

Trends and distribution of inpatient malaria-related mortality in Uganda, 2015–2024

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Abstract

Background

Malaria remains a leading cause of morbidity and mortality in Uganda, which is among the countries with the highest malaria burden globally. The country set a target to reduce malaria mortality rates (MR) to < 5 deaths/100,000 population by 2025. We assessed trends and distribution of inpatient malaria MR in Uganda, 2015–2024, to inform targeted interventions.

Methods

We conducted a descriptive analysis of routine malaria surveillance data reported through District Health Information Software (DHIS2) for all 146 districts. Malaria-related deaths were defined as inpatient deaths among patients with laboratory-confirmed malaria. We calculated malaria mortality rates per 100,000 population using Uganda Bureau of Statistics (UBOS) population estimates and case-fatality rates (CFRs) among confirmed inpatient malaria cases. Temporal trends were assessed using the Mann–Kendall trend test.

Results

Overall, 48,012 inpatient malaria-related deaths were reported, corresponding to a mean annual mortality rate of 12 deaths per 100,000 population. Annual mortality rates declined significantly from 18 deaths per 100,000 in 2015 to 6 per 100,000 in 2024 ($\tau = -0.76$; $p = 0.001$). Among children aged < 5 years, mortality declined from 71 to 19 deaths per 100,000 ($\tau = -0.78$; $p = 0.0024$) but remained higher than in persons aged ≥ 5 years. West Nile recorded the greatest regional decline, from 38 to 7 deaths per 100,000. Mean annual national malaria CFR was 0.61%, declining from 0.89% in 2015 to 0.36% in 2024. CFRs were highest at National Referral Hospitals (2.3%), Regional Referral Hospitals (1.9%), and General Hospitals (0.9%).

Conclusion

Despite substantial declines in inpatient malaria-related mortality, Uganda had not yet reached the malaria mortality level targeted for 2025 by the end of 2024. Persistently high mortality among children aged < 5 years and higher CFRs at referral hospitals highlight the need to strengthen timely referral and management of severe malaria.

BACKGROUND

Malaria remains a major global public health problem, with an estimated 282 million cases and 610,000 deaths in 2024, most occurring in the WHO African Region (1). Uganda remains one of the top 3

countries most affected by malaria and among the top ten contributors to global malaria mortality recording approximately 19,600 malaria-related deaths annually (1). According to the Uganda National Malaria Elimination Plan, 2026–2030, the malaria incidence declined from 308 per 1,000 in 2020 to 274 per 1,000 in 2024, but did not meet the national target of 185 per 1,000. Malaria is endemic in over 95% of the districts in the country and is the leading cause of outpatient attendance (30–50%) and up to 20% of inpatient deaths (2). Children under five years and pregnant women are most affected due to lower immunity and increased physiological vulnerability (3, 4) .

Over the past decade, Uganda has implemented multiple malaria-control interventions in line with national priorities and the WHO Global Technical Strategy for Malaria 2016–2030 (5). These have included mass distribution of long-lasting insecticidal nets, expanded access to malaria diagnosis and effective antimalarial treatment, intermittent preventive treatment in pregnancy, integrated community case management, indoor residual spraying in selected high-burden areas, and malaria chemoprevention in selected settings (6). Despite these efforts, malaria-related mortality remains substantial, with persistent challenges related to intervention coverage, access to timely care, referral, and health-system capacity (2, 7, 8).

Understanding long-term trends and the distribution of malaria-related mortality is important for identifying population groups, geographic areas, and levels of care where mortality remains high and for assessing progress toward national malaria mortality-reduction targets. We assessed trends and distribution of inpatient malaria related-deaths in Uganda, 2015–2024, to inform targeted interventions.

METHODS

Study Setting

This study was conducted in Uganda, which is divided into 15 administrative regions with varying malaria transmission intensity. High-burden regions such as West Nile and Acholi experience the highest transmission, while regions including Kampala, Kigezi, Ankole, and Tooro experience lower transmission (9). Uganda operates a free public healthcare system, with malaria case management delivered across all health facility levels (10). However, severe malaria case management primarily occurs at Health Centre IVs, General Hospitals, Regional and National Referral Hospitals.

