age, high malaria prevalence is observed in provinces such as Sandaun (10.4%), Madang (8.3%), and Western (4.0%). Sandaun exhibits the highest prevalence of *P. falciparum* (10.4%) and also reports mixed infections. Madang and Western provinces also report notable levels of *P. vivax*. Conversely, provinces such as Central, NCD, SHP, Enga, WHP, and EHP report zero prevalence for all malaria species (Table C4, Appendix 4).

Out of 103 surveyed villages, 35 reported zero prevalence for all malaria species, indicating no detected cases of *P. falciparum*, *P. vivax*, *P. malariae*, or mixed infections. Additionally, 42 villages have a malaria prevalence of less than 5%, and 12 villages have a prevalence of less than 10%. These results highlight significant geographical variability, with certain provinces and villages maintaining low or zero malaria prevalence (Table C5, Appendix C).

The composition of malaria species in PNG reveals distinct patterns for *P. falciparum* and *P. vivax* across the general population and children under 5 years of age. Among the provinces reported with any malaria species, *P. falciparum* is predominantly observed. Seven provinces show malaria in all surveyed villages. Five provinces including Western, Enga, Chimbu, Morobe and NIP provinces have malaria present in 4 villages. Additionally, there are 2 provinces with malaria detected in 3 villages each, 2 provinces with malaria in 2 villages each, and 2 provinces with malaria in 1 village each. Out of 103 surveyed villages, 42 villages reported no *P. falciparum* infections, and 68 villages reported no *P. vivax* infections. Only 11 villages reported over 2% prevalence of *P. vivax*. For children under 5 years of age, 77 villages reported no *P. falciparum* infections, and 87 villages reported no *P. vivax* infections. However, *P. vivax* parasitic prevalence of over 2% is observed in 17 villages, with the highest of 20% prevalence in a village from NIP (Table C4, Appendix C).

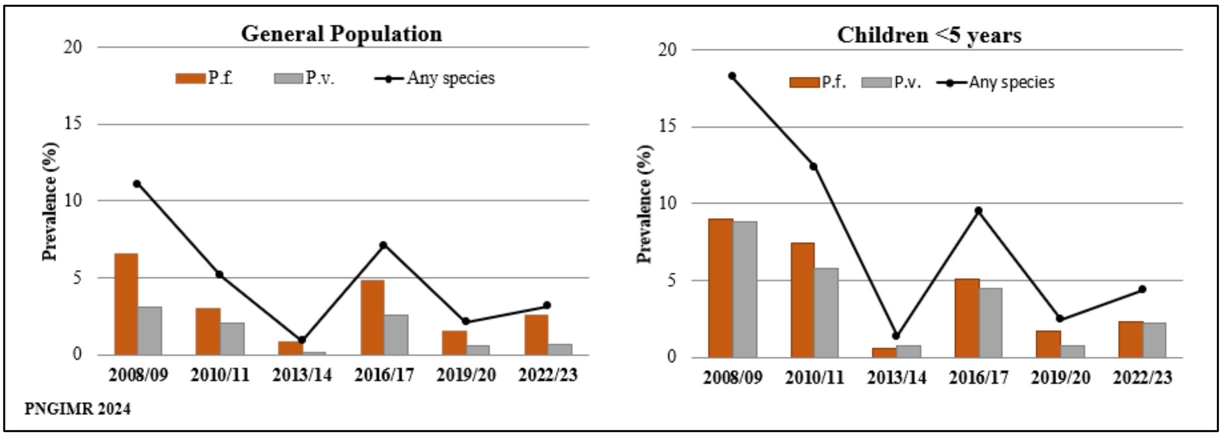


Figure 9: Country-wide malaria parasite prevalence in the general population and in children <5 years of age (< 1600 m altitude).

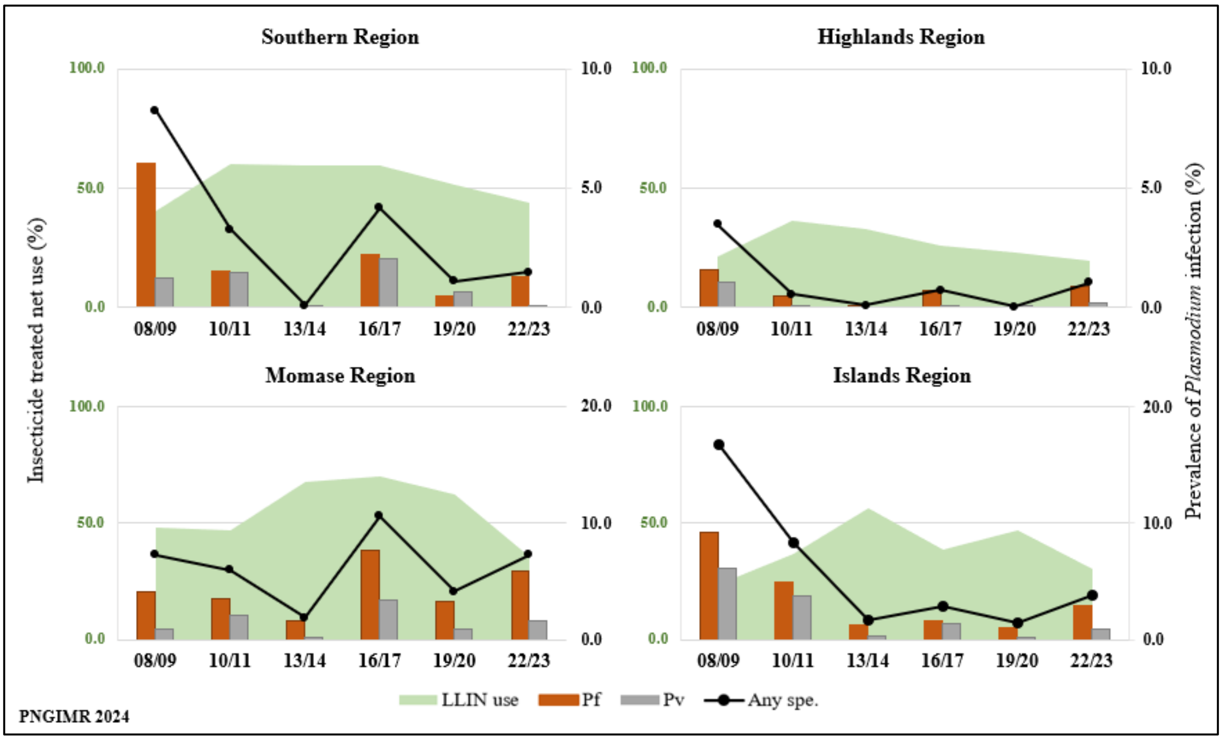


Figure 10: ITN use and malaria parasite prevalence in the general population by region
Note: right y-axes (prevalence) have different scales.

Target: The target of 1.5% prevalence in children under 5 years of age was not reached on a national or regional level in areas <1600 m altitude where malaria conditions are favorable for transmission. On a provincial level, the target was met in all provinces in the Highlands Region except Chimbu, in 3/6 provinces in the Southern Region (Central, NCD and Milne Bay). The target was not met in provinces of the Momase and Islands Regions (Table C3, Appendix C).

Trend: In the latest MIS, there has been an increase in malaria prevalence in both the general population and children under 5 years of age in Papua New Guinea. By 2022/23, the prevalence of infection with any species, and with *P. falciparum* and *P. vivax* in particular, has risen compared to the previous MIS conducted in 2019/20. This recent upward trend in malaria prevalence across all species is troubling, particularly given the progress made in reducing malaria prevalence in earlier years. The increase in 2022/23 indicates that despite previous successes, malaria control efforts need to be intensified to address the resurgence of the disease in both the general population and young children. The recent increase in malaria prevalence in PNG coincides with a decrease in ownership and use of ITNs across all regions (See Figure 9 & Figure 10) and a slight decrease in the proportion of febrile individuals attending health facilities.

3.6 Prevalence of malaria-associated morbidity

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

The overall percentage and 95% confidence intervals (CI) for the key indicators were as follows: reported fever (2.5%, 95% CI: 1.8, 3.3), acute fever (1.9%, 95% CI: 1.3, 2.5), anemia (52.5%, 95% CI: 46.5, 53.4), severe anemia (3.5%, 95% CI: 2.8, 4.4), and splenomegaly (3.0%, 95% CI: 2.0, 4.3). These estimates were roughly comparable to those from the MIS.

The prevalence of reported fever in the past two weeks varied slightly by background characteristics. By altitude, the percentage of reported fever was highest at altitudes below 1200 meters (2.9%) and lowest at altitudes between 1200 to 1599 meters (0.8%). The prevalence of acute fever was highest in the Southern region (3.2%) and lowest in the Highlands (0.8%). Among age groups, acute fever ranged from 1.4% in individuals aged 40 and above to 2.7% in those aged 10-14 years. Males reported a slightly higher prevalence of acute fever (2.3%) compared to females (1.7%).

The highest prevalence of anaemia observed in Momase (79.4%) and the lowest in the Highlands (24.9%). By altitude, anaemia prevalence was highest below 1200 meters (70.8%) and lowest at altitudes of 1600 meters and above (22.7%). Among age groups, children under five had the highest prevalence of anaemia (70.7%), while those aged 40 and above had the lowest (53.4%). Females reported a higher prevalence of anaemia (59.5%) compared to males (53.9%). Momase reported the highest prevalence of severe anaemia (9.7%), and the Highlands the lowest (1.2%). The prevalence was highest in children under five (9.0%) and lowest in individuals aged 40 and above (5.2%). Females had a slightly higher prevalence of severe anaemia (4.6%) compared to males (3.5%).

The splenomegaly reported was mostly mild, classified as grade 1 on the Hackett scale. Splenomegaly was more prevalent is Islands region (16.3%) and least prevalent in the Southern region (0.1%). This higher prevalence in Islands region was mostly contributed by West New Britain province. Urban areas reported a higher prevalence of splenomegaly (9.2%) compared to rural areas (4.0%). By altitude, prevalence data was incomplete, but the highest recorded prevalence was at altitudes below 1200 meters (5.8%). Among children under five, the prevalence was 5.5%. Both males and females showed similar prevalence rates for splenomegaly, at 4.4% and 4.6%, respectively.

Among the participants who reported having a recent fever, 17% (56 out of 329) tested positive for malaria by LM. Whereas, 12.5% (31 out of 249) of participants suffering from acute fever at the time of the survey tested positive for malaria by LM.

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

Percentage of persons with reported fever, acute fever, hemoglobin below the WHO threshold for anemia and severe anemia, and splenomegaly, according to background characteristics, Papua New Guinea, 2022-2023

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	2.9	9,415	2.4	9415	70.8	8.2	8,684	5.8	2,154
1200 to 1599	0.8	1,312	0.9	1312	27.4	1.3	1,302		259
1600+	1.9	2,131	0.7	2131	22.7	1.0	2,131		295
Residence									
Rural	2.6	11,193	2.2	11,193	56.3	6.3	10,452	4.0	2,367
Urban	2.2	1,665	1.0	1,665	67.7	6.5	1,665	9.2	341
Region									
Southern	2.7	3,538	3.2	3,538	67.4	7.7	3,484	0.1	805
Highlands	1.4	3,554	0.8	3,554	24.9	1.2	3,547		571
Momase	3.7	2,542	3.0	2,542	79.4	9.7	2,279	0.2	578
Islands	2.6	3,224	0.9	3,224	69.3	7.9	2,807	16.3	754
Age in years									
<5	2.6	1,254	1.8	1,254	70.7	9.0	1,151	5.5	943
5-9	2.6	1,789	2.4	1,789	66.5	6.0	1,675	3.9	1,765
10-14	2.6	1,391	2.7	1,391	61.2	5.1	1,310		
15-19	2.7	1,061	2.6	1,061	52.5	5.7	993		
20-39	2.8	3,834	1.9	3,834	50.9	5.6	3,619		
40+	2.4	3,529	1.4	3,529	53.4	5.2	3,369		
	P = 0.848		P = 0.012		P < 0.001	P < 0.001		P = 0.054	
Sex									
Female	2.3	6,877	1.7	6,877	59.5	4.6	6,479	4.6	1,315
Male	2.9	5,981	2.3	5,981	53.9	3.5	5,638	4.4	1,393
	P = 0.116		P = 0.01		P < 0.001	P = 0.005		P = 0.817	
Total	**2.5**	**12,858**	**1.9**	**12,858**	**52.5**	**3.5**	**12,117**	**3.0**	**2,708**
(95% CI)	(1.8, 3.3)		(1.3, 2.5)		(46.5,53.4)	(2.8, 4.4)		(2.0,4.3)	

[1] Acute fever was defined as axillary temperature >37.5°C. [2] Anemia and severe anemia 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.

