

Malaria Diagnostic Positivity and Testing Patterns in Liberia: An Ecological Analysis of Routine Surveillance Data, 2021–2025

Germue M. Gbawoquiya¹ and Allen S. Kpehe²

^{1,2}Department of Epidemiology, Cuttington University School of Graduate and Professional Studies,
Liberia

¹ORCID: <https://orcid.org/0009-0005-5793-4482>

²ORCID: <https://orcid.org/0009-0002-1294-0414>

DOI: 10.46609/IJSSER.2026.v11i10.001 URL: <https://doi.org/10.46609/IJSSER.2026.v11i10.001>

Received: 15 August 2026 / Accepted: 24 September 2026 / Published: 10 October 2026

ABSTRACT

Malaria remains an important public health problem in Liberia, and routine diagnostic data can show differences in testing patterns across counties and facility types that are not captured in national summaries. We conducted a retrospective longitudinal ecological analysis of aggregated routine malaria surveillance data for 2021–2025. The dataset comprised 300 county-by-facility-type-year observations covering all 15 counties and four facility types. Diagnostic testing was defined from recorded microscopy and rapid diagnostic test (RDT) positive and negative results, and diagnostic positivity as positive tests divided by all recorded tests. Across the study period, 7,097,294 diagnostic tests were recorded, including 3,914,734 positive results (55.2% overall positivity). RDTs accounted for 59.0% of testing and microscopy for 41.0%. Annual positivity declined from 59.1% in 2021 to 51.2% in 2025, while recorded testing increased by 11.0%. County-level positivity ranged from 46.9% in Rivercess to 63.4% in Bomi. Public facilities contributed 64.7% of recorded testing, whereas Private facilities had the highest aggregate positivity (62.9%). Eighty observations had all diagnostic variables missing, with missingness concentrated in non-public facility categories. The data show geographic and health-system variation in routine malaria diagnostic activity and indicate that test positivity should be interpreted with testing volume, diagnostic method, and reporting completeness rather than as a direct estimate of population prevalence.

Keywords: county, diagnostic positivity, diagnostic testing, malaria, routine surveillance

1.0 Introduction

Malaria remains a major infectious disease in sub-Saharan Africa. The World Health Organization (WHO) estimated 282 million malaria cases and 610,000 deaths globally in 2024, with the African Region accounting for approximately 94% of cases and 95% of deaths [1]. Liberia remains malaria-endemic, and WHO's 2024 country profile classified the entire population as living in a high-transmission setting [2]. Liberia has also made measurable progress in malaria control; WHO reported that malaria prevalence measured by microscopy declined from 28% in 2011 to 10% in 2022 [3].

Parasite-based diagnosis is central to malaria case management and surveillance. WHO recommends prompt diagnosis by microscopy or a malaria rapid diagnostic test (RDT) for patients suspected of malaria before antimalarial treatment is given [4,5]. Microscopy can identify parasite species and quantify parasite density, while RDTs provide rapid diagnosis where quality-assured microscopy is not readily available [4,5]. The volume and type of malaria testing can help describe routine surveillance activity.

Routine health information systems are useful to malaria programmes because they provide repeated observations across geographic areas and health-service settings. WHO guidance notes, however, that routine surveillance can be affected by incomplete reporting, inconsistent application of case definitions, and differences in the representation of private and other non-government services [6]. These factors also affect how test positivity should be interpreted because positivity depends on the population tested and may change with testing practices, health-care use, diagnostic methods, and reporting completeness.

Liberia's health information and malaria surveillance systems allow these patterns to be examined at the subnational level. The Ministry of Health maintains malaria surveillance and health information data, while national survey evidence provides complementary information on malaria burden [7,8]. National summaries, however, may conceal differences between counties and health-service settings. A county with a large testing volume may not have the highest positivity, just as a facility category with high positivity may account for a relatively small share of national testing.

This study uses an aggregated five-year routine malaria dataset containing observations for all 15 counties and four facility-type categories—Concession, Faith Based, Private, and Public. The dataset includes annual malaria diagnostic results disaggregated by age group and pregnancy status. Because the data are aggregated and do not contain individual patients, named facilities, monthly observations, or a direct denominator for all persons suspected of malaria, the analysis

focuses on diagnostic testing volume, diagnostic method, and test positivity rather than estimating the proportion of suspected cases tested.

1.1 Research Problem

Routine malaria surveillance data provide an opportunity to examine diagnostic activity across counties and health-service settings, but interpretation becomes difficult when testing volume, diagnostic method, and reporting completeness vary. Diagnostic positivity may change because of differences in the people tested, testing practices, health-care utilization, diagnostic availability, or reporting rather than changes in malaria transmission alone [6].

In Liberia, national summaries can conceal important subnational and health-system differences. The surveillance dataset used in this study covers all 15 counties and four facility-type categories, but it is aggregated and contains incomplete diagnostic reporting for some observations. This analysis describes where testing occurs, how positivity varies, and how reporting completeness affects interpretation of routine malaria diagnostic indicators.

1.2 Research Objectives

The study aimed to:

1. Characterize malaria test positivity and testing patterns across counties and facility types in Liberia from 2021 to 2025.
2. Describe temporal changes in malaria testing volume and diagnostic method during the study period.
3. Assess geographic and health-system heterogeneity relevant to interpretation of routine malaria surveillance data.