Study Design and Data Source

We conducted a descriptive analysis of routine malaria mortality data reported through the District Health Information Software version 2 (DHIS2). This is Uganda's national web-based health management information system used for the collection, aggregation, analysis, and reporting of health service delivery data from public, private not-for-profit, and selected private health facilities. It serves as the primary platform providing routinely reported facility-level data that support evidence-based decision-making at district, regional, and national levels. A malaria-related death was defined as the death of a patient with

confirmed malaria by microscopy or malaria rapid diagnostic test (mRDT) at a reporting health facility. This surveillance definition identifies deaths occurring among patients with confirmed malaria and does not necessarily establish malaria as the underlying cause of death.

Study Variables

We extracted monthly data on confirmed inpatient malaria-related deaths and confirmed inpatient malaria cases for 2015–2024. Data were disaggregated by year, district, region, age group (< 5 years and ≥ 5 years), sex, health-facility level, and facility ownership. We also extracted annual inpatient reporting completeness from DHIS2 nationally and by region.

Annual district population estimates for 2015–2024 were obtained from Uganda Bureau of Statistics population projections for 2015–2030. Deaths were geographically assigned according to the location of the reporting health facility rather than the patient's district of residence.

Data Management and Analysis

Data were downloaded and exported into Microsoft Excel for management and cleaning. Data quality checks included assessment for missing values, identification of extreme outliers, and internal consistency verification by comparing reported malaria deaths against malaria admissions and confirmed malaria cases. We computed annual malaria mortality rates (MMR) per 100,000 population using confirmed malaria deaths as numerators and district population estimates as denominators. We also calculated malaria CFRs (overall, by facility ownership and facility level) using the number of confirmed inpatient malaria deaths as the numerator and total confirmed inpatient malaria cases as the denominator. We used descriptive statistics to summarize malaria mortality trends over time and across population subgroups. Trend analyses were conducted nationally and stratified by age group and sex to identify variations in malaria mortality patterns across different population groups. Temporal trends in malaria mortality were assessed for statistical significance using the Mann–Kendall trend test, with Kendall's tau (τ) and a significance threshold of $p < 0.05$. Spatial distribution of malaria mortality was described using choropleth maps.

Ethical Considerations

This descriptive study was conducted under the approval of the Ministry of Health of Uganda. This analysis used aggregated surveillance data reported through DHIS2, no individual identifiers were accessed and consent was not applicable. The Office of the Associate Director for Science at the US Centers for Disease Control and Prevention (CDC) Uganda determined that this investigation was non-research and that its primary intent was public health practice or disease control.

RESULTS

Trends in inpatient malaria-related mortality, Uganda, 2015–2024

During 2015–2024, 48,012 inpatient malaria-related deaths were reported, with a mean annual mortality rate of 12 deaths per 100,000 population. The annual mortality rate declined significantly from 18 deaths per 100,000 population in 2015 to 6 per 100,000 in 2024 ($\tau=-0.76$; $p = 0.001$). By 2024, the mortality rate remained above the national target of < 5 deaths per 100,000 population set for 2025. Annual inpatient reporting completeness increased from 84.4% in 2015 to 94.2% in 2024 (Fig. 1).

Malaria-related mortality by age group and sex

Among children aged < 5 years, the malaria-related mortality rate declined significantly from 71 deaths per 100,000 population in 2015 to 19 per 100,000 in 2024 ($\tau=-0.78$; $p = 0.0024$) and remained consistently higher than among persons aged ≥ 5 years.

Among males, malaria-related mortality declined significantly during 2016–2024 ($\tau=-0.67$; $p = 0.015$). A similar decline was observed among females ($\tau=-0.72$; $p = 0.008$) (Fig. 2).