3.7 Treatment-seeking for fever

This section presents details on the treatment-seeking behavior of the 158 household members reporting an episode of fever in the two weeks preceding the survey.

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%**

Overall, 54.7% (95% CI 38.7, 69.7) of individuals with fever sought advice or treatment from sources outside the home and 39.6% (95% CI 24.2, 57.3) had their blood taken for a diagnostic test. Among children under the age of 5 years with a fever (N=17), 47.1% (95% CI 20.6, 75.3) sought outside advice or treatment and 26.1% (95% CI 4.6, 71.9) had a blood test. Percentages observed were comparable in urban and rural areas.

Table 18. Diagnosis, and treatment of persons with fever

Percentage of persons and children under the age of 5 years 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, 2022-2023.

	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	54.5	39.6	147	47.1	26.1	17
Urban	58.2	39.1	11	n/a	n/a	0
	P = 0.871	P = 0.986				
Region						
Southern	43.1	24.0	73	33.4	0.0	6
Highlands	91.9	83.5	22	100	73.4	2
Momase	48.4	29.2	17	100	100	1
Islands	35.9	28.2	46	32.3	23.4	8
	P = 0.015	P = 0.003		*P = 0.091	*P = 0.080	
Sex						
Female	60.2	43.2	82	59.1	34.8	9
Male	48.5	35.5	76	28.4	12.5	8
	P = 0.115	P = 0.466		P = 0.462	P = 0.587	
Total	**54.7**	**39.6**	**158**	**47.1**	**26.1**	**17**
(95% CI)	(38.7, 69.7)	(24.2, 57.3)		(20.6, 75.3)	(4.6, 71.9)	

[1] Includes advice or treatment from sources outside the home.
*Fisher's exact test was used

Overall, there were significant differences in treatment seeking and blood test between geographical regions ($P < 0.05$). The Highlands region reported the highest percentage of seeking advice or treatment (91.9%) and blood tests (83.5%). In the other three regions, less than 50% of febrile individuals sought advice or treatment and less than 30% had their blood taken for a test. Due to the small number of children under the age of 5 years with a fever, differences between background characteristics are difficult to interpret for this age group. Treatment seeking and blood tests were more often reported for females than males, both overall and in children under 5 years; however, the differences did not reach statistical significance (Table 18).

Health facilities were the most common source of advice or treatment. Among those individuals who sought outside advice or treatment (N=80), 85.5% (95% CI 63.8, 95.2) went to a formal health facility (incl. hospital, health center, aid post, or similar structure). A further 10.1% attended a Village Health Volunteer and 4.4% another source. Among children under the age of 5 years, 70.8% (95% CI 16.1, 96.8) attended a health facility and 29.2% another source including relatives and neighbors. No child was seen by a Village Health Volunteer (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, 2022-2023

	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	46.7	85.5	33.3	70.8
Hospital	11.4	20.8	0.0	0.0
Health Centre	26.3	48.2	6.6	14.1
Aid Post	7.9	14.4	26.7	56.7
Community Health Post	0.7	1.3	0.0	0.0
Clinic	0.5	0.9	0.0	0.0
Village Health Volunteer	5.5	10.1	0.0	0.0
Private medical sector				
Pharmacy	0.0	0.0	0.0	0.0
Other private sector				
Store	0.0	0.0	0.0	0.0
Other	2.4	4.4	13.8	29.2
Number	**158**	**80**	**17**	**9**

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

The treatment taken was assessed for those survey participants who reported a fever in the two weeks preceding the survey. Not all of these fevers would have been due to malaria; the absolute percentages provided here should therefore be interpreted cautiously. Overall, 46.2% (95% CI 30.5, 62.8) of survey participants with a recent fever took an antimalarial medication, with ACT, specifically the first-line treatment AL (Artemether-Lumefantrine), being the most commonly used treatment (45.8%, 95% CI 29.9, 62.6). Antipyretics (31.4%, 95% CI 19.8, 46.0) and antibiotics (13.4%, 95% CI 6.0, 26.9) were more commonly administered than Primaquine (7.6%, 95% CI 3.5, 15.7), a 14-day dose of which is supposed to follow AL as radical cure of hypnozoites in infections with *P. vivax* (Table 20).

The use of AL and antibiotics appeared higher in rural areas, while Primaquine was more frequently provided in urban areas. The Highlands region reported the highest usage of antimalarials (70.9%), predominantly AL, while in the other three regions less than 40% of individuals had taken an antimalarial. The same was observed for antibiotics in the Highlands (30.3%), while their use was particularly low in Southern region (5.4%).

Children under the age of 5 years were significantly less likely to take antimalarials (8.8%) compared to older individuals (50.0%), while the opposite appeared to be the case for antibiotics and antipyretics. While no significant difference in antimalarial use was noted between genders, females were significantly more likely to use an antibiotic than males (17.2% vs. 9.0%).

A total of 44 individuals (83.8% of those 57 reporting a test was done) reported having received a positive malaria test result and 50 individuals (71.7% of those 77 for whom advice or treatment was sought at a health facility or from a village health volunteer) reported being told by a health worker that they had malaria. Almost everyone who reported a positive malaria test or who had been told they had malaria was treated with AL (98.6% and 98.8%, respectively), while 22.8% and 20.2%, respectively, used Primaquine and only few individuals also received an antibiotic. Antibiotics were taken primarily by those cases that had a negative malaria test or were told they did not have malaria (Table 20).

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, 2022-2023

	Percentage of persons who took:								
Background characteristic	Any antimalarial	AL	Prima-quine	SP	Chloro-quine	Artesunate or artemether injection/IV	Antibiotic	Anti-pyretic	No. persons with fever
Residence									
Rural	46.6	46.2	6.7	1.0	0.4	0.4	13.7	31.5	147
Urban	34.7	34.7	32.5	0.0	0.0	0.0	2.2	30.3	11
	P = 0.693	P = 0.703	P = 0.112	P = 0.866	P = 0.895	P = 0.754	P = 0.084	P = 0.966	
Region									
Southern	40.6	39.9	8.4	0.8	0.8	3.6	5.4	36.7	73
Highlands	70.9	70.9	0.0	0.0	0.0	0.0	30.3	20.7	22
Momase	38.3	38.3	12.8	0.0	0.0	0.0	10.1	28.6	17
Islands	29.0	29.0	13.8	4.5	0.0	0.0	15.8	33.5	46
	P = 0.148	P = 0.151	P = 0.323	P = 0.621	P = 0.910	P = 0.538	P = 0.133	P = 0.594	
Age in years									
<5	8.8	8.8	3.9	0.0	0.0	0.0	21.6	55.5	17
5+	50.0	49.6	8.0	1.1	0.4	2.0	12.5	29.0	141
	P = 0.005	**P = 0.005**	P = 0.587	P = 0.700	P = 0.795	P = 0.557	P = 0.442	**P = 0.040**	
Sex									
Female	44.7	44.7	4.4	0.5	0.0	0.0	17.2	34.7	82
Male	48.0	47.1	11.2	1.4	0.8	4.0	9.0	27.7	76
	P = 0.804	P = 0.854	P = 0.270	P = 0.282	P = 0.391	**P = 0.007**	P = 0.159	P = 0.401	
***Test result**									
No test	48.8	48.8	0.0	4.5	0.0	0.0	25.6	76.2	20
Test done	83.7	82.7	19.1	1.0	1.0	4.7	20.5	27.1	57
No malaria	19.6	19.6	0.0	0.9	0.0	0.0	16.0	37.6	13
Malaria	99.8	98.6	22.8	1.2	1.2	5.6	8.1	19.0	44
	P < 0.001	P < 0.001	P = 0.020	P = 0.857	P = 0.276	P = 0.058	P = 0.218	P = 0.162	
***Clinician diagnosis**									
No malaria	13.0	13.0	0.0	0.0	0.0	0.0	58.5	77.9	27
Malaria	99.8	98.8	20.2	2.6	1.0	5.0	7.2	23.6	50
	P < 0.001	P < 0.001	P = 0.2419	P = 0.5562	P = 0.6475	P = 0.3768	P = 0.0004	P = 0.0008	
Total	**46.2**	**45.8**	**7.6**	**1.0**	**0.4**	**1.9**	**13.4**	**31.4**	**158**
95% CI	(30.5, 62.8)	(29.9, 62.6)	(3.5, 15.7)	(0.2, 5.7)	(0.0, 4.2)	(0.7, 5.2)	(6.0, 26.9)	(19.8, 46.0)	

*Applies to persons who reported seeking treatment/help from a health facility or Village Health Volunteer (N=77)

Reason for not attending a health facility

Of all the fever cases who did not seek advice or treatment from a health facility (N=78), 56 provided a reason. The most frequently cited reason was that the illness was not or not yet considered serious, the person was feeling better, or they would wait for the illness to get more serious before attending a health facility (26/56) (Figure 11). Many respondents reported relying on home treatment (18/56).

In the words of survey respondents:

"I felt better and found no reason to go to the health center after consuming herbal water." (Respondent from Oro province).

"I got cured after taking antimalarial from home." (Respondent from Gulf province).

Accessibility of health facilities was often reported by respondents, particularly concerns about the distance of the health facility or about transportation (n/56). Other reasons included a lack of money for transport or a conflict in the village. A respondent from Gulf province said: *"The health center is too far"*.

Another responded from East Sepik province explained: *"The community has a conflict and tribal fight with the neighboring village which the health facility is located. Therefore, they were not able to seek help from the health facility"*.

A respondent from Gulf province explained that they wouldn't seek help outside their home at the onset of symptoms instead they wait for the illness to get severe. *"Accessibility to health facility is very hard so we remain to wait for the sickness to get worse, then we start look for health facilities."*

Some respondents reported that they were not satisfied with the healthcare services and having trust issues on health workers. Some also raised concerns about the availability of antimalarials at the health facilities.

"Our health facility and health workers are unreliable. No medicines at time when we felt sick, so we don't want to waste time go walk all the way down just for nothing." (Respondent from Oro province)

"I don't want to go to Lorengau hospital to wait the whole day without getting treated. They are too slow. So, I had to help myself to get better." (Respondent from Manus province)

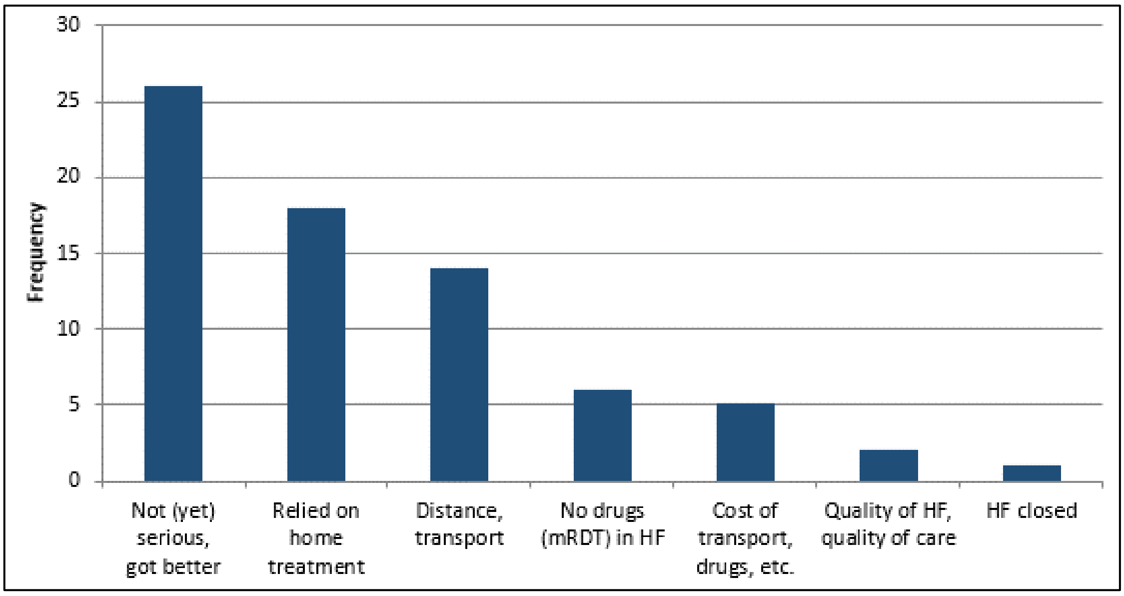


Figure 11. Frequency of reported reasons for not attending a health facility among all 105 persons reporting a reason.

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 number of observations (Table F1, Appendix F).