1.3 Contribution of the Study

This study describes five years of routine malaria diagnostic testing across all 15 counties and four facility-type categories in Liberia. The analysis considers testing volume, diagnostic method, positivity, geographic variation, facility type, and reporting completeness together. Because the data are ecological and aggregated, the contribution is descriptive rather than causal or individual-level; the findings are intended to support interpretation of routine surveillance indicators and identify areas where reporting and diagnostic monitoring may require further review.

2.0 Literature Review

2.1 Malaria Diagnosis and Routine Surveillance

Parasite-based diagnosis is central to malaria case management and surveillance. WHO recommends diagnosis by microscopy or malaria RDT for patients suspected of malaria before antimalarial treatment is administered [4,5]. Microscopy can identify parasite species and quantify parasite density, while RDTs provide rapid diagnosis where quality-assured microscopy is not readily available [4,5]. Routine surveillance can describe the volume and composition of malaria diagnostic activity.

2.2 Interpretation of Diagnostic Test Positivity

Diagnostic positivity is the proportion of recorded diagnostic tests that produce a positive result. It depends on the population that presents for care and is selected for testing. Changes in testing thresholds, health-seeking behaviour, referral patterns, diagnostic availability, or reporting can alter observed positivity even when underlying transmission is unchanged. Routine surveillance guidance recommends interpreting trends in relation to reporting completeness and the representativeness of the populations captured by the system [6].

2.3 Malaria Surveillance Context in Liberia

Liberia's Ministry of Health maintains malaria surveillance and health information systems, while national survey evidence provides complementary measures of malaria burden [7,8]. Routine data available at county and facility-type levels allow diagnostic patterns to be examined below the national level. Separating the data by county and facility type is important because testing volume and positivity describe different aspects of service activity and should not be treated as interchangeable measures.

2.4 Research Gap

National malaria reports and population-based surveys provide information on malaria burden in Liberia, but routine diagnostic activity can vary by county and facility type. The aggregated surveillance data used in this study provide an opportunity to examine these differences together with changes in testing volume, diagnostic method, positivity, and reporting completeness. The study therefore focuses on these surveillance patterns rather than individual-level risk factors or causal relationships.

3.0 Research Methodology

The study design, setting, data source, measures, data completeness, and analytical approach are described in this section.

3.1 Study Design

We conducted a retrospective longitudinal ecological study using aggregated routine malaria surveillance data from Liberia for the period 2021–2025. The unit of analysis was the county-by-facility-type-year observation. The dataset contained aggregated diagnostic testing information rather than individual patient records; therefore, all analyses were conducted at the aggregate surveillance level. The study was structured and reported with reference to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for observational studies [9].

3.2 Study Setting

The study covered Liberia's 15 counties: Bomi, Bong, Gbarpolu, Grand Bassa, Grand Cape Mount, Grand Gedeh, Grand Kru, Lofa, Margibi, Maryland, Montserrado, Nimba, River Gee, Rivercess, and Sinoe. The health-service categories represented in the dataset were Concession, Faith Based, Private, and Public.

3.3 Data Source and Dataset Structure

The analysis used an aggregated routine malaria surveillance dataset supplied for this study by the Liberia Ministry of Health/National Malaria Control Program [10]. The dataset contains 300 rows and 57 variables. The 300 observations represent the complete structural combination of 15 counties, four facility types, and five years. Each year therefore contributes 60 county-by-facility-type observations, and each facility category contributes 75 observations across the study period. Because the analysis included the complete structural combination available in the dataset, no formal sample-size calculation was performed.

3.4 Diagnostic Variables

The diagnostic component contains 12 variables: microscopy-positive, microscopy-negative, RDT-positive, and RDT-negative counts for children younger than five years, persons aged five years and older, and pregnant women. The file also contains additional variables describing clinical malaria activity, confirmed malaria, severe and uncomplicated malaria, treatment indicators, antenatal care, delivery, and community-based services. These variables were not included in the primary analysis because they do not directly define the diagnostic-testing denominator.

3.5 Study Population and Unit of Analysis

The study population comprised malaria diagnostic encounters represented in the aggregated routine surveillance records. Because the dataset is aggregated, individual patients cannot be followed longitudinally and individual-level demographic, clinical, or behavioral risk factors cannot be modeled. Each observation represents a county, facility-type, and year combination rather than a patient or an individually identified health facility.

3.6 Operational Definitions

Microscopy testing was defined as the sum of microscopy-positive and microscopy-negative counts across the three reported population groups. RDT testing was defined analogously as the sum of RDT-positive and RDT-negative counts. Total recorded testing was defined as the sum of microscopy and RDT tests. Total positive tests were defined as microscopy-positive plus RDT-positive results.

$$\text{Diagnostic positivity (\%)} = (\text{Total positive tests} / \text{Total recorded tests}) \times 100$$

Method-specific positivity was calculated separately for microscopy and RDTs. The RDT share of testing was calculated as RDT tests divided by all recorded tests. These definitions were selected because they use denominators directly supported by the supplied data and avoid substituting unrelated service indicators for a diagnostic denominator.