Trends in malaria case-fatality rate, Uganda, 2015–2024

The mean annual national malaria case-fatality rate (CFR) during 2015–2024 was 0.61%. The annual CFR declined significantly from 0.89% in 2015 to 0.36% in 2024 ($\tau=-0.58$; $p = 0.0025$) (Fig. 3).

Malaria case-fatality rate by health-facility level and ownership

Across 2015–2024, CFRs were highest at National Referral Hospitals (2.27%), Regional Referral Hospitals (1.93%), and General Hospitals (0.88%). CFRs were lower at Health Centre IVs (0.49%), Health Centre IIIs (0.29%), and Health Centre IIs (0.44%) (Fig. 4).

Mean CFRs were similar across facility ownership categories: 0.58% in government facilities, 0.49% in private-not-for-profit facilities, and 0.59% in private-for-profit facilities (Fig. 4).

Geographic distribution of malaria-related mortality

Malaria-related mortality was highest in the northern regions, particularly West Nile and Acholi, during much of the study period. Central, South Central, Ankole, Kigezi, and Tooro generally recorded lower mortality rates.

Mortality declined across all regions during 2015–2024, with the largest reduction observed in West Nile, where the mortality rate declined from 38 to 7 deaths per 100,000 population ($\tau=-0.85$; $p < 0.001$). By 2024, nearly all regions had mortality rates within the lowest mapped category of 0–10 deaths per 100,000 population (Fig. 5).

DISCUSSION

Uganda experienced a marked decline in inpatient malaria mortality rate between 2015 and 2024, from 18 to 6 deaths per 100,000 population. Mortality rates decreased across age, sex, and geographic regions, but remained disproportionately high among children aged < 5 years. Case-fatality rates also declined, although they were highest at referral-level hospitals. The largest regional reduction occurred in West Nile Region.

The decline in inpatient malaria mortality rate observed in Uganda is consistent with broader reductions in malaria mortality rates reported globally and across sub-Saharan Africa (1). During the same period, Uganda expanded several malaria-control interventions, including mass distribution of long-lasting insecticidal nets, access to malaria diagnosis and effective treatment, and targeted vector-control interventions in high-burden areas (11–14). Notably, inpatient reporting completeness increased from 84.4% in 2015 to 94.2% in 2024, suggesting that the observed decline occurred despite improving surveillance coverage. However, because this was a descriptive analysis of routine surveillance data, the contribution of individual interventions to the mortality decline cannot be determined.

Despite the substantial decline, the inpatient malaria mortality rate in 2024 remained above the national target of < 5 deaths per 100,000 population set for 2025. Further reductions may be constrained by persistent gaps in uptake of preventive interventions, delayed care-seeking, interruptions in access to essential malaria commodities, and inequities in timely access to quality care (7). Emerging antimalarial drug and insecticide resistance may further threaten these recent gains (1). These findings underscore the need to sustain effective prevention and strengthen timely diagnosis, treatment, and surveillance.

Children < 5 years consistently experienced higher mortality rates than those $\geq$ 5 years. This finding is consistent with known epidemiology of malaria in high-transmission settings, where young children bear the greatest burden of severe disease and death. Similar age-related vulnerability has been reported in Kenya and Nigeria where children < 5 years accounted for the majority of severe cases and deaths (15, 16). Encouragingly, this group also experienced a marked decline in mortality during 2015–2024. Although this period coincided with expansion of several child-focused interventions, including seasonal malaria chemoprevention in selected areas (17), causal attribution is not possible from this descriptive analysis. Protecting this age group will require sustaining effective prevention, early diagnosis, and prompt treatment.

The national malaria CFR declined substantially over the study period, suggesting improved survival among patients with confirmed malaria who reached inpatient care. However, CFRs remained highest at National Referral Hospitals, Regional Referral Hospitals, and General Hospitals. These facilities commonly manage patients with severe or complicated malaria referred from lower-level facilities and therefore likely receive a more severely ill case mix (18). Delayed care-seeking and referral may further contribute to advanced disease at presentation and increased risk of death (19). Strengthening early recognition of severe disease, pre-referral management, and timely referral may help further reduce malaria deaths.