Trend: The percentage of fever cases brought to a health facility for treatment has decreased since 2020. The previous steady rise in malaria testing among patients who visit health facilities has ended and the percentage of children tested for malaria appears to have decreased to below 30%. On the other hand, there has been a continuous upward trend in the percentage of patients receiving first-line antimalarial treatment after testing positive for malaria, reaching almost 100% (Figure 12).

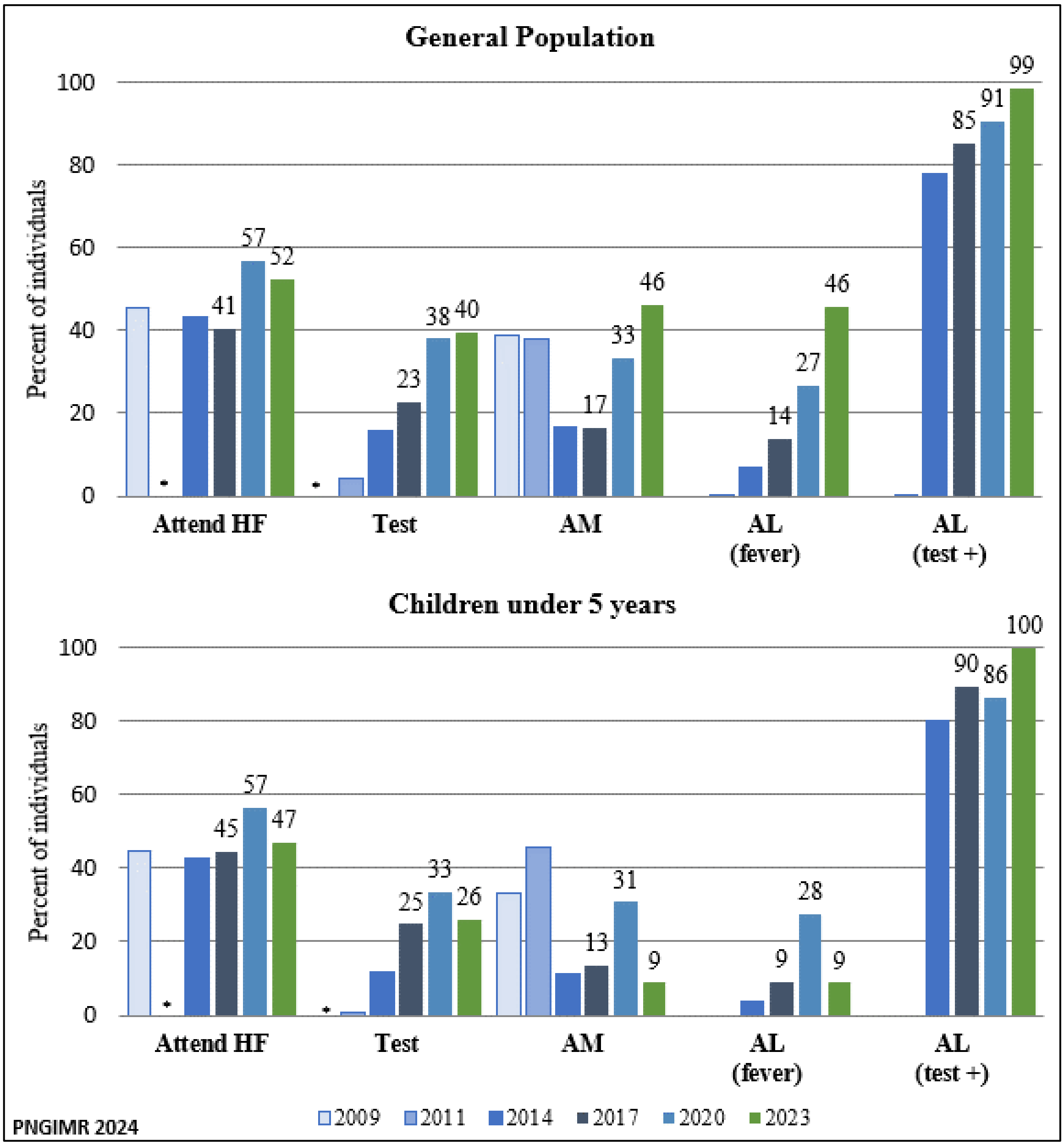


Figure 12. Trends in treatment seeking indicators in the general population and in children <5 years of age.

* Indicates no data available. National survey results 2009-2023. HF = health facility, AM = antimalarial, AL = artemether-lumefantrine. Source: PNGIMR surveys.

4 DISCUSSION AND RECOMMENDATIONS

This section juxtaposes important findings from the current MIS with those from previous MIS conducted in PNG, with a particular focus on trends in malaria prevalence, ITN ownership, access, and usage over the past two and a half decades (2009-2023). Findings are discussed within the broader context of malaria control efforts and complementary studies conducted in PNG.

Overall, the PNG MIS 2022-2023 documents an increase in malaria prevalence compared to the MIS 2019-2020, persistent heterogeneity in malaria infection prevalence, and a reduction or stagnation in the coverage and uptake of malaria control interventions such as ITNs, case management, and IPTp. Time trends in prevalence assessed through subsequent MIS broadly reflect trends in malaria case incidence reported through the National Health Information System, with an initial drop in prevalence and incidence following the scale-up of ITNs (since 2004) and ACT (since late 2012) and a continuous resurgence in both indicators since approximately 2015.

None of the year 2022 targets for key indicators defined in the Global Fund performance framework were achieved by the time of the MIS 2022-2023.

Malaria prevalence dynamics

An increase in malaria prevalence was observed in all four geographical regions. The strongest increase and highest prevalence were found in Momase and Islands regions where villages with >10% prevalence were most frequently found. The increase in prevalence coincided with a decrease in ITN use, with the strongest decreases in net sue observed in Momase and Islands regions. The increase in prevalence in lowland areas (<1,600 m) was more pronounced in children under 5 years of age (2.4% to 4.4%) than in the general population (2.4% to 3.2%), suggesting an increase in exposure to local transmission.

At aggregated level, *P. falciparum* infections were more common than *P. vivax*, although in certain villages in the provinces Morobe, Madang and West New Britain, *P. vivax* infections were more common than *P. falciparum*. In children under 5 years of age, *P. falciparum* and *P. vivax* infections were equally common. There also seems to have been an increase in the number of infections with *P. malariae*. It should be noted that, with overlapping confidence limits, changes between the 2019-2020 and 2022-2023 surveys did not reach statistical significance.

Even though the overall findings from this survey do not indicate that there is a gender disparity in malaria infection prevalence, if disaggregated by age group and region, females in younger age groups (<20 years) were more likely to be infected with malaria than males. The opposite was the case in the Highlands region and in the age group of ≥40 years. The observed patterns are likely multifactorial. Distinct behavior of different demographic groups, such as different occupations, household chores or caretaking activities, leisure activities, or the frequenting of different locations in a villages based on a person's gender (due to local customs), may lead to differential risk in exposure to vector mosquitoes as previously documented in PNG and elsewhere [28, 29]. In this survey, female household members were generally more likely to use ITN, which might in part have contributed to a higher prevalence of infection in males in the oldest age group (≥40 years). Similarly, albeit not statistically significant, females were found to seek care more frequently than males. Addressing gender disparities in malaria infection may require additional investigations and a gender-sensitive malaria control program.

Malaria in highland areas

In survey villages in highland areas (≥1,600 m), the MIS 2019-2020 had found no infections in children <5 years of age and <0.01% in the general population. The increase to 2% in the general population warrants further investigation, whereas the estimate for children <5 years is impossible to interpret as an increase as it is based on a single diagnosed infection in a small number of surveyed children (N = 61). For the overall prevalence estimate in highland areas, it is important to consider that 1) the estimate for in 2022-2023 does not include Hela province (not surveyed due to security reasons), where in the previous survey, prevalence was 0%; 2) the increase is driven primarily by high prevalence in two villages of Enga province (Tumandan 16% and Maip 13%) and one in Chimbu province (Aulabol, 9%). The villages in Enga are located […]. A further village with 13% prevalence was located in Chimbu at 1479m. Across these four villages with high prevalence ≥1,600 m, only one child <5 years of age was diagnosed with malaria by mRDT (but negative by microscopy). The absence of microscopy-positive children in high prevalence villages in highland areas points to imported infections rather than endemic transmission or an ongoing local outbreak at the time of the MIS. The movement of non-immune populations between highland areas and areas with endemic malaria transmission that is expected to increase in certain areas as a result of road and transport infrastructure developments can be expected to exacerbate the problem of malaria importation into highland areas. Favourable weather patterns or climate change may then lead to the proliferation of vector mosquitoes at higher altitudes and subsequent local malaria outbreaks with high morbidity and potentially mortality, as observed prior to the scale-up of the Global Fund-supported malaria control programme [2]. It is therefore advisable to strengthen malaria surveillance and response mechanisms in highland areas, which requires concerned Provincial Health Authorities to conduct timely analyses and interpretation of malaria incidence data and immediate response action following clearly defined protocols in case a local increase in cases in highland areas is suspected to reflect a local outbreak. Road and transport infrastructure developments between the Highlands provinces and coastal areas should ideally be accompanied by health impact assessments that include an assessment of the risk of malaria importation and the implementation of mitigating measures.

The goal to reduce prevalence in children <5 years of age to 1.5% remains unmet and the trend of increase in malaria prevalence suggests an urgent need to intensify malaria control efforts with distinct approaches in areas with endemic local transmission and areas with high risk of importation.

Morbidity and healthcare utilization patterns

Despite the increase in malaria prevalence, malaria-associated morbidity indicators of reported recent fever, acute fever, and anaemia, remained largely unchanged compared to the previous MIS in 2019-2020. Anaemia remained frequent (52.5%), particularly in lowland areas, in urban settings, and in younger age groups and female study participants. As in previous years, anaemia and severe anaemia were most frequent in Momase region (79.4%). Strikingly, over 90% of survey participants in East Sepik (Momase region) and Gulf provinces (Southern region) were found to be anaemic, whereas the highest prevalence of severe anaemia was found in survey villages in Madang province (19.5%). An increase in splenomegaly in children aged 2-9 years was driven almost exclusively by results from West New Britain province, where 77.8% of 152 surveyed children were found to have low-grad splenomegaly (primarily Hackett grade 1).

In PNG, malaria treatment in rural areas is provided almost exclusively in formal health facilities and, in selected areas, through home-based management schemes implemented by Village Health Volunteers. Pharmacies can be found only in urban areas. The consistently low proportion of recent fever cases who sought care (54.7%) reflects persistent barriers to healthcare utilization. For many survey participants, the decision not to seek medical advice or treatment at a health facility was influenced by the belief that their illness was not serious enough to warrant professional attention, an improvement in their symptoms, or a preference to wait until their condition became more severe. This was compounded by a reliance on home treatments, including herbal remedies and stocked antimalarials, reflecting a degree of self-reliance in health management. Moreover, dissatisfaction with healthcare services, mistrust towards healthcare workers, and concerns over the availability of essential medicines further deterred individuals from seeking professional medical care. Additional barriers, such as financial constraints, local conflicts, and logistical challenges related to the distance and accessibility of health facilities, were also frequent deterrents to accessing a health facility. These findings underscore the complexity of healthcare utilization patterns and highlight the necessity for continued investment in health system strengthening. Enhancing the reliability, responsiveness, and accessibility of healthcare services is crucial to ensure prompt and effective management of febrile illnesses, including cases of malaria to prevent progression to severe malaria, lasting disability and death.

Dynamics of ITN ownership and usage

The PNG NMCP relies exclusively on ITNs for malaria vector control and a substantial proportion of the financial support from the Global Fund is invested for the procurement of ITNs and their mass distribution to the household level.

Since 2017, three subsequent MIS have documented a steady decrease in population access and use of ITNs across PNG. With 58% household ownership, 49% population access and 31% use of an ITN in 2022-2023, key net coverage indicators have dropped in part below the levels measured in the MIS 2010/11 (82% ownership, 44% access, 49% use). In fact, in pre-distribution surveys conducted in selected sentinel sites, ownership and use of any type of net were higher than ITN ownership and ITN use in this latest MIS.

The reduction in ITN usage to a mere 31% country-wide, 33% in areas <1600m altitude and 44% among children <5 years of age living <1600m signifies a considerable vulnerability of a majority of the population in PNG to the bites of potentially malaria-carrying mosquitoes at night.