3.7 Data Quality and Completeness

The dataset contained a complete structural grid of 300 county-facility-type-year observations, but diagnostic reporting was incomplete for some observations. Eighty of the 300 observations had all 12 microscopy and RDT diagnostic fields missing. These observations occurred in Concession, Faith Based, and Private categories, whereas public observations contained diagnostic values throughout the supplied file. The missing observations were treated as missing surveillance information rather than zero testing.

Potential sources of bias included incomplete reporting, differences in the representation of facility sectors, variation in testing practices, and differences in the populations accessing diagnostic services. The analysis therefore identified missing diagnostic observations, reported testing volume and positivity separately, and treated positivity as a surveillance indicator rather than a population prevalence estimate.

Across the 3,600 diagnostic cells represented by the 12 microscopy/RDT variables, 960 cells were missing (26.7%). Because the missingness occurred as complete diagnostic blocks at the observation level in the supplied file, the primary aggregate estimates were based on

observations with recorded diagnostic information. Missing reports were not treated as zero tests because doing so would artificially reduce the recorded testing volume [6].

3.8 Statistical Analysis

We summarized testing volume, positive and negative results, test positivity, and diagnostic method nationally and by year, county, and facility type. Aggregated counts were retained as counts rather than treated as patient-level independent observations. Counts were summarized as absolute frequencies, while proportions were reported as percentages. County and facility-type summaries were aggregated across the available study years, and annual summaries were reported separately for each year. Annual estimates were compared descriptively across 2021–2025. The annual dataset did not permit assessment of seasonal variation. County and facility-type comparisons considered both testing volume and positivity because these measures address different questions and should not be treated as interchangeable.

The analysis was descriptive because the main aim was to describe routine surveillance patterns rather than test causal or individual-level hypotheses. Aggregated counts were not treated as independent patient observations, and the same county-by-facility-type combinations were observed repeatedly over the five-year period. Diagnostic reporting was also incomplete for 80 of the 300 observations, with missingness concentrated in non-public facility categories. Descriptive measures and graphical summaries were therefore used to present testing volume, test positivity, diagnostic method, geographic and facility-type variation, and reporting completeness within the available surveillance data.

3.9 Software and Reproducibility

Data cleaning, indicator construction, descriptive analysis, and visualization were conducted in R version 4.5. The analysis workflow preserves the raw dataset, documents derived variables, identifies missing diagnostic blocks, and generates reproducible summary outputs and figures.

4.0 Results

Results from the aggregated malaria surveillance data for Liberia from 2021–2025 are presented by diagnostic volume, temporal patterns, diagnostic method, geographic variation, and facility type.

4.1 Dataset Characteristics and Diagnostic Volume

Table 1: Annual malaria diagnostic testing and test positivity in Liberia, 2021–2025

Year	Diagnostic observations, n	Total tests, n	RDT tests, n	Positive tests, n	Microscopy-positive, n	Overall positivity, %	Microscopy positivity, %	RDT positivity, %	RDT share, %
2021	42	1,463,900	946,486	864,748	327,830	59.1	63.4	56.7	64.7
2022	43	1,350,262	848,010	734,127	291,558	54.4	58.1	52.2	62.8
2023	45	1,188,755	538,330	664,485	366,889	55.9	56.4	55.3	45.3
2024	45	1,469,977	818,065	820,123	359,505	55.8	55.1	56.3	55.7
2025	45	1,624,400	1,039,613	831,251	305,278	51.2	52.2	50.6	64.0

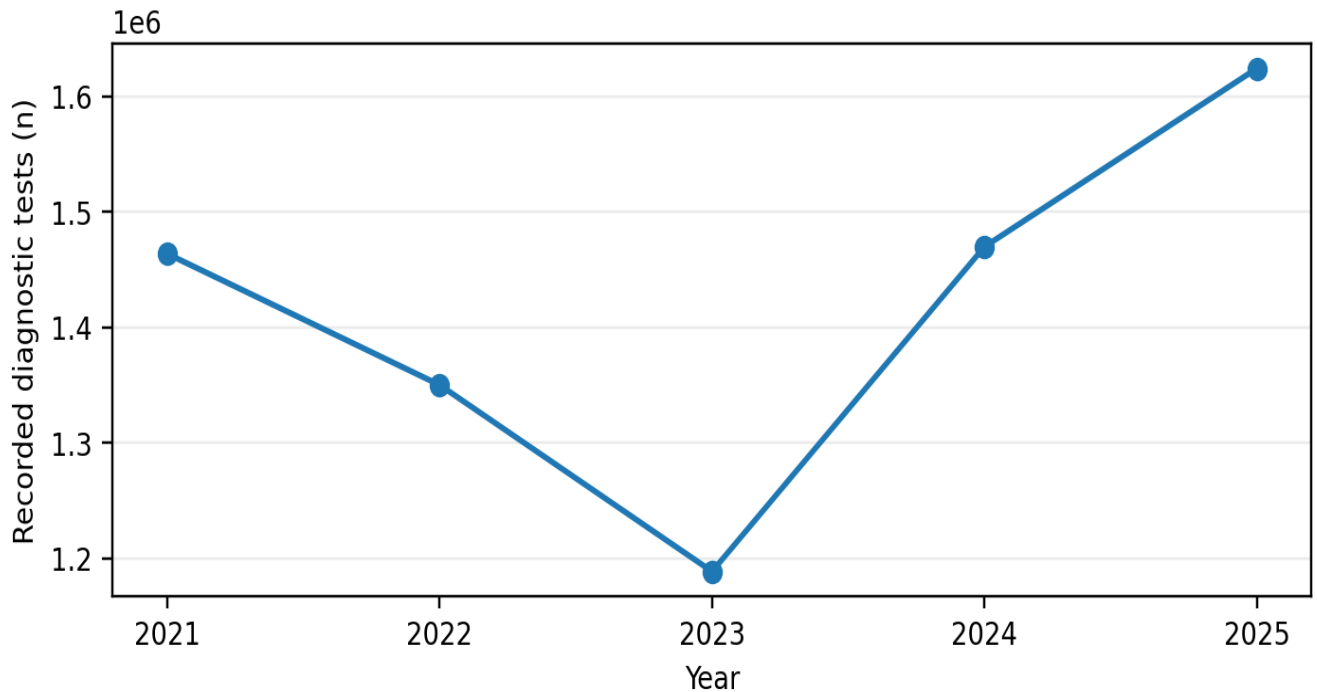
Note. RDT, rapid diagnostic test. Positivity is positive tests divided by total recorded diagnostic tests $\times 100$. Diagnostic observations indicate county–facility-type observations with available diagnostic data.