The broad decline in malaria-related mortality across regions suggests nationwide progress, although West Nile and Acholi remained among the higher-burden areas during much of the study period. West Nile recorded the largest decline, which coincided with targeted malaria-control interventions in northern Uganda (11, 12). However, facility-based attribution of deaths may distort regional estimates, particularly where referral hospitals receive patients from neighbouring or distant districts.

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, DHIS2 captures deaths occurring within reporting health facilities and therefore underestimates malaria-related mortality occurring in the community or outside the formal health system. Second, the surveillance definition classified deaths among patients with laboratory-confirmed malaria as malaria-related deaths; consequently, some deaths may have been due primarily to other conditions, resulting in misclassification. Third, routine surveillance data are subject to variation in reporting completeness and data quality across facilities and over time. Finally, geographic estimates were based on the location of the reporting facility rather than the patient's place of residence, which may have distorted regional mortality patterns, particularly around referral hospitals.

CONCLUSION

Inpatient malaria-related mortality in Uganda declined substantially between 2015 and 2024, but the 2024 rate remained above the national target set for 2025, and children aged < 5 years continued to bear the greatest mortality burden. Further reductions will require sustained malaria prevention, timely recognition and referral of cases with severe disease, and effective inpatient management. Further studies should assess patient-level determinants of malaria mortality, including severity at presentation, delays in care-seeking and referral, comorbid conditions, and quality of severe-malaria management, particularly at referral hospitals.

ABBREVIATIONS

MoH Ministry of Health

RRH Regional Referral Hospital

LLINs Long-Lasting Insecticide Nets

IRS Indoor Residual Spraying (IRS)

iCCM Integrated Community Case Management

UBOS Uganda Bureau of Statistics

DHIS2 District Health Information System Version 2

QGIS Quantum Geographic Information System

HC Health Centre

RDTs Rapid Diagnostic Test

ACT Artemisinin-based Combination Therapy

CFR Case Fatality Rate

DECLARATIONS

ETHICS APPROVAL

This descriptive study was conducted under the direction and approval of the Ministry of Health of Uganda. This analysis used aggregated surveillance data reported through DHIS2, no individual identifiers were accessed and consent was not applicable. The Office of the Associate Director for Science at the US Centers for Disease Control and Prevention (CDC) Uganda determined that this investigation was non-research and that its primary intent was public health practice or disease control. This activity was reviewed by CDC and conducted consistent with applicable federal law and CDC policy. See, e.g., 45 C.F.R. part 46; 21 C.F.R. part 56; 42 U.S.C. § 241(d); 5 U.S.C. § 552a; and 44 U.S.C. § 3501 et seq.

COMPETING INTERESTS

The authors declare that they had no competing interests.

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Author Contribution

MM Conceived and designed the study, acquired, analyzed, interpreted the data and wrote the first draft of the manuscript. MN, JW, SN, REK, RN, JN, ML, MA, JR, MK, GR, MGZ, CM, DK, RRB, RM, PE, LB, BK, ARA provided technical supervision and Manuscript review

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Data Availability

The datasets upon which our findings are based belong to the Uganda Public Health Fellowship Program. The data sets are available upon request from the corresponding author and with permission from the Uganda Public Health Fellowship Program.