The observed decline in ITN indicators may be attributed to a number of factors:

Firstly, as a result of funding constraints and in light of previous findings indicating an absence of malaria transmission in most of the highland areas [14, 26], the NMCP stopped household level ITN distributions in areas above 1200m altitude in 2020. Yet, while this would contribute to a decline in net coverage indicators across the country, it cannot fully explain the decrease in ITN ownership in surveys locations at <1600m altitude from 77% in 2019-2020 to 33% in this survey (as only few people live between 1200 and 1600m). Logistical challenges in distributing ITNs may have increased in certain areas – often due to security concerns – potentially jeopardizing village level distributions. Yet, this scenario is more likely in the Highland provinces and locations with persistent security concerns would also not be covered by the MIS (e.g. Hela province). In certain locations, a significant drop in ownership and usage was compounded by a lack of new ITN acquisitions or replacement campaigns for over three years.

A series of recent investigations by PNGIMR found a significant decrease in bioefficacy of Permanet 2 after 2013 and a short effective life span of Yahe nets [13, 30]. The change in bioefficacy of Permanet 2 coincided with changes in the manufacturing process. There have been concerns that ITNs on the market may not or no longer be as effective and long-lasting as indicated by manufacturers. As a result, nets may become unusable sooner and net coverage may decline faster than previously.

Interestingly, population access to an ITN decreased in all regions except in the Highlands, making it more difficult for many people to use a net. While overall, ITN use decreased in all regions, in Southern region, ITN use increased among those people with access, whereas it decreased among those with access in the other three regions. Hence, while the decreased use can to a degree be explained by decreased ownership and access, it appears that an increasing number of people chose note to use an ITN even though they have access to one.

The initial PNGIMR investigations into ITN bioefficacy were triggered by community complaints about nets not working, suggesting that the real or perceived effectiveness of nets may be an important factor determining their use. Previous qualitative investigations in PNG also found other reasons for not using available nets, including indifference to disease, heat, and other factors [27]. This is reflected in the disparity between ITN access and actual use for example in the Islands Region, where available nets are not being used. This gap may be accentuated by the reluctance of adolescent and adult men to use ITNs, possibly pointing to indifference to the disease as a key factor underlying low usage rates among those with access to ITNs. In the Highlands provinces, the underuse of ITNs is not only linked to their insufficient availability but the lower abundance of mosquitoes and low risk of malaria in these areas might also lead to a reduced perceived need for using ITNs.

In spite of the decreasing trend in ITN use and available evidence on reasons for not using an ITN when one was available, exposure to malaria messages decreased over time from 8% in 2016-2017 to 5% in 2019-2020 to 4% in this MIS. These findings reveal that the methods of behavior change communication implemented by the NMCP might not be sufficient to reach the population with messages that highlight the risks of malaria and promote the use of ITNs. With only a small percentage of household heads reporting exposure to malaria information in the past 3 months—most of which was provided by health workers—there is a clear gap in the dissemination of malaria-related behavior change messages. This situation is slightly better in the Islands region but still falls short of significantly boosting ITN usage.

ITN coverage targets for the year 2022 defined in the Global Fund performance framework was met by the time of the MIS 2022-2023, as was the case in the previous two MIS. Achieving universal coverage with ITNs requires a distribution strategy that ensures that 1) a sufficient number of ITNs are available in all households; 2) ITNs have a sufficient physical longevity and bio-efficacy to remain effective for at least 3 years; and 3) available ITNs are used. While all of these aspects require an increase in available funding, regulatory measures and entomological monitoring are required to address the second points and innovative behavior change communication approaches using diverse means of communication should be employed to effectively convey critical messages related to the importance of ITN use in malaria prevention.

Intermittent Preventive Treatment during pregnancy (IPTp)

Apart from ITNs, IPTp is the only other malaria prevention measure currently promoted by the NMCP. Compared to the previous MIS in 2019-2020, the coverage with at least one or two doses of IPTp with SP appears to have slightly increased (35.0% to 45.4% and 30.8% to 41.7%, respectively). However, the overall sample of surveyed women was limited (N=423) and the changes were not statistically significant. No change was observed in coverage with three or more doses of IPTp. As in previous years, better education and higher socio-economic status were associated with IPTp coverage. Obstacles to IPTp uptake in PNG have not yet been thoroughly investigated; however, access to ANC services particularly in rural areas may be an important driver, whereas the availability of SP in health facilities and health worker knowledge appeared in a recent health facility survey not to be a limiting factor [31].

Limitations of the survey

This MIS followed standard methodology for data collection in line with previous MIS conducted in PNG, using survey questionnaires based on templates applied across malaria endemic countries. The survey is designed to provide national-level estimates for all indicators and regional estimates for some. As elsewhere, an MIS is usually not powered to detect small changes in low malaria prevalence as the required sample size would be beyond what is operationally feasible to implement. Provincial level estimates are provided for informational purposes only as the small number of survey locations in a context with generally high within-province heterogeneity makes extrapolation to the entire province difficult. It is therefore important to consider the selection (location) of specific survey villages when interpreting sub-national estimates. Similarly, observed trends over time may to a certain degree be influenced by the random selection of survey sites and by the necessity to change certain locations for operational and security considerations.

The MIS is a cross-sectional survey that reflects the situation at the time of the survey team's visit. For operational and financial reasons, and based on many years of local experience, the PNG MIS is conducted by a small number of PNGIMR survey teams that travel to the survey sites across that country, rather than in a decentralized manner by a large number of survey teams deployed simultaneously. As a result, the survey is conducted over an extended period, spanning approximately one year and hence different malaria transmission seasons. This temporal variability may to a certain extent affect estimates of malaria prevalence, and morbidity and treatment seeking indicators, even though prevalence is expected to be less prone to seasonal variability than transmission and clinical incidence. Similarly, ITN coverage, especially ownership, is expected to be negatively correlated with the time since the last distribution. How long after the last distribution in a particular village the MIS was carried out would hence influence coverage estimates.

Reliance of any MIS on self-reported data for ITN ownership and usage, fever episodes, treatment-seeking behavior makes it prone to recall and social desirability biases. These biases could lead to overestimation or underestimation of key indicators, impacting the validity of the findings. To address this concern, specifically for ITN ownership and use indicators, field teams were instructed to observe the nets directly and respond to specific questions based on these observations. This approach ensured that ITN ownership and use data were not solely dependent on participants' self-reporting, thereby improving the accuracy and reliability of these key indicators.

These developments necessitate a reassessment of risk profiles across different regions and the adaptation of vector control strategies accordingly. Further in-depth studies are warranted to investigate the underlying causes of these changing transmission patterns in greater detail.

Conclusion

An increasing trend in malaria prevalence alongside a stark decrease in most ITN coverage metrics and a stagnation in treatment coverage across PNG have led to the programme missing the 2022 Global Fund performance targets for key indicators assessed through the MIS. Subsequent MIS findings reflect ongoing challenges in malaria control in PNG. Data from NHIS and research studies conducted by PNGIMR and others provide confirmation of an increase in malaria burden in PNG and contextual information related to challenges in malaria control efforts.

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 thorough understanding of factors underlying the resurgence of malaria in PNG. Further in-depth analyses and studies may be warranted to investigate underlying causes of changing malaria patterns.

To combat the rise in malaria prevalence, the NMCP must implement strategies to counter the fall in ITN coverage and explore options to intensify malaria control efforts particularly in the most affected areas in the lowlands. Broader health systems strengthening efforts will be required to increase access to prompt and effective malaria treatment. Efforts should include not only enhanced interventions, but also strategic public health messaging tailored to the context of PNG. A sub-national tailoring approach as recommended by WHO should be implemented to move away from a one-size-fits all approach and identify combinations of approaches and interventions expected to have the biggest impact in distinct sub-national settings, making best use of constraint resources.

Considering a stagnation in funding for malaria control and significantly increased operational costs in PNG, additional efforts are required to ensure sufficient funding for vector control, diagnosis, treatment, behavior change campaigns, operational research and broader health systems strengthening measures. 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, 2022-2023

Background characteristic		Households			*De facto* population		
		Rural	Urban	Total	Rural	Urban	Total
Province	01 WESTERN	118	31	149	531	151	682
	02 GULF	152	0	152	879	0	879
	03 CENTRAL	135	0	135	749	0	749
	04 NCD	0	139	139	0	572	572
	05 MILNE BAY	113	30	143	584	155	739
	06 ORO	86	0	86	490	0	490
	07 SHP	151	0	151	719	0	719
	08 ENGA	153	0	153	660	0	660
	09 WHP	151	0	151	710	0	710
	10 CHIMBU	142	0	142	831	0	831
	11 EHP	159	0	159	913	0	913
	12 MOROBE	115	30	145	580	181	761
	13 MADANG	119	30	149	479	125	604
	14 E. SEPIK	115	30	145	666	210	876
	15 SANDAUN	111	31	142	554	141	695
	16 MANUS	113	30	143	677	185	862
	17 NEW IRELAND	156	0	156	865	0	865
	18 ENB	149	0	149	483	0	483
	19 WNB	111	30	141	609	203	812
	20 BOUGAINVILLE	164	0	164	787	0	787
	21 HELA	NA	NA	NA	NA	NA	NA
	22 JIWAKA	135	0	135	531	151	682
Region	Southern	604	200	804	3,233	878	4,111
	Highlands	756	0	756	3,833	0	3,833
	Momase	460	121	581	2,279	657	2,936
	Islands	828	60	888	4,167	388	4,555
Altitude (m)	<1200m	1,793	381	2,174	9,084	1,923	11,007
	1200 to <1600	300	0	300	1,768	0	1,768
	1600+ m	555	0	555	2,660	0	2,660
Age (years)	<5				1,435	195	1,630
	<1				161	22	183
	1-4				1,274	173	1,447
	5-9				1,852	231	2,083
	10-14				1,601	179	1,780
	15-19				1,332	170	1,502
	20-39				3,757	713	4,470
	40+				3,535	435	3,970
Sex	Male				6,658	937	7,595
	Female				6,854	986	7,840
Total		**2,726**	**573**	**3,299**	**13,515**	**1,923**	**15,435**

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 insecticide-treated net (ITN); average number of nets and ITNs per household; and percentage of households with at least one net and ITN per two persons who stayed in the household last night, according to background characteristics, Papua New Guinea, 2022-2023

	Percentage of households with at least one mosquito net			Average number of nets per household			
Province[1]	Any mosquito net	ITN[2]	Percentage of households with at least two ITN	Any mosquito net	ITN	Percentage of households with at least one ITN 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	80.5	80.5	57.0	1.9	1.9	52.1	149
02 GULF	96.1	96.1	89.5	2.9	2.9	64.1	152
03 CENTRAL	89.6	89.6	77.8	2.5	2.5	52.3	135
04 NCD	4.3	4.3	0.7	0.1	0.1	0.5	139
05 MILNE BAY	29.4	29.4	20.3	0.7	0.7	10.4	143
06 ORO	97.7	97.7	80.2	2.6	2.6	55.5	86
07 SHP	59.6	59.6	46.4	1.4	1.4	31.9	151
08 ENGA	14.4	14.4	7.8	0.3	0.3	5.6	153
09 WHP	41.7	41.7	32.5	1.0	1.0	22.0	151
10 CHIMBU	45.8	45.8	24.6	0.9	0.9	12.1	142
11 EHP	67.3	67.3	61.0	1.9	1.9	37.0	159
12 MOROBE	61.4	61.4	43.4	1.5	1.5	36.7	145
13 MADANG	34.2	34.2	24.2	0.7	0.7	36.7	149
14 E. SEPIK	64.8	64.8	55.2	2.0	2.0	38.0	145
15 SANDAUN	67.6	67.6	46.5	1.5	1.5	45.6	142
16 MANUS	79.0	79.0	67.1	2.8	2.8	47.1	143
17 NEW IRELAND	81.4	81.4	68.6	2.4	2.4	28.2	156
18 ENB	47.7	47.7	30.9	0.9	0.9	63.2	149
19 WNB	93.6	93.6	86.5	2.6	2.6	49.0	141
20 BOUGAINVILLE	36.6	36.6	23.2	0.8	0.8	20.9	164
21 HELA	NA	NA	NA	NA	NA	NA	NA
22 JIWAKA	41.5	41.5	20.0	0.7	0.7	32.7	135

[1]Provincial figures are unweighted proportions.
[2] Green shading indicates that Global Fund target of **75%** was reached

Table B2. Access to an ITN

Percentage of the *de facto* population with access to an ITN in the household, by province, Papua New Guinea, 2022-2023