The dataset contained 300 county-facility-type-year observations covering all 15 counties and four facility types from 2021 through 2025. Each year contributed 60 observations, and the four facility categories were structurally balanced with 75 observations each. Across observations with recorded diagnostic information, 7,097,294 malaria diagnostic tests were recorded during the five-year period. Of these, 3,914,734 were positive and 3,182,560 were negative, corresponding to an overall diagnostic positivity of 55.2%. RDTs accounted for 59.0% of all recorded tests, while microscopy accounted for 41.0%.

The recorded testing volume was substantial during the study period. Because the dataset is aggregated, these tests cannot be interpreted as tests of unique individuals. Positivity also depends on the population reaching diagnostic services and on the reporting frame. Routine test positivity should therefore be interpreted as a surveillance indicator rather than a direct estimate of population prevalence [6].

4.2 Temporal Patterns in Testing and Positivity

Figure 1. Annual malaria diagnostic testing volume in Liberia, 2021–2025.



Source: Liberia Ministry of Health/National Malaria Control Program aggregated routine malaria surveillance dataset, 2021–2025 [10].

Recorded testing was lowest in 2023, at 1,188,755 tests, and highest in 2025, at 1,624,400 tests. Compared with 2021, the number of recorded tests in 2025 was 11.0% higher. In contrast, the number of positive tests changed from 864,748 in 2021 to 831,251 in 2025, representing a 3.9% decrease.

Overall diagnostic positivity declined from 59.1% in 2021 to 51.2% in 2025, a reduction of 7.9 percentage points. Positivity was 54.4% in 2022, 55.9% in 2023, and 55.8% in 2024. Testing increased toward the end of the study period, while the proportion of positive tests declined. The increase in recorded testing between 2021 and 2025 coincided with lower positivity, but the available aggregated dataset cannot determine whether this reflects reduced transmission, broader testing, changes in patient selection, diagnostic practice, or health-service utilization. WHO surveillance guidance recommends considering reporting completeness and representativeness when interpreting routine data [6].

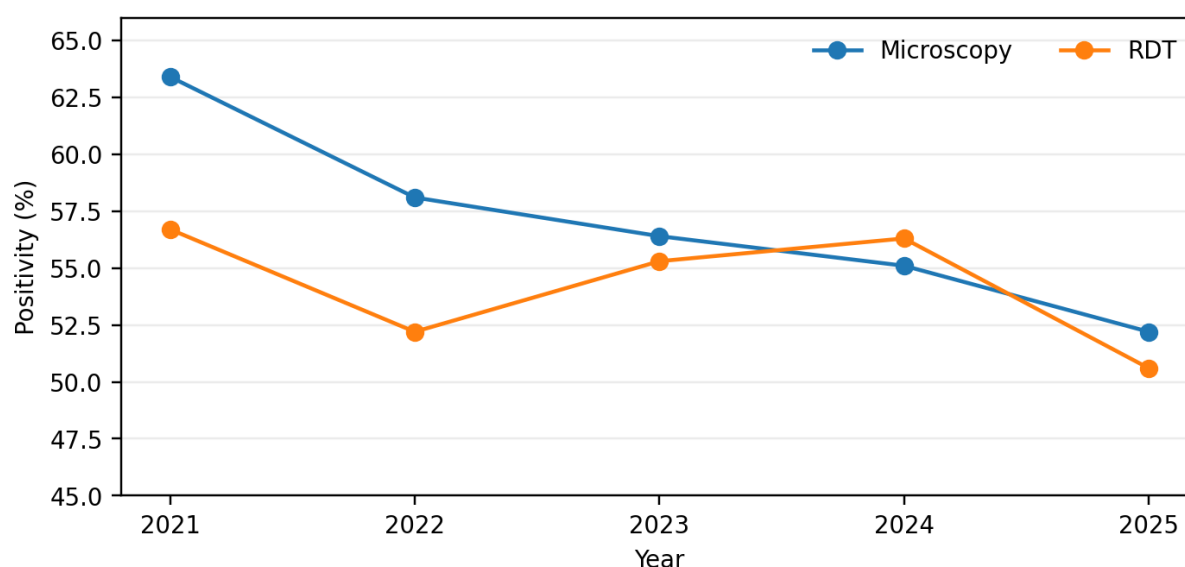
Table 2: Malaria diagnostic testing by diagnostic method, Liberia, 2021–2025