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Figures

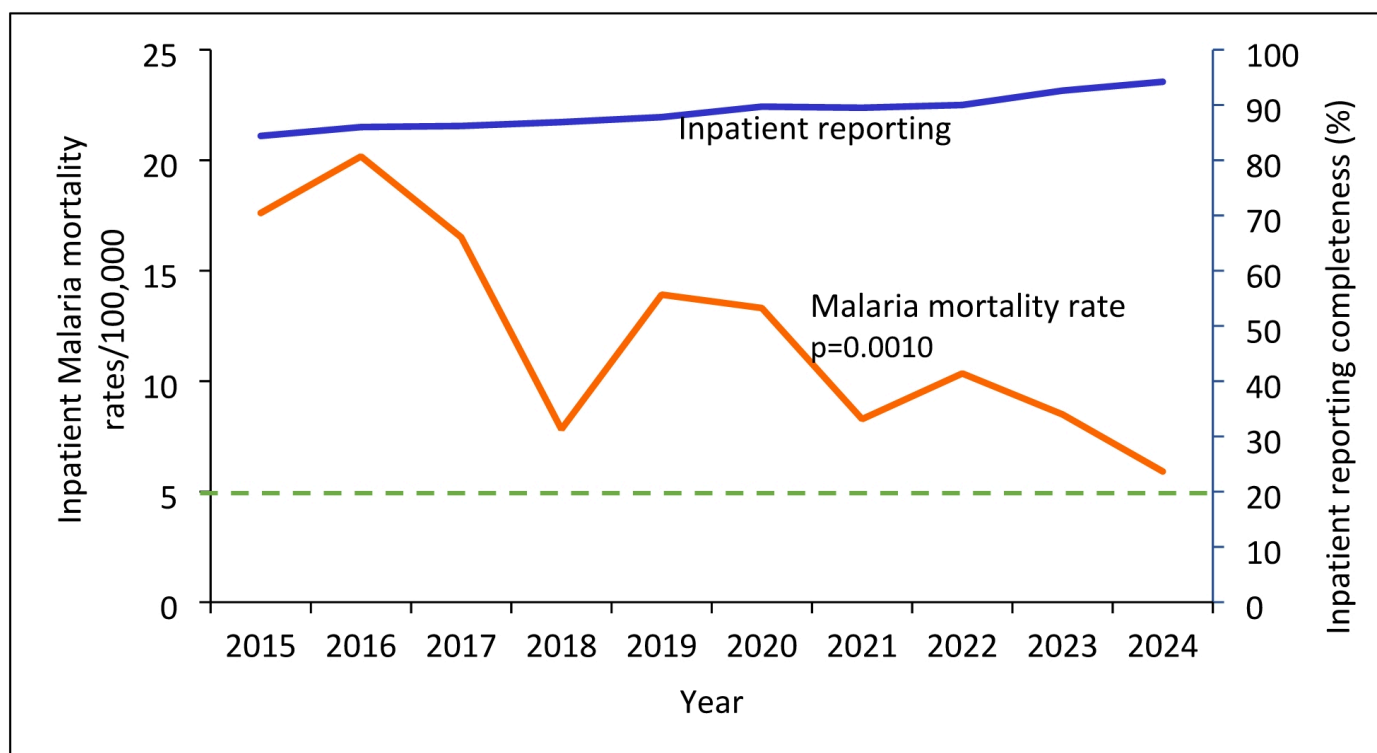


Figure 1

Annual inpatient malaria-related mortality rates and inpatient reporting completeness, Uganda, 2015–2024