Province	Percentage of the *de facto* population with access to an ITN[1,2]
01 WESTERN	66.9
02 GULF	87.2
03 CENTRAL	77.5
04 NCD	2.6
05 MILNE BAY	22.7
06 ORO	82.8
07 SHP	49.0
08 ENGA	10.7
09 WHP	34.2
10 CHIMBU	30.0
11 EHP	58.7
12 MOROBE	49.4
13 MADANG	31.1
14 E. SEPIK	55.3
15 SANDAUN	56.8
16 MANUS	66.8
17 NEW IRELAND	69.2
18 ENB	42.5
19 WNB	81.2
20 BOUGAINVILLE	26.4
21 HELA	NA
22 JIWAKA	24.8

[1] Percentage of *de facto* household population who could sleep under an ITN if each ITN 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 an insecticide-treated net (ITN); and among the *de facto* household population in households with at least one ITN, percentage who slept under an ITN the night before the survey, according to background characteristics, Papua New Guinea, 2022-2023

	Household population			Household population in households with at least one ITN	
Province	Percentage who slept under any mosquito net last night	Percentage who slept under an ITN last night[1]	Number of persons	Percentage who slept under an ITN last night	Number of persons
01 WESTERN	50.6	50.6	682	62.6	551
02 GULF	82.1	82.1	879	85.9	841
03 CENTRAL	63.6	63.6	749	72.5	657
04 NCD	1.2	1.2	572	35.0	20
05 MILNE BAY	11.1	10.7	739	38.4	206
06 ORO	71.6	71.6	490	73.6	477
07 SHP	12.5	12.5	719	20.2	446
08 ENGA	2.4	2.5	660	17.6	91
09 WHP	3.0	3.0	710	6.6	319
10 CHIMBU	21.7	21.7	831	48.7	370
11 EHP	36.8	36.8	913	55.9	601
12 MOROBE	39.2	39.2	761	62.2	479
13 MADANG	11.6	11.6	604	40.2	174
14 E. SEPIK	49.7	49.7	876	77.3	563
15 SANDAUN	40.7	40.7	695	61.5	460
16 MANUS	42.3	42.3	862	53.3	685
17 NEW IRELAND	24.6	24.6	865	30.1	708
18 ENB	14.3	14.3	483	27.7	249
19 WNB	69.8	69.8	812	74.3	763
20 BOUGAINVILLE	14.0	14.0	787	36.0	306
21 HELA	NA	NA	NA	NA	NA
22 JIWAKA	16.9	16.9	746	39.0	323

[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 insecticide-treated net (ITN); and among children under age 5 in households with at least one ITN, percentage who slept under an ITN the night before the survey, according to background characteristics, Papua New Guinea, 2022-2023

	Children under age 5 in all households			Children under age 5 in households with at least one ITN	
Province	Percentage who slept under any mosquito net last night	Percentage who slept under an ITN last night[1]	Number of children	Percentage who slept under an ITN last night	Number of children
01 WESTERN	66.7	66.7	84	76.7	73
02 GULF	86.4	86.4	110	89.6	106
03 CENTRAL	78.5	78.5	93	92.4	79
04 NCD	5.0	5.0	60	75.0	4
05 MILNE BAY	17.2	17.2	58	55.6	18
06 ORO	80.8	80.8	52	80.8	52
07 SHP	16.9	16.9	65	29.0	38
08 ENGA	8.7	8.7	46	57.1	7
09 WHP	4.2	4.2	71	12.5	24
10 CHIMBU	33.3	33.3	78	81.3	32
11 EHP	50.0	50.0	70	70.0	50
12 MOROBE	47.3	47.3	93	75.9	58
13 MADANG	23.9	23.9	71	70.8	24
14 E. SEPIK	58.6	58.6	70	95.4	43
15 SANDAUN	50.6	50.6	83	73.7	57
16 MANUS	60.0	60.0	85	75.0	68
17 NEW IRELAND	35.4	35.4	96	44.2	77
18 ENB	20.4	20.4	54	34.4	32
19 WNB	78.2	78.2	110	84.3	102
20 BOUGAINVILLE	18.2	18.2	88	45.7	35
21 HELA	NA	NA	NA	NA	NA
22 JIWAKA	30.1	30.1	93	63.6	44

[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, 2022-2023

	Malaria prevalence using mRDT[1]		Malaria prevalence according to microscopy					
Province	mRDT positive	Number of persons	Any species	*P. falciparum*	*P. vivax*	*P. malariae*	Mixed *P.f.* & *P.v.*	Number of persons
01 WESTERN	3.6	566	2.6	2.4	0.7	0.0	0.5	523
02 GULF	11.9	850	3.0	2.7	0.3	0.0	0.0	649
03 CENTRAL	2.7	623	0.0	0.0	0.0	0.0	0.0	617
04 NCD	0.5	708	2.1	2.0	0.0	0.2	0.0	585
05 MILNE BAY	4.3	564	0.0	0.0	0.0	0.0	0.0	620
06 ORO	12.4	559	1.7	1.4	0.2	0.2	0.0	430
07 SHP	0.4	673	0.0	0.0	0.0	0.0	0.0	561
08 ENGA	16.8	476	6.5	4.4	2.6	0.7	1.0	540
09 WHP	1.2	503	0.3	0.3	0.0	0.0	0.0	531
10 CHIMBU	2.0	597	5.0	5.0	0.0	0.0	0.0	597
11 EHP	0.0	641	0.1	0.1	0.0	0.0	0.0	679
12 MOROBE	2.5	826	3.4	2.5	1.0	0.0	0.1	554
13 MADANG	20.1	759	10.9	8.7	2.2	1.2	0.8	616
14 E. SEPIK	11.4	768	4.1	3.6	0.7	0.0	0.1	746
15 SANDAUN	19.6	733	7.3	7.2	1.1	0.0	0.9	605
16 MANUS	14.8	613	8.1	7.0	1.4	0.0	0.4	728
17 NEW IRELAND	10.4	576	6.9	5.5	1.4	0.0	0.0	690
18 ENB	7.7	536	3.2	2.8	0.3	0.0	0.0	612
19 WNB	18.1	471	3.9	1.3	2.5	0.5	0.4	576
20 BOUGAINV.	1.3	566	2.6	2.6	0.0	0.0	0.0	584
21 HELA	NA	NA	NA	NA	NA	NA	NA	NA
22 JIWAKA	0.3	761	0.1	0.0	0.0	0.1	0.0	586

mRDT = malaria Rapid Diagnostic Test

Table C2. Prevalence of malaria infection in children <5 years of age by background characteristics*

Percentage of children classified in two tests as having malaria, using light microscopy and RDTs, Papua New Guinea, 2022-2023.

Background characteristic	Malaria prevalence according to microscopy						Malaria prevalence according to mRDT[1]	
	Any species	*P. falciparum*	*P. vivax*	*P. malariae*	Mixed *P.f.* & *P.v.*	Number of children	mRDT positive	Number of children
Altitude in meters								
<1200	5.3	2.9	2.8	0.2	0.4	993	8.4	1,017
1200 to 1599	0.0	0.0	0.0	0.0	0.0	95	0	95
1600+	0.7	0.7	0.0	0.0	0.0	136	1.9	140
	P = 0.104	P = 0.222	P = 0.493	P = 0.875	P = 0.814			
Residence								
Rural	4.4	2.4	2.3	0.2	0.4	1,066	7.2	1,078
Urban	1.8	1.1	0.7	0.0	0.0	158	2.5	174
	P = 0.103	P = 0.293	P = 0.201	P = 0.637	P = 0.54			
Region								
1 Southern	2.6	2.2	0.4	0.0	0.0	351	6.5	365
2 Highlands	0.2	0.2	0.0	0.0	0.0	237	0.6	241
3 Momase	7.0	3.3	4.5	0.2	0.8	273	9.5	273
4 Islands	7.4	3.5	3.9	0.6	0.6	363	10.7	373
	P < 0.001	P = 0.038	P < 0.001	P = 0.638	P = 0.633		8.4	1,017
Sex								
Female	3.7	2.7	1.1	0.3	0.4	618	4.3	629
Male	4.4	1.7	3.0	0.0	0.3	606	4.0	623
	P = 0.593	P = 0.141	P = 0.045	P = 0.201	P = 0.891			

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

[1]mRDT = malaria Rapid Diagnostic Test

Table C3. 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, 2022-2023

	Malaria prevalence using mRDT		Malaria prevalence according to microscopy					
Province	mRDT positive	Number of children	Any species	P. falciparum	P. vivax	P. malariae	Mixed P.f. & P.v.	Number of children
01 WESTERN	4.4	68	4.0	2.7	1.3	0.0	0.0	61
02 GULF	14.1	64	6.4	6.4	0.0	0.0	0.0	64
03 CENTRAL	1.2	82	0.0	0.0	0.0	0.0	0.0	82
04 NCD	0.0	65	0.0	0.0	0.0	0.0	0.0	58
05 MILNE BAY	4.4	46	0.0	0.0	0.0	0.0	0.0	46
06 ORO	25.0	40	6.5	6.5	0.0	0.0	0.0	40
07 SHP	0.0	42	0.0	0.0	0.0	0.0	0.0	42
08 ENGA	4.8	21	0.0	0.0	0.0	0.0	0.0	21
09 WHP	0.0	30	0.0	0.0	0.0	0.0	0.0	29
10 CHIMBU	2.0	49	2.2	2.2	0.0	0.0	0.0	46
11 EHP	0.0	29	0.0	0.0	0.0	0.0	0.0	29
12 MOROBE	3.9	78	4.4	2.2	3.3	0.0	1.1	77
13 MADANG	22.7	75	8.3	4.8	3.6	1.2	0.0	75
14 E. SEPIK	6.4	47	5.3	1.8	3.5	0.0	0.0	47
15 SANDAUN	20.6	73	10.4	10.4	4.5	0.0	4.6	74
16 MANUS	11.0	73	6.8	5.7	1.1	0.0	0.0	72
17 NEW IRELAND	12.2	82	6.1	2.0	4.1	0.0	0.0	80
18 ENB	6.2	65	6.3	3.8	2.5	0.0	0.0	65
19 WNB	23.3	86	11.4	3.8	7.6	1.3	1.3	79
20 BOUGAINVILLE	1.5	67	2.7	2.7	0.0	0.0	0.0	67
21 HELA	NA	NA	NA	NA	NA	NA	NA	NA
22 JIWAKA	0.0	70	0.0	0.0	0.0	0.0	0.0	70

mRDT = malaria Rapid Diagnostic Test

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

Percentage of persons and children < 5 years classified in two tests as having malaria, by survey village, Papua New Guinea, 2022-2023

Background characteristic			Malaria prevalence								Malaria prevalence in children < 5 years of age							
			According to RDT[1]		According to microscopy						According to RDT[1]		According to microscopy					
Province	Village name	Elevation (meters)	RDT positive	Number of persons	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of persons	RDT positive	Number of children	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of children
WESTERN	Aragi	6	0.6	183	2.2	2.2	0.0	0.0	0.0	179	0.0	29	3.6	3.6	0.0	0.0	0.0	28
WESTERN	Balimo 02	30	0.0	119	1.5	1.5	0.0	0.0	0.0	66	0.0	13	0.0	0.0	0.0	0.0	0.0	7
WESTERN	Tabubil	276	2.2	138	3.7	3.7	1.5	0.0	1.5	135	0.0	11	9.1	9.1	0.0	0.0	0.0	11
WESTERN	Mimigire	100	8.0	100	3.0	2.0	1.0	0.0	0.0	100	25.0	12	8.3	0.0	8.3	0.0	0.0	12
WESTERN	Ulawas	30	17.8	45	0.0	0.0	0.0	0.0	0.0	43	0.0	3	0.0	0.0	0.0	0.0	0.0	3
GULF	Aveoa/Apeawa	72	2.7	111	1.8	1.8	0.0	0.0	0.0	111	0.0	14	7.1	7.1	0.0	0.0	0.0	14
GULF	Mirimurua	61	14.5	117	4.3	4.3	0.0	0.0	0.0	116	10.0	10	10.0	10.0	0.0	0.0	0.0	10
GULF	Aroaro	57	19.4	98	5.2	4.1	1.0	0.0	0.0	97	28.6	7	14.3	14.3	0.0	0.0	0.0	7
GULF	Keakea	42	12.0	150	4.0	3.3	0.7	0.0	0.0	150	29.4	17	5.9	5.9	0.0	0.0	0.0	17
GULF	Avuipi	12	13.4	172	1.7	1.7	0.0	0.0	0.0	175	6.3	16	6.3	6.3	0.0	0.0	0.0	16
CENTRAL	Sirianumu	509	1.8	113	0.0	0.0	0.0	0.0	0.0	113	0.0	14	0.0	0.0	0.0	0.0	0.0	14
CENTRAL	Tarova	16	2.9	102	0.0	0.0	0.0	0.0	0.0	100	0.0	12	0.0	0.0	0.0	0.0	0.0	12
CENTRAL	Iruone	8	0.7	144	0.0	0.0	0.0	0.0	0.0	142	0.0	19	0.0	0.0	0.0	0.0	0.0	19
CENTRAL	Akuku	16	6.5	153	0.0	0.0	0.0	0.0	0.0	155	4.0	25	0.0	0.0	0.0	0.0	0.0	25
CENTRAL	Bereina 603 (Paikua S'ment)	13	0.9	107	0.0	0.0	0.0	0.0	0.0	107	0.0	12	0.0	0.0	0.0	0.0	0.0	12
NCD	Koboka/Kaugere	44	1.3	150	2.0	2.0	0.0	0.0	0.0	150	0.0	21	0.0	0.0	0.0	0.0	0.0	21
NCD	Koukou S'mnt	20	0.0	96	0.0	0.0	0.0	0.0	0.0	94	0.0	7	0.0	0.0	0.0	0.0	0.0	6
NCD	Granville Farm	29	0.7	145	0.0	0.0	0.0	0.0	0.0	144	0.0	11	0.0	0.0	0.0	0.0	0.0	11
NCD	Dotterel St.	55	0.0	140	5.0	4.0	0.0	1.0	0.0	100	0.0	25	0.0	0.0	0.0	0.0	0.0	19
NCD	Pacific Adventist Uni	40	1.0	97	6.2	6.2	0.0	0.0	0.0	97	0.0	1	0.0	0.0	0.0	0.0	0.0	1
MILNE BAY	Logea	10	5.0	139	0.0	0.0	0.0	0.0	0.0	138	20.0	5	0.0	0.0	0.0	0.0	0.0	5
MILNE BAY	Samarai	6	8.5	129	0.0	0.0	0.0	0.0	0.0	128	0.0	6	0.0	0.0	0.0	0.0	0.0	6
MILNE BAY	Divinai	12	1.9	160	0.0	0.0	0.0	0.0	0.0	159	0.0	9	0.0	0.0	0.0	0.0	0.0	9
MILNE BAY	Isudiudiu	18	1.5	65	0.0	0.0	0.0	0.0	0.0	65	0.0	9	0.0	0.0	0.0	0.0	0.0	9