Diagnostic method	Tests, n	Positive, n	Negative, n	Positivity, %	Share of tests, %
Microscopy	2,906,790	1,651,060	1,255,730	56.8	41.0
RDT	4,190,504	2,263,674	1,926,830	54.0	59.0

Note. RDT, rapid diagnostic test. Method-specific positivity is calculated within each diagnostic method.

RDTs accounted for the majority of malaria diagnostic testing during the study period, with 4,190,504 tests representing 59.0% of all recorded diagnostic tests. Of these, 2,263,674 were positive and 1,926,830 were negative, giving an overall RDT positivity of 54.0%. Microscopy accounted for 2,906,790 tests, or 41.0% of all recorded testing, with 1,651,060 positive and 1,255,730 negative results and a method-specific positivity of 56.8%. RDTs were used more frequently than microscopy, while the proportion of positive results was slightly higher among microscopy tests. Because RDTs accounted for the larger share of testing, changes in RDT use may also affect the overall positivity recorded in the surveillance data.

Figure 2. Annual malaria diagnostic positivity by diagnostic method in Liberia, 2021–2025



Source: Liberia Ministry of Health/National Malaria Control Program aggregated routine malaria surveillance dataset, 2021–2025 [10].

The diagnostic mix changed over time. RDTs represented 64.7% of recorded tests in 2021, declined to 45.3% in 2023, and increased again to 64.0% in 2025. RDT positivity declined from

56.7% in 2021 to 50.6% in 2025, while microscopy positivity declined from 63.4% to 52.2%. WHO considers microscopy and RDTs complementary parasite-based diagnostic methods, with their use influenced by the availability and quality of microscopy services and the operational context of care [4,5]. The changes in method-specific positivity also need to be considered when interpreting the overall trend.

4.3 Geographic Variation

Table 3: Malaria diagnostic testing and positivity by county, Liberia, 2021–2025

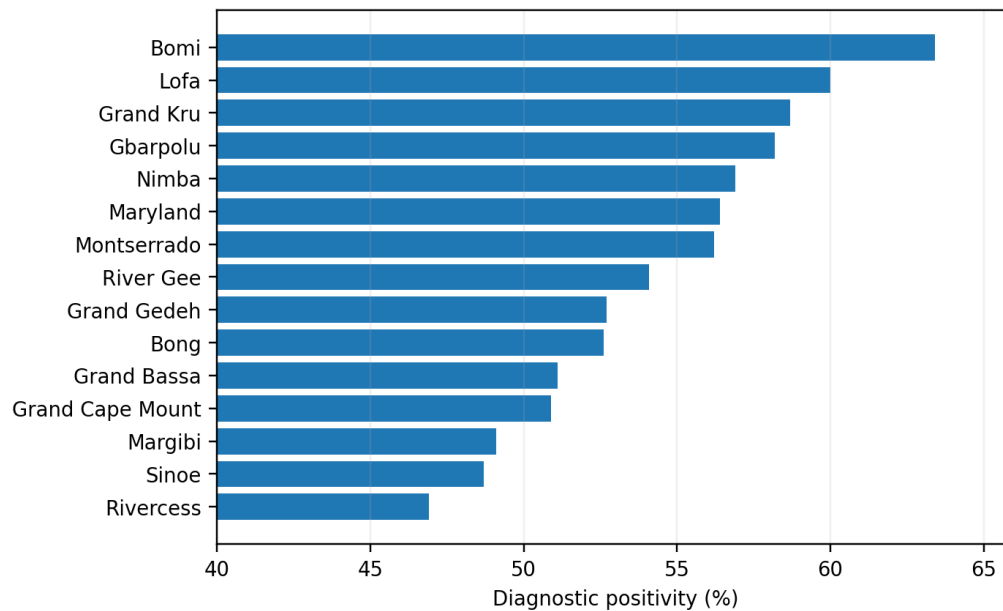
County	Total tests, n	Positive tests, n	Diagnostic positivity, %	Share of testing, %
Bomi	248,900	157,685	63.4	3.5
Lofa	526,526	315,679	60.0	7.4
Grand Kru	173,779	101,962	58.7	2.4
Gbarpolu	109,615	63,754	58.2	1.5
Nimba	842,112	479,519	56.9	11.9
Maryland	279,786	157,747	56.4	3.9
Montserrado	2,568,959	1,444,186	56.2	36.2
River Gee	169,786	91,800	54.1	2.4
Grand Gedeh	248,319	130,948	52.7	3.5
Bong	480,970	252,826	52.6	6.8
Grand Bassa	403,222	206,149	51.1	5.7
Grand Cape Mount	212,110	108,052	50.9	3.0
Margibi	462,138	227,137	49.1	6.5
Sinoe	185,784	90,460	48.7	2.6
Rivercess	185,288	86,830	46.9	2.6

Note. Values are aggregated across facility types and years. Diagnostic positivity is the proportion of positive tests among recorded diagnostic tests.