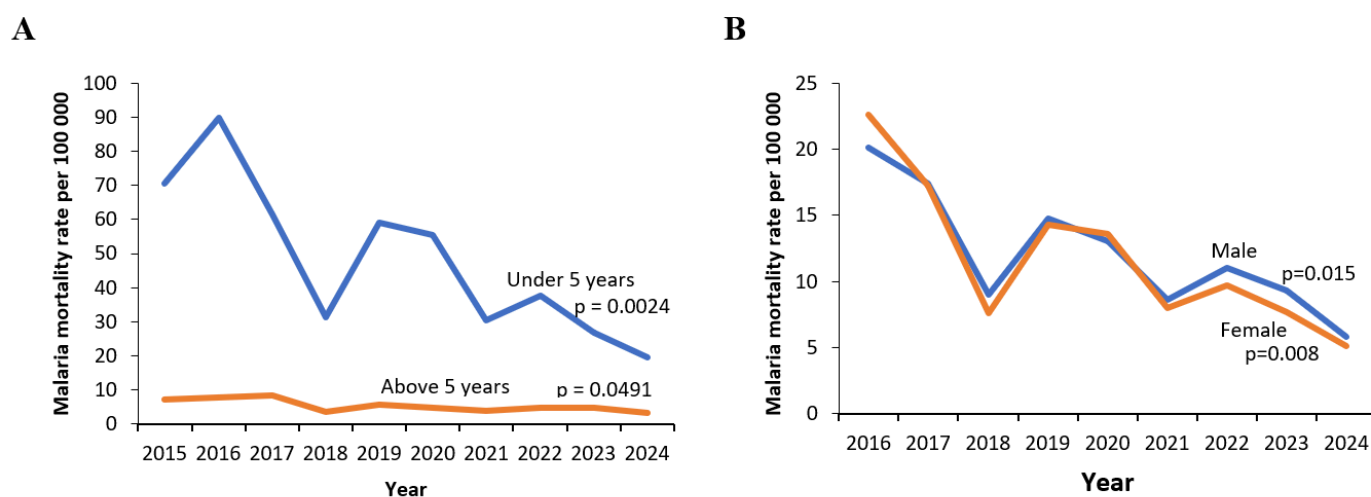


Figure 2

Annual inpatient malaria-related mortality rates by (A) age group, 2015–2024, and (B) sex, 2016–2024, Uganda