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

Percentage of persons and children < 5 years classified in two tests as having malaria, by survey village, Papua New Guinea, 2022-2023

Background characteristic			Malaria prevalence								Malaria prevalence in children < 5 years of age							
			According to RDT[1]		According to microscopy						According to RDT[1]		According to microscopy					
Province	Village name	Elevation (meters)	RDT positive	Number of persons	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of persons	RDT positive	Number of children	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of children
MILNE BAY	Harbour	37	1.5	130	0.0	0.0	0.0	0.0	0.0	130	5.9	17	0.0	0.0	0.0	0.0	0.0	17
ORO	Urarituru	80	12.5	120	2.5	0.8	0.8	0.8	0.0	120	28.6	7	0.0	0.0	0.0	0.0	0.0	7
ORO	Ururu	587	4.7	150	1.3	1.3	0.0	0.0	0.0	150	0.0	17	0.0	0.0	0.0	0.0	0.0	17
ORO	Afore	736	20.6	160	1.9	1.9	0.0	0.0	0.0	160	50.0	16	18.8	18.8	0.0	0.0	0.0	16
SHP	Ibutaba	778	0.9	113	0.0	0.0	0.0	0.0	0.0	112	0.0	8	0.0	0.0	0.0	0.0	0.0	8
SHP	Komoli	1362	0.0	160	0.0	0.0	0.0	0.0	0.0	160	0.0	19	0.0	0.0	0.0	0.0	0.0	19
SHP	Taukumbu	1376	1.6	125	0.0	0.0	0.0	0.0	0.0	132	0.0	6	0.0	0.0	0.0	0.0	0.0	6
SHP	Eravi	765	0.0	86	0.0	0.0	0.0	0.0	0.0	86	0.0	8	0.0	0.0	0.0	0.0	0.0	8
SHP	Ilo	2019	0.0	78	0.0	0.0	0.0	0.0	0.0	78	0.0	1	0.0	0.0	0.0	0.0	0.0	1
ENGA	Tumandan	2206	36.9	122	16.4	9.0	6.6	0.8	0.0	122	0.0	3	0.0	0.0	0.0	0.0	0.0	3
ENGA	Pausa	1635	0.0	71	0.0	0.0	0.0	0.0	0.0	70	0.0	2	0.0	0.0	0.0	0.0	0.0	2
ENGA	Unda	1877	6.5	108	1.9	1.9	0.9	0.0	0.9	108	0.0	4	0.0	0.0	0.0	0.0	0.0	4
ENGA	Maip	2501	33.8	139	13.0	8.0	6.5	2.9	3.6	138	33.3	3	0.0	0.0	0.0	0.0	0.0	3
ENGA	Lyagen	2036	1.0	103	1.0	1.0	0.0	0.0	0.0	102	0.0	9	0.0	0.0	0.0	0.0	0.0	9
WHP	Ambra	1600	0.0	63	1.6	1.6	0.0	0.0	0.0	63	0.0	2	0.0	0.0	0.0	0.0	0.0	2
WHP	Paglum High School	1722	1.7	115	0.0	0.0	0.0	0.0	0.0	114	0.0	2	0.0	0.0	0.0	0.0	0.0	2
WHP	Tambul Bible Sch	2214	1.6	125	0.0	0.0	0.0	0.0	0.0	123	0.0	13	0.0	0.0	0.0	0.0	0.0	13
WHP	Kokop	1761	1.6	129	0.8	0.8	0.0	0.0	0.0	127	0.0	9	0.0	0.0	0.0	0.0	0.0	9
WHP	Waporo	2219	1.9	107	0.0	0.0	0.0	0.0	0.0	104	0.0	4	0.0	0.0	0.0	0.0	0.0	3
CHIMBU	Kombugl	1654	2.3	130	0.8	0.8	0.0	0.0	0.0	128	0.0	9	0.0	0.0	0.0	0.0	0.0	9
CHIMBU	Oginel	1971	2.1	146	4.2	4.2	0.0	0.0	0.0	144	0.0	15	6.7	6.7	0.0	0.0	0.0	15
CHIMBU	Aulabol	1942	2.0	100	9.0	9.0	0.0	0.0	0.0	100	0.0	10	0.0	0.0	0.0	0.0	0.0	10
CHIMBU	Miunde	1479	0.8	119	12.7	12.7	0.0	0.0	0.0	118	0.0	6	0.0	0.0	0.0	0.0	0.0	6
CHIMBU	Darambuno	1643	2.8	141	0.0	0.0	0.0	0.0	0.0	107	11.1	9	0.0	0.0	0.0	0.0	0.0	6

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

Percentage of persons and children < 5 years classified in two tests as having malaria, by survey village, Papua New Guinea, 2022-2023

Background characteristic			Malaria prevalence								Malaria prevalence in children < 5 years of age							
			According to RDT[1]		According to microscopy						According to RDT[1]		According to microscopy					
Province	Village name	Elevation (meters)	RDT positive	Number of persons	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of persons	RDT positive	Number of children	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of children
EHP	Jackson 5	1553	0.0	170	0.0	0.0	0.0	0.0	0.0	170	0.0	5	0.0	0.0	0.0	0.0	0.0	5
EHP	Lufa High School	1953	0.0	108	0.0	0.0	0.0	0.0	0.0	106	0.0	3	0.0	0.0	0.0	0.0	0.0	3
EHP	Mauten Motos	1575	0.0	126	0.8	0.8	0.0	0.0	0.0	126	0.0	10	0.0	0.0	0.0	0.0	0.0	10
EHP	Yagasie Pltn	1509	0.0	133	0.0	0.0	0.0	0.0	0.0	132	0.0	7	0.0	0.0	0.0	0.0	0.0	7
EHP	Orimu	1526	0.0	145	0.0	0.0	0.0	0.0	0.0	145	0.0	4	0.0	0.0	0.0	0.0	0.0	4
MOROBE	Wafibumpung	234	3.9	102	1.0	1.0	0.0	0.0	0.0	103	5.3	19	5.3	5.3	0.0	0.0	0.0	19
MOROBE	Gobadik	224	3.9	129	8.5	7.8	1.6	0.0	0.8	129	7.1	14	14.3	7.1	14.3	0.0	7.1	14
MOROBE	Mountain Crest	44	0.0	116	0.0	0.0	0.0	0.0	0.0	115	0.0	16	0.0	0.0	0.0	0.0	0.0	15
MOROBE	Warambung	1335	1.1	88	2.3	1.1	1.1	0.0	0.0	88	0.0	10	0.0	0.0	0.0	0.0	0.0	10
MOROBE	Pawa Line	1179	3.3	120	3.4	0.8	2.5	0.0	0.0	119	5.3	19	5.3	0.0	5.3	0.0	0.0	19
MADANG	Inamtap	131	16.6	139	13.8	10.1	2.9	2.2	0.7	138	7.7	13	7.7	0.0	7.7	0.0	0.0	13
MADANG	Malas	6	19.8	126	13.7	12.1	1.6	2.4	1.6	124	29.6	27	14.8	14.8	0.0	3.7	0.0	27
MADANG	Awar Comm. School	6	34.7	144	7.0	5.6	1.4	0.0	0.0	143	32.0	25	8.0	0.0	8.0	0.0	0.0	25
MADANG	Madang TTC P/Farm	305	5.0	120	2.5	2.5	0.0	0.0	0.0	118	0.0	4	0.0	0.0	0.0	0.0	0.0	4
MADANG	Sahgala	19	6.5	93	3.2	0.0	3.2	0.0	0.0	93	0.0	6	0.0	0.0	0.0	0.0	0.0	6
ESP	Tumambe	27	18.8	160	8.4	7.7	1.3	0.0	0.7	155	0.0	8	11.1	0.0	11.1	0.0	0.0	9
ESP	Lumi Camp/Dump	9	4.3	163	3.8	3.8	0.0	0.0	0.0	159	5.9	17	6.3	6.3	0.0	0.0	0.0	16
ESP	Forok 2	91	14.7	150	4.1	3.4	0.7	0.0	0.0	148	0.0	8	0.0	0.0	0.0	0.0	0.0	8
ESP	Uruwaru	95	5.8	103	1.9	1.9	0.0	0.0	0.0	103	14.3	7	0.0	0.0	0.0	0.0	0.0	7
ESP	Serakikum No 2	149	13.3	181	1.7	1.1	0.6	0.0	0.0	181	14.3	7	14.3	0.0	14.3	0.0	0.0	7
WSP	Ningra	8	29.3	147	5.4	5.4	0.7	0.0	0.7	147	30.0	20	5.0	5.0	0.0	0.0	0.0	20
WSP	Skotiaho	177	28.7	157	13.4	13.4	2.6	0.0	2.6	157	36.0	25	20.0	20.0	8.0	0.0	8.0	25
WSP	Salame 1	5	1.7	119	3.3	2.5	0.8	0.0	0.0	120	0.0	13	0.0	0.0	0.0	0.0	0.0	14
WSP	Karate	135	8.3	132	11.5	11.5	0.0	0.0	0.0	131	0.0	10	10.0	10.0	0.0	0.0	0.0	10

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

Percentage of persons and children < 5 years classified in two tests as having malaria, by survey village, Papua New Guinea, 2022-2023