County-level positivity ranged from 46.9% in Rivercess to 63.4% in Bomi. Sinoe (48.7%) and Margibi (49.1%) were also among the lower counties, while Grand Kru (58.7%) and Maryland (56.4%) were among those with higher values.

Montserrado accounted for 36.2% of all recorded diagnostic tests, with 2,568,959 tests and an aggregate positivity of 56.2%. Nimba contributed 11.9% of testing and Lofa contributed 7.4%. Testing volume and positivity capture different aspects of routine surveillance; the county contributing the most tests was not the county with the highest positivity.

Figure 3. Malaria diagnostic positivity by county in Liberia, 2021–2025



Source: Liberia Ministry of Health/National Malaria Control Program aggregated routine malaria surveillance dataset, 2021–2025 [10].

The county differences should not be interpreted as direct differences in population malaria prevalence. They may reflect genuine variation in malaria transmission, differences in the populations seeking care, testing practices, access to diagnostics, referral patterns, or reporting completeness. Because the data are ecological, the study cannot attribute county-level differences to individual-level risk factors. Montserrado's large testing volume illustrates the importance of considering testing volume alongside positivity: high-volume service areas may generate the greatest absolute number of positive encounters even when their positivity is not the highest.

4.4 Variation by Facility Type

Table 4: Malaria diagnostic testing and positivity by facility type, Liberia, 2021–2025

Facility type	Total tests, n	Positive tests, n	Diagnostic positivity, %	Share of testing, %
Private	1,589,147	999,140	62.9	22.4
Public	4,588,593	2,469,757	53.8	64.7
Faith Based	668,790	333,204	49.8	9.4

Facility type	Total tests, n	Positive tests, n	Diagnostic positivity, %	Share of testing, %
Concession	250,764	112,633	44.9	3.5

Note. Values are aggregated across counties and years.

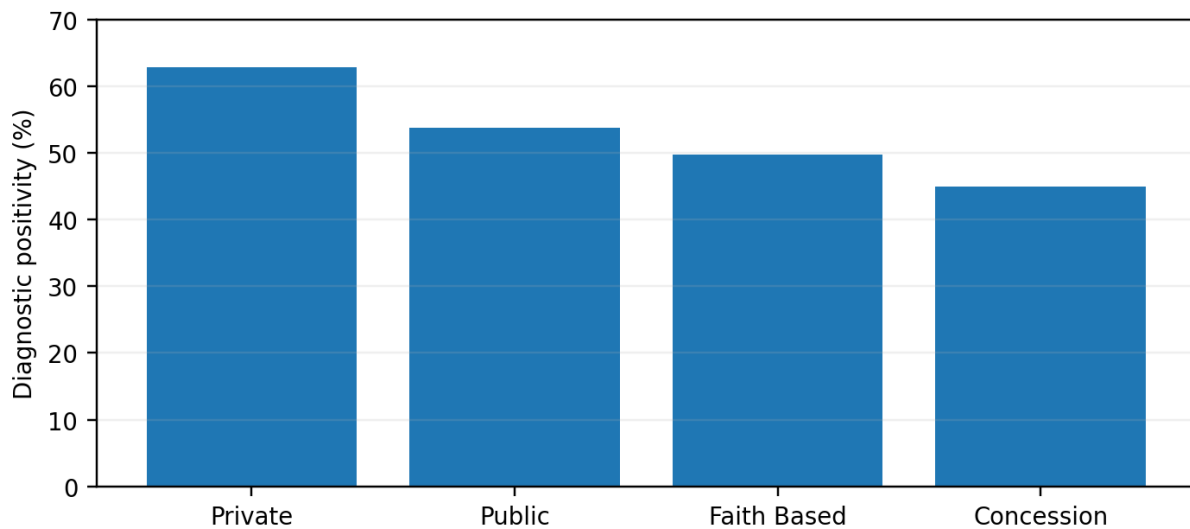
Public facilities recorded 4,588,593 tests, representing 64.7% of all recorded testing, with an aggregate diagnostic positivity of 53.8%. Private facilities recorded 1,589,147 tests, representing 22.4% of all recorded testing, with an aggregate positivity of 62.9%. Faith Based facilities recorded 668,790 tests, representing 9.4% of all recorded testing, with an aggregate positivity of 49.8%. Concession facilities recorded 250,764 tests, representing 3.5% of all recorded testing, with an aggregate positivity of 44.9%.