Background characteristic			Malaria prevalence								Malaria prevalence in children < 5 years of age							
			According to RDT[1]		According to microscopy						According to RDT[1]		According to microscopy					
Province	Village name	Elevation (meters)	RDT positive	Number of persons	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of persons	RDT positive	Number of children	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of children
WSP	Ibru	81	52.0	50	4.0	4.0	0.0	0.0	0.0	50	0.0	5	0.0	0.0	0.0	0.0	0.0	5
MANUS	Nutt Point	42	17.3	110	4.6	4.6	0.0	0.0	0.0	110	11.1	9	0.0	0.0	0.0	0.0	0.0	9
MANUS	Riwiriu	6	10.9	175	5.7	5.7	0.6	0.0	0.6	175	5.3	19	5.3	5.3	0.0	0.0	0.0	19
MANUS	Sirrah	191	17.4	155	12.9	9.0	5.2	0.0	1.3	155	22.2	18	11.1	5.6	5.6	0.0	0.0	18
MANUS	Pelipowai	36	13.3	143	3.6	2.1	1.4	0.0	0.0	140	0.0	13	0.0	0.0	0.0	0.0	0.0	13
MANUS	Mauswara Settlement	50	18.7	150	14.2	14.2	0.0	0.0	0.0	148	14.3	14	23.1	23.1	0.0	0.0	0.0	13
NIP	Lamalava	25	12.9	155	13.3	10.7	2.7	0.0	0.0	150	25.0	16	26.7	6.7	20.0	0.0	0.0	15
NIP	Lamusmus 2	21	11.1	162	6.9	4.4	2.5	0.0	0.0	160	17.7	17	5.9	0.0	5.9	0.0	0.0	17
NIP	Ulaputur Pltn	7	19.5	118	5.2	3.5	1.7	0.0	0.0	116	12.5	16	6.7	6.7	0.0	0.0	0.0	15
NIP	Kurumut	92	5.1	117	0.0	0.0	0.0	0.0	0.0	117	5.0	20	0.0	0.0	0.0	0.0	0.0	20
NIP	Pinatgin	65	5.3	150	7.4	7.4	0.0	0.0	0.0	148	0.0	13	0.0	0.0	0.0	0.0	0.0	13
ENB	Ulu Plantation	775	7.9	101	0.0	0.0	0.0	0.0	0.0	99	9.1	11	0.0	0.0	0.0	0.0	0.0	11
ENB	Vunapaka H/Centre	106	4.7	129	0.0	0.0	0.0	0.0	0.0	129	0.0	14	0.0	0.0	0.0	0.0	0.0	14
ENB	Korere Clifton Sett.	10	8.9	135	7.4	6.7	0.7	0.0	0.0	135	8.7	23	17.4	13.0	4.4	0.0	0.0	23
ENB	Ilugi Plantation	225	12.6	127	7.1	6.4	0.8	0.0	0.0	126	7.7	13	7.7	0.0	7.7	0.0	0.0	13
ENB	Taulil No.1	202	4.8	124	0.0	0.0	0.0	0.0	0.0	123	0.0	4	0.0	0.0	0.0	0.0	0.0	4
WNB	Kavutu	28	22.0	118	6.8	3.4	3.4	0.9	0.9	118	40.0	20	20.0	10.0	10.0	0.0	0.0	20
WNB	Taba Rikau Settlement	132	7.4	121	0.8	0.0	0.8	0.0	0.0	119	5.3	19	0.0	0.0	0.0	0.0	0.0	18
WNB	Lolobau Plantation	23	35.8	120	2.6	0.0	1.7	0.9	0.0	116	21.1	19	0.0	0.0	0.0	0.0	0.0	15
WNB	Bola (Incl. Huvale)	36	12.8	109	2.8	0.9	1.9	0.9	0.9	108	23.1	13	25.0	8.3	16.7	8.3	8.3	12
WNB	Dagi	14	18.5	119	7.8	3.5	5.2	0.0	0.9	116	26.7	15	14.3	0.0	14.3	0.0	0.0	14
AROB	Namatoa	583	0.8	127	3.9	3.9	0.0	0.0	0.0	127	0.0	18	0.0	0.0	0.0	0.0	0.0	18
AROB	Ibirai	101	0.9	117	8.6	8.6	0.0	0.0	0.0	116	0.0	14	7.1	7.1	0.0	0.0	0.0	14
AROB	Pirunava	11	0.9	117	1.7	1.7	0.0	0.0	0.0	117	0.0	14	7.1	7.1	0.0	0.0	0.0	14

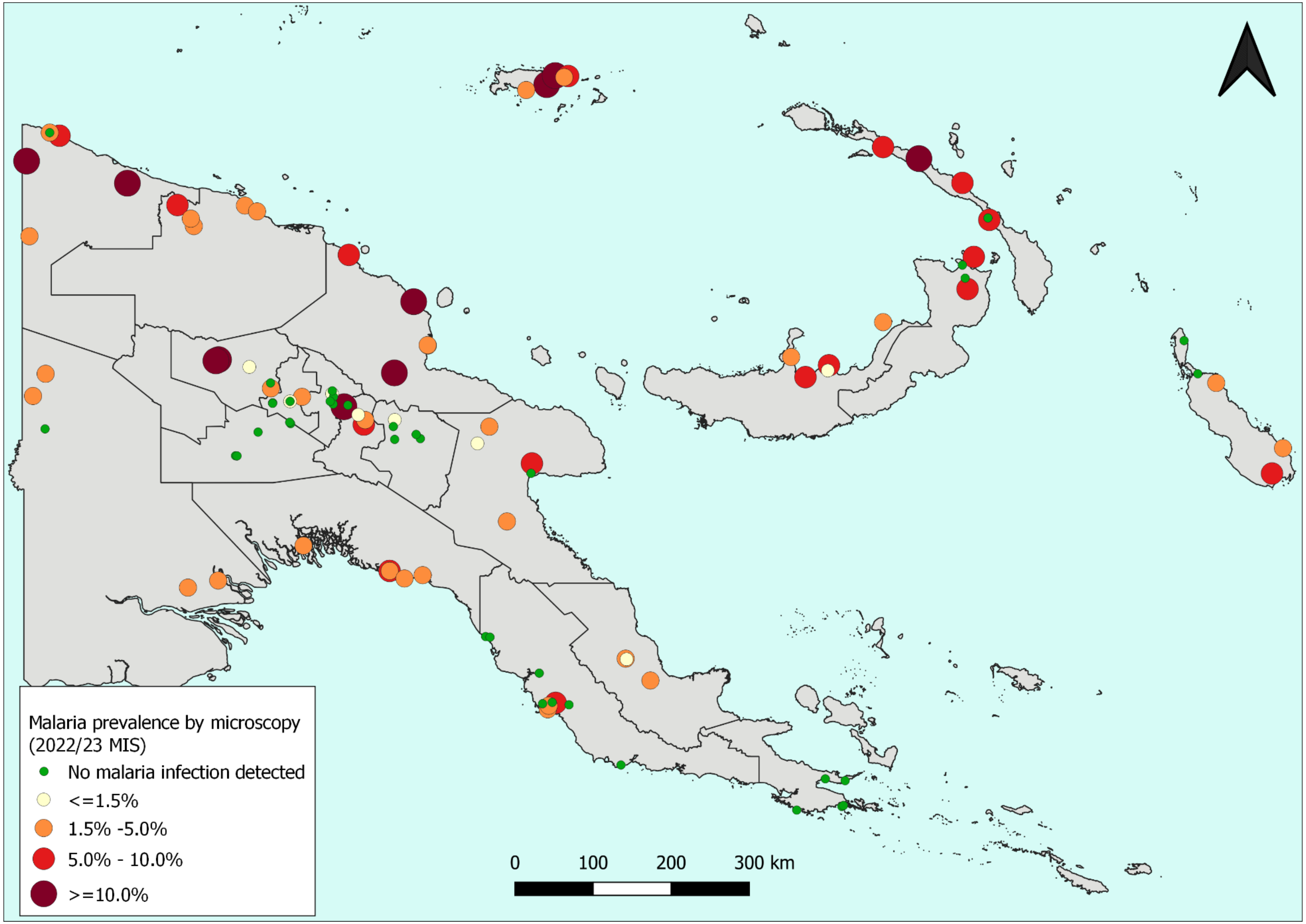
Table C4. Prevalence of malaria by survey village (raw data)

Percentage of persons and children < 5 years classified in two tests as having malaria, by survey village, Papua New Guinea, 2022-2023

Background characteristic			Malaria prevalence								Malaria prevalence in children < 5 years of age							
			According to RDT[1]		According to microscopy						According to RDT[1]		According to microscopy					
Province	Village name	Elevation (meters)	RDT positive	Number of persons	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of persons	RDT positive	Number of children	Any species	*P.f.*	*P.v.*	*P.m.*	Mixed *P.f.* & *P.v.*	Number of children
AROB	Ton	45	4.0	100	0.0	0.0	0.0	0.0	0.0	100	12.5	8	0.0	0.0	0.0	0.0	0.0	8
AROB	Hanahan No. 1	90	0.8	124	0.0	0.0	0.0	0.0	0.0	124	0.0	13	0.0	0.0	0.0	0.0	0.0	13
JIWAKA	Sindinda	1605	0.0	155	0.0	0.0	0.0	0.0	0.0	153	0.0	24	0.0	0.0	0.0	0.0	0.0	24
JIWAKA	Goimil Ebc	1568	0.0	110	0.0	0.0	0.0	0.0	0.0	109	0.0	11	0.0	0.0	0.0	0.0	0.0	11
JIWAKA	Kusnguna (Laswari)	1949	1.6	64	0.0	0.0	0.0	0.0	0.0	62	0.0	8	0.0	0.0	0.0	0.0	0.0	8
JIWAKA	Anjinimp	1557	0.0	136	0.0	0.0	0.0	0.0	0.0	135	0.0	17	0.0	0.0	0.0	0.0	0.0	17
JIWAKA	Aprup 1	1729	0.8	127	0.8	0.0	0.0	0.8	0.0	127	0.0	10	0.0	0.0	0.0	0.0	0.0	10

[1] mRDT = malaria Rapid Diagnostic Test

Figure C1: Malaria parasite prevalence in the surveyed villages by light microscopy



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. **parasceen**® (Pan/Pf) Rapid Test for Malaria, 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 Plasmodium Lactate Dehydrogenase (pLDH) which detect all malaria parasites but relatively short-lived after treatment. 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)

Specificity = 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 **parasceen**® with the light microscopy as a gold standard. Apparently, the sensitivity of RDT brand is low 48.1%, while the diagnostic kit shows a high specificity 93.4%.

Table D1. Crosstab of results of malaria RDT brand (**parasceen**® (Pan/Pf) Rapid Test for Malaria) with the results of light microscopy, MIS 2022/23, PNG

		RESULTS BY MICROSCOPY		
		Negative	Positive	Total
RESULTS BY RDT	Negative	11,371	234	11,605
		93.4%	51.9%	92.0%
	Positive	798	217	1,015
		6.6%	**48.1%**	8.0%
	Total	12,169	451	12,620
		100%	100%	100%

2) Prevalence of malaria using mRDT

Below 1600 m altitude, 6.2% (95% CI 4.8, 8.1) of people tested positive with mRDTs. In highland areas at 1600 m and above, 3.9% (95% CI 1.8, 8.4) 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, 6.9% (95% CI 5.2, 9.1) tested positive using mRDTs, while only two malaria infection was found in the 142 children surveyed in highland villages at 1600 m and above (Table D3).

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, 2022-2023

	Number				Malaria prevalence according to mRDT[1] (%)			
Altitude	negative	positive	failed*	tested	*Pf*	non-*Pf*	*Pf* or mixed	All
<1600 m	9,817	901	6	10,724	3.4	1.2	1.9	**6.4**
(95% CI)					(2.5,4.5)	(0.9,1.6)	(1.7,3.0)	(4.8,8.4)
≥1600 m	2,009	122	0	2,131	1.5	1.5	1	**3.9**
(95% CI)					(0.6,3.7)	(0.7,2.9)	(0.4,2.6)	(1.8,8.4)
Overall	**11,826**	**1,023**	**6**	**12,855**	**3.2**	**1.3**	**1.8**	**6.2**
(95% CI)					(2.4,4.1)	(1.0,1.6)	(1.2,2.8)	(4.8,8.1)

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

Table D3. 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, 2022-2023

Altitude	Totals				Malaria prevalence according to mRDT[1] (%)			
	negative	positive	failed*	tested	*Pf*	non-*Pf*	*Pf* or mixed	All
<1600 m	1112	106	0	1218	2.4	2.7	1.8	6.9
(95% CI)					(1.6,3.7)	(1.9,3.9)	(1.0,2.9)	(5.2,9.1)
≥1600 m	140	2	0	142	0.5	1.4	0.0	1.9
(95% CI)					(0.1,2.5)	(0.3,6.7)		(0.5,6.4)
Overall	**1252**	**108**	**0**	**1360**	**2.3**	**2.6**	**1.6**	**6.5**
(95% CI)					(1.5,3.5)	(1.9,3.7)	(0.9,2.7)	(4.9,8.5)

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

Malaria prevalence varies significantly with altitude. Areas below 1200 meters have the highest prevalence at 8.3%, indicating a substantial malaria burden in lower altitude regions. In contrast, the prevalence drops to 0.2% in areas ranging from 1200 to 1599 meters and increases slightly to 3.9% in regions above 1600 meters, showcasing how altitude influences malaria transmission dynamics.

Rural areas exhibit a higher malaria prevalence (6.9%) compared to urban areas (1.8%), reflecting the rural-urban divide in exposure to malaria vectors and access to prevention and treatment services. The Momase region reports the highest malaria prevalence at 12.5%, followed by the Islands region at 7.5%, the Southern region at 5.0%, and the Highlands region at 1.6%. These differences highlight the regional disparities in malaria risk within the country.

The age group analysis reveals that children aged 10-14 years have the highest malaria prevalence at 9.9%, followed closely by the 5-9 years age group at 8.2%. The lowest prevalence is observed in infants under 1 year at 1.9% and pregnant women at 2.0%, suggesting varying levels of exposure and possibly differential access to preventive measures across age groups.

Furthermore, the survey indicates a slight gender difference in malaria prevalence, with males experiencing a higher rate (6.6%) than females (5.9%). Among women aged 15-49, those not pregnant show a prevalence of 5.7%, compared to 2.0% in pregnant women, suggesting effective targeted malaria prevention efforts for pregnant women. These findings emphasize the need for tailored malaria control strategies, particularly focusing on high-risk regions and vulnerable population groups to reduce the burden of malaria across PNG (Table D4).

Malaria prevalence in nine provinces exceeded 10%, Madang with highest prevalence (20.1%) followed by Sandaun (19.6%) and WNB (18.1%). For children under 5 years of age, four provinces reported to exceed 20% of malaria prevalence, Oro province reported highest prevalence (25%) (Tables C1, Appendix C).

Table D4. Prevalence of malaria infection by background characteristics

Percentage of persons above 6 months of age classified by mRDT as having malaria, according to background characteristics, Papua New Guinea, 2022-2023

Background characteristic	Totals			Malaria prevalence according to mRDT				
	negative	positive	failed*	Pf %	Non-Pf %	Mixed/Pf %	All %	Obs
Altitude (m)								
<1200	8,509	897	6	4.4	1.5	2.4	8.3	9,406
1200 to 1599	1,308	4	0	0.1	0.1	0.0	0.2	1,312
1600+	2,009	122	0	1.5	1.5	1.0	3.9	2,131
Residence								
Rural	10,233	952	6	3.5	1.4	2.0	6.9	11,185
Urban	1,593	71	0	0.9	0.5	0.3	1.8	1,664
Region								
Southern	3,333	200	5	2.6	1.3	1.1	5.0	3,533
Highlands	2,838	124	0	0.6	0.7	0.4	1.6	2,962
Momase	2,199	340	0	6.8	1.7	4.0	12.5	2,539
Islands	3,456	359	1	3.7	1.6	2.3	7.5	3,815
Age in years								
<5	1,144	108	0	2.0	1.3	0.9	4.2	1,252
5-9	1,608	181	0	3.8	1.8	2.7	8.2	1,789
10-14	1,224	167	0	4.7	1.9	3.3	9.9	1,391
15-19	953	107	1	3.9	0.8	3.3	8.0	1,060
20-39	3,549	283	2	3.1	1.1	1.4	5.6	3,832
40+	3,348	177	3	2.4	0.6	0.6	3.6	3,525
Sex								
Female	6,373	501	2	3.2	1.1	1.7	5.9	6,874
Male	5,453	522	4	3.2	1.5	1.9	6.6	5,975
Women 15-49 years								
Not pregnant	3,307	222	1	3.5	0.6	1.6	5.7	3,529
Pregnant	88	5	0	0.7	0.0	1.3	2.0	93

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

Prevalence was higher in males than in females (Table C3, Appendix C) and the difference was statistically significant in particular age groups in the Southern, Islands and Momase regions. 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 (5.5%) and male (8.29%) children ($P > 0.05$). 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 C3, Appendix C).

In this MIS round, it was found that 31 villages showed malaria prevalence rates exceeding 10%. Contrastingly, in the highland villages, malaria prevalence was generally below 3%, with only three exceptions. In the provinces of Gulf, Madang, East Sepik, West Sepik, Manus, New Ireland, and West New Britain, at least three surveyed villages reported adult malaria prevalence rates over 10%, and at least two villages reported rates above 10% in children under 5 years old. Notably, in Oro province, up to 50% of children under 5 were affected. Outside of the Highlands, the data revealed localized areas of high prevalence among both children and adults in certain villages, while others reported infections predominantly in older children and adults, and some villages reported no infections whatsoever. (Table C4, Appendix C).

Out of 103 surveyed villages, 17 villages reported no malaria infections, and in 63 villages, no infections were detected in children under 5 years old. The presence of infections exclusively in older children or adults in some villages suggests a lower likelihood of ongoing local malaria transmission. Particularly in the Highlands region, out of 17 villages with reported malaria cases, only two had infections among children, indicating that most infections could be imported rather than resulting from local spread. Surprisingly, Enga province, located in the Highlands, showed a malaria prevalence up to 36% in the general population, with these cases presumed to be imported. (Table C5, Appendix C).

APPENDIX E: MORBIDITY INDICATORS BY PROVINCE

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

Percentage of persons with reported fever, acute fever, hemoglobin below the WHO threshold for anemia and severe anemia, and splenomegaly, according to background characteristics, Papua New Guinea, 2022-2023

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	1.7	585	0.3	585	63.2	9.9	585	0.0	148
02 GULF	8.4	651	12.1	651	90.9	2.5	651	0.7	138
03 CENTRAL	0.2	621	0.2	621	58.8	3.2	621	0.0	170
04 NCD	1.0	628	0.1	628	55.5	3.8	628	0.0	129
05 MILNE BAY	0.4	623	2.3	623	66.5	2.7	623	0.0	110
06 ORO	4.9	430	4.3	430	62.7	3.1	376	0.0	110
07 SHP	0.4	562	0.2	562	22.4	0.4	562	0.0	111
08 ENGA	3.3	543	1.6	543	27.2	0.3	543	0.0	48
09 WHP	1.0	539	0.0	539	9.9	1.0	539	0.0	72
10 CHIMBU	2.7	636	0.5	636	26.9	2.1	636	0.0	115
11 EHP	0.9	682	1.9	682	25.9	0.7	682	0.0	98
12 MOROBE	3.8	556	1.4	556	60.7	2.9	431	0.0	137
13 MADANG	4.6	622	3.7	622	77.2	19.5	485	0.0	124
14 E. SEPIK	2.5	758	4.2	758	93.3	5.3	758	0.0	148
15 SANDAUN	4.6	606	1.7	606	78.1	5.3	605	0.5	169
16 MANUS	4.6	734	1.6	734	66.5	2.2	730	0.0	160
17 NEW IRELAND	1.4	702	0.9	702	82.9	4.9	668	0.5	166
18 ENB	1.4	616	0.0	616	48.1	8.9	616	0.0	133
19 WNB	3.4	587	1.7	587	77.5	3.4	553	77.8	152
20 BOUGAINVILLE	2.3	585	0.5	585	77.9	6.6	240	0.0	143
21 HELA	NA	NA	NA	NA	NA	NA	NA	NA	NA
22 JIWAKA	0.6	592	0.0	592	26.1	0.8	585	0.0	127

[1] Acute fever was defined as axillary temperature >37.5°C
[2] Anemia and severe anemia 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, 2022-2023.

	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	100.0	100.0	2	0.0	0.0	0
02 GULF	45.7	26.4	50	33.4	0.0	6
03 CENTRAL	21.0	10.9	11	0.0	0.0	0
04 NCD	0.0	0.0	0	0.0	0.0	0
05 MILNE BAY	44.6	0.0	6	0.0	0.0	0
06 ORO	20.3	20.3	4	0.0	0.0	0
08 ENGA	0.0	0.0	0	0.0	0.0	0
09 WHP	100.0	100.0	1	0.0	0.0	0
10 CHIMBU	100.0	100.0	1	0.0	0.0	0
11 EHP	100.0	76.0	7	100.0	100.0	1
12 MOROBE	91.9	91.9	9	0.0	0.0	0
13 MADANG	0.0	0.0	1	0.0	0.0	0
14 E. SEPIK	0.0	0.0	0	0.0	0.0	0
15 SANDAUN	52.9	31.9	16	100.0	100.0	1
16 MANUS	0.0	0.0	0	0.0	0.0	0
17 NEW IRELAND	68.5	61.2	23	100.0	0.0	1
18 ENB	81.2	72.5	9	100.0	73.8	3
19 WNB	0.0	0.0	3	0.0	0.0	0
20 BOUGAINVILLE	0.0	0.0	5	0.0	0.0	1
21 HELA	NA	NA	NA	NA	NA	NA
22 JIWAKA	48.6	0.0	4	100.0	0.0	1

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

APPENDIX G: IMPLEMENTATION TIMELINE OF MIS 2022-2023

Province	Start Date	End Date	ITN Distribution*	No. Months since last ITN distribution*	Surveyed Villages	Form 2 (Household interviews)	Form 2.1 (Treatment Seeking)	Form 3 (Prevalence Quest're)	Form 4 (Women's Quest're)
01 WESTERN	23-Apr-2023	16-May-2023	Oct 2022	8	5	149	4	591	76
02 GULF	18-Sep-2022	26-Oct-2022	Aug 2022	2	5	152	137	664	129
03 CENTRAL	6-Jun-2023	28-Jun-2023	Jul 2022	12	5	135	17	621	85
04 NCD	21-Feb-2023	25-Mar-2023	NA	NA	5	139	6	628	13
05 MILNE BAY	7-Jun-2023	26-Jun-2023	Apr 2022	38	5	143	12	623	26
06 ORO	8-Nov-2022	22-Nov-2022	Sept 2022	2	3	86	7	430	64
07 SHP	6-Jun-2023	23-Jun-2023	Apr 2022	15	5	151	2	569	50
08 ENGA	18-Jul-2023	3-Aug-2023	Jul 2021	37	5	153	7	543	41
09 WHP	8-Feb-2023	18-Aug-2023	Apr 2021	26	5	151	2	539	50
10 CHIMBU	7-Feb-2023	30-Mar-2023	May 2021	23	5	142	9	637	75
11 EHP	10-Nov-2022	2-Dec-2022	Jun 2021	18	5	159	30	687	84
12 MOROBE	10-Nov-2022	24-Dec-2022	Sept 2021	16	5	145	3	556	75
13 MADANG	25-Apr-2023	13-May-2023	Dec 2021	18	5	149	19	631	12
14 E. SEPIK	26-Apr-2023	15-May-2023	Dec 2021	18	5	145	23	758	86
15 SANDAUN	13-Sep-2022	17-Oct-2022	Feb 2021	20	5	142	15	606	9
16 MANUS	13-Sep-2022	14-Oct-2022	Oct 2022	1	5	143	29	738	71
17 NEW IRELAND	13-Feb-2023	14-Mar-2023	Nov 2022	4	5	156	17	707	91
18 ENB	10-Nov-2022	28-Dec-2022	Apr 2020	33	5	149	7	625	7
19 WNB	8-Aug-2023	29-Aug-2023	May 2023	4	5	141	20	588	75
20 BOUGAINVILLE	12-Sep-2022	13-Oct-2022	Nov 2019	35	5	164	11	586	55
21 HELA	NA	NA	NA	NA	NA	NA	NA	NA	NA
22 JIWAKA	17-Jul-2023	3-Aug-2023	Jun 2021	26	5	135	10	592	70

* Data from the ITN distribution team of Rotarians Against Malaria.

APPENDIX H: NAMES OF CONTRIBUTORS

Management, coordination, supervision	Mr. Melvin Kualawi	Project Manager
	Ms. Clara Goiye	Accounts Clerk
	Ms. Florence Unga	Logistics Officer
Field teams	Mr. Micah Muri	Scientific Officer
	Ms. Clara Are	Scientific Officer
	Mr. Philemon Goi	Scientific Officer
	Mr Nelson Koata	Senior Research Nurse
	Ms. Tracey Foropo	Research Nurse
	Mr. Jordan Ese	Research Nurse
	Mr. John Bruce	Research Nurse
	Ms. Leonnie Oyhalae	Research Nurse
	Ms. Selina Amute	Research Nurse
	Mr. Philip Teine	Research Nurse
	Mr. Enoch Makoni	Research Assistant
	Mr. Ismart Martin	Research Assistant
	Mr. Jacob Girupano	Research Assistant
	Mr. Wilbert Neiembe	Research Assistant
	Mr. Bill Kotuno	Driver
	Mr. Robin Hagoveneta	Driver
Microscopy	Ms. Lina Lorry	Senior Microscopist
	Mr. Levi Kaisa	Microscopist
	Mr. David Kikua	Microscopist
	Mr. Westly Kabileng	Microscopist
	Mr. Frank Kisba	Microscopist
Data management	Mr. Yangta Ura	Senior Data Manager
Survey design and analyses	Dr. Joseph G. Giduthuri	Project Scientific Coordinator
	Ms. Diana Timbi	Senior Scientific Officer
	Dr. Manuel Hetzel	Co-Principal Investigator
	Dr. William Pomat	Co-Principal Investigator