Table 5: Annual malaria diagnostic testing and positivity by facility type, Liberia, 2021–2025

Facility type	Year	Total tests (n)	Positive tests (n)	Diagnostic positivity (%)
Concession	2021	48,733	24,817	50.9
Concession	2022	46,855	20,757	44.3
Concession	2023	47,034	23,154	49.2
Concession	2024	50,527	22,427	44.4
Concession	2025	57,615	21,478	37.3
Faith Based	2021	127,330	69,318	54.4
Faith Based	2022	118,762	59,492	50.1
Faith Based	2023	128,391	65,378	50.9
Faith Based	2024	143,130	66,924	46.8
Faith Based	2025	151,177	72,092	47.7
Private	2021	320,035	205,396	64.2
Private	2022	306,528	193,207	63.0
Private	2023	312,415	199,255	63.8
Private	2024	332,883	210,562	63.3
Private	2025	317,286	190,720	60.1
Public	2021	967,802	565,217	58.4
Public	2022	878,117	460,671	52.5
Public	2023	700,915	376,698	53.7
Public	2024	943,437	520,210	55.1
Public	2025	1,098,322	546,961	49.8

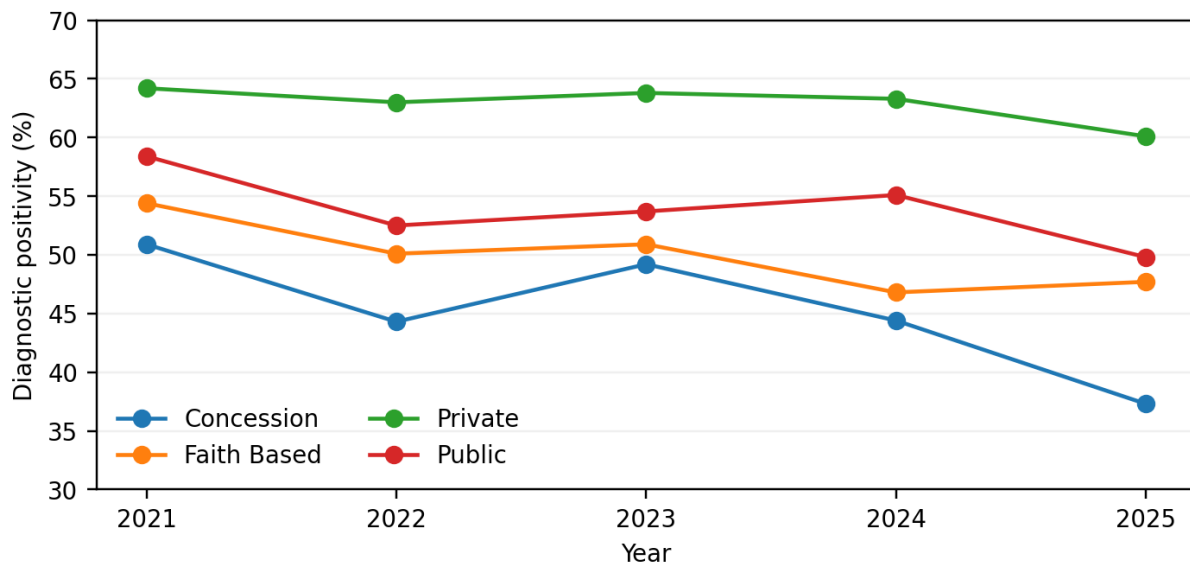
Note. Values show annual testing volume and positivity within each facility type.

Figure 4. Malaria diagnostic positivity by facility type in Liberia, 2021–2025



Source: Liberia Ministry of Health/National Malaria Control Program aggregated routine malaria surveillance dataset, 2021–2025 [10].

Figure 5. Trends in malaria diagnostic positivity by facility type in Liberia, 2021–2025



Source: Liberia Ministry of Health/National Malaria Control Program aggregated routine malaria surveillance dataset, 2021–2025 [10].

Public facilities generated nearly two-thirds of recorded diagnostic testing, reflecting their large contribution to the surveillance dataset. Private facilities had higher aggregate positivity than Public facilities. WHO has noted that routine systems may underrepresent private and other non-government services, which complicates comparisons across sectors [6]. In this dataset, the 80 observations without diagnostic information were concentrated in Concession, Faith Based, and Private categories. This concentration of missing observations further limits comparisons across facility types.

5.0 Discussion

Over the study period, recorded testing increased in the later years while diagnostic positivity declined. This pattern is consistent with the decline in malaria burden reported for Liberia, although routine diagnostic positivity and population-based malaria prevalence measure different things [3,8]. The decline in positivity alone does not show that malaria transmission decreased. Positivity can also change with the people seeking care, testing practices, diagnostic availability, and reporting completeness [6].

RDTs accounted for more of the recorded testing than microscopy during the study period. Both methods remained important for malaria diagnosis, but they provide different information. Microscopy can identify parasite species and quantify parasite density, while RDTs provide rapid parasite-based diagnosis where quality-assured microscopy may not be readily available [4,5]. The change in the mix of diagnostic methods is therefore relevant when interpreting the overall positivity trend.

Diagnostic activity and positivity varied across counties. The county-level differences are consistent with the geographic variation in malaria transmission described in Liberia, but routine diagnostic data capture people who reach health services rather than the entire county population [8]. Differences in health-seeking behaviour, access to diagnostic services, referral patterns, testing practices, and reporting completeness may also contribute to the observed pattern [6]. County-level positivity should therefore not be interpreted as population malaria prevalence.

The facility-type results show a similar need for caution. Public facilities accounted for most recorded testing, while Private facilities had higher aggregate positivity. These differences may reflect differences in the populations served, service use, testing practices, and reporting. The 80 observations without diagnostic information were concentrated in Concession, Faith Based, and Private categories, which further limits direct comparisons between facility types. WHO has also noted that routine surveillance systems may not fully represent private and other non-government services [6].

Taken together, the findings show that routine malaria surveillance in Liberia needs to be interpreted using testing volume, diagnostic method, geographic distribution, facility type, and reporting completeness. The increase in testing toward 2025 alongside lower positivity may reflect broader testing, changes in the patient population, diagnostic practice, health-service use, malaria transmission, or reporting; the available aggregated data do not allow these explanations to be separated [6]. Population-based surveys remain useful complementary evidence for understanding malaria burden [7,8].

6.0 Policy Implications

For programme monitoring, testing volume, diagnostic method, positivity, and reporting completeness should be reviewed together. A single national positivity estimate can obscure whether observed changes are associated with malaria epidemiology or with changes in diagnostic service use. County- and facility-type analyses can help the National Malaria Control Program identify areas requiring further investigation, strengthen reporting completeness, and prioritize diagnostic quality-assurance activities.

The observed variation also highlights the importance of maintaining parasite-based diagnosis and strengthening routine surveillance. WHO emphasizes that early and accurate malaria diagnosis is essential for appropriate case management and strong surveillance [5]. Where microscopy quality varies, RDTs can provide rapid diagnostic access, while quality-assured microscopy remains important for species identification, parasite quantification, and investigation of treatment failure [4].

7.0 Limitations of the Study

This study is based on aggregated ecological surveillance data, so the findings cannot establish individual-level risk factors or causal relationships. The analytic unit was the county-by-facility-type-year observation rather than an individual patient or individually identified facility.

Diagnostic reporting was incomplete for some observations, with missing information concentrated in non-public facility categories. Missing reports were treated as missing surveillance information rather than zero testing, but incomplete reporting may affect comparisons across facility types and geographic areas [6].

The dataset provides annual observations and therefore does not permit assessment of seasonal variation. The analysis also cannot determine whether changes in diagnostic positivity reflect changes in malaria transmission, patient selection, diagnostic practice, health-service utilization, or reporting completeness.

Because the dataset does not contain individual patient records or a population denominator for all persons suspected of malaria, diagnostic positivity should not be interpreted as population malaria prevalence. The analysis is descriptive and should be interpreted within the reporting frame of the routine surveillance system.

8.0 Conclusion

Diagnostic positivity from routine malaria surveillance should be interpreted in relation to geographic variation, health-service setting, and reporting completeness. Reviewing diagnostic data by county and facility type can help identify areas requiring closer surveillance, diagnostic quality assurance, and improved reporting. Future surveillance efforts should improve the completeness and detail of routine data and link diagnostic information with relevant epidemiological and health-system indicators.

Acknowledgements

The author acknowledges the Liberia Ministry of Health/National Malaria Control Program for providing the aggregated routine malaria surveillance dataset used in this analysis.

References

- [1] World Health Organization. (2024a). World malaria report 2024. Geneva: World Health Organization. <https://www.who.int/publications/i/item/9789240104440>
- [2] World Health Organization. (2024b). Malaria 2024 Liberia country profile. Geneva: World Health Organization. <https://cdn.who.int/media/docs/default-source/country-profiles/malaria/malaria-2024-lbr.pdf>
- [3] World Health Organization. (2025a). Liberia country profile: WHO results report 2024–2025. Geneva: World Health Organization. <https://www.who.int/about/accountability/results/who-results-report-2024-2025/country-profile/2024/liberia>
- [4] World Health Organization. (2023). WHO guidelines for malaria. Geneva: World Health Organization. <https://www.who.int/publications/i/item/guidelines-for-malaria>
- [5] World Health Organization. (2025b). Diagnostic testing for malaria. Geneva: World Health Organization. <https://www.who.int/activities/treating-malaria/diagnostic-testing-for-malaria>
- [6] World Health Organization. (2018). Malaria surveillance, monitoring & evaluation: A reference manual. Geneva: World Health Organization.

<https://www.who.int/docs/default-source/documents/publications/gmp/malaria-surveillance-monitoring-and-evaluation---a-reference-manual.pdf>

- [7] Ministry of Health, Republic of Liberia. (2022a). Liberia health sector strategic plan 2022–2026. Monrovia: Ministry of Health. <https://www.moh.gov.lr/wp-content/uploads/Liberia-Health-Sector-Strategic-Plan.2022-2026.pdf>
- [8] Ministry of Health, Republic of Liberia. (2022b). Liberia malaria indicator survey 2022. Monrovia: Ministry of Health. <https://moh.gov.lr/documents/malaria-indicator-survey/>
- [9] von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., Vandenbroucke, J. P., & STROBE Initiative. (2007). The Strengthening of the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *PLoS Medicine*, 4(10), e296. <https://doi.org/10.1371/journal.pmed.0040296>
- [10] Liberia Ministry of Health, National Malaria Control Program. (2021–2025). Aggregated malaria routine surveillance dataset [Unpublished dataset].