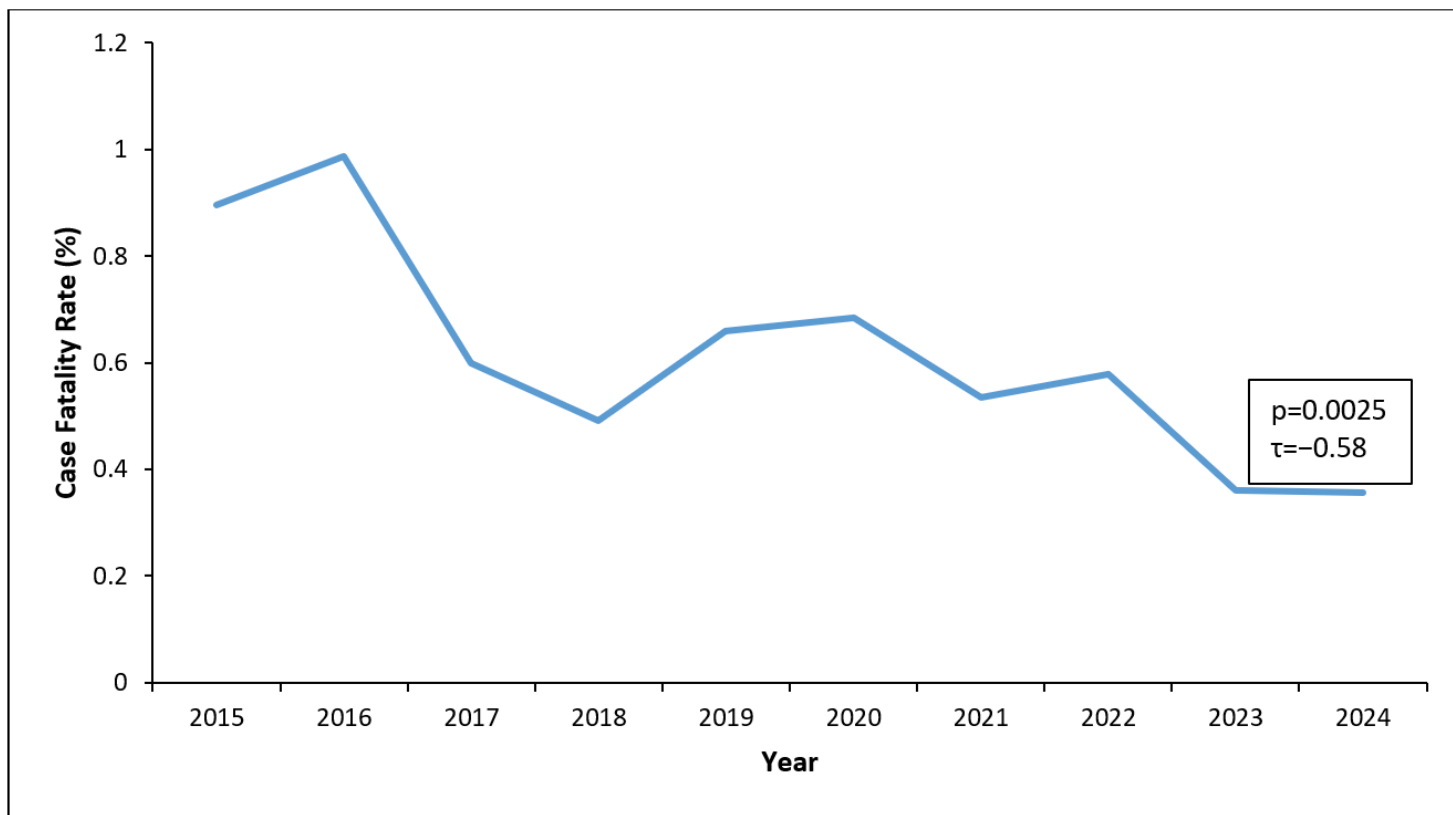


Figure 3

Annual malaria case-fatality rates, Uganda, 2015–2024

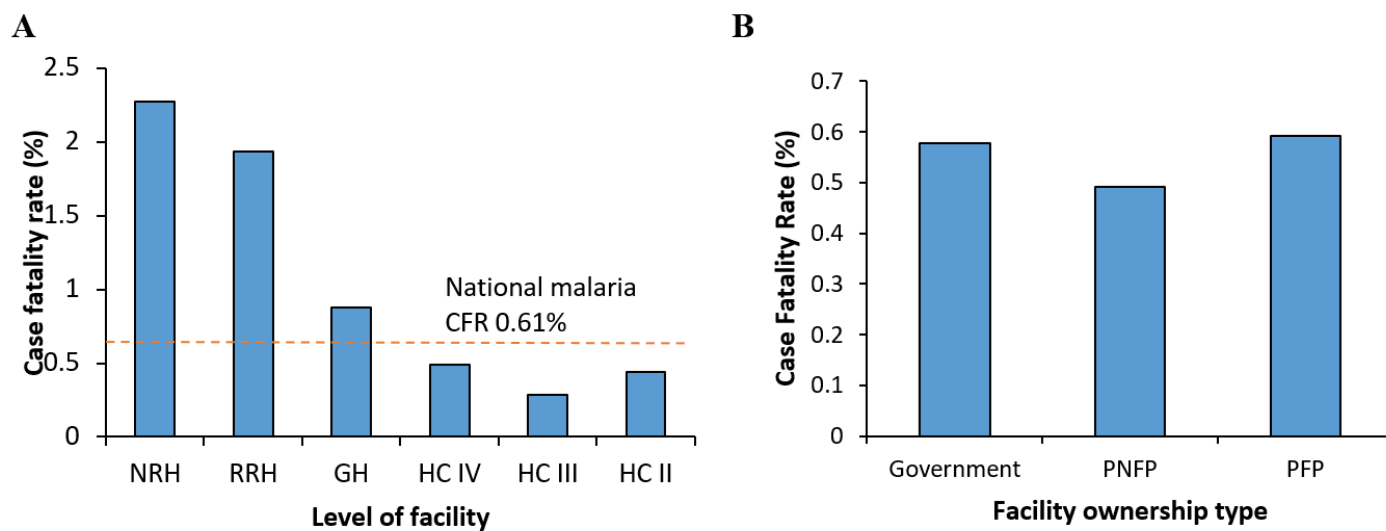


Figure 4

Mean malaria case-fatality rates by (A) health-facility level and (B) facility ownership, Uganda, 2015–2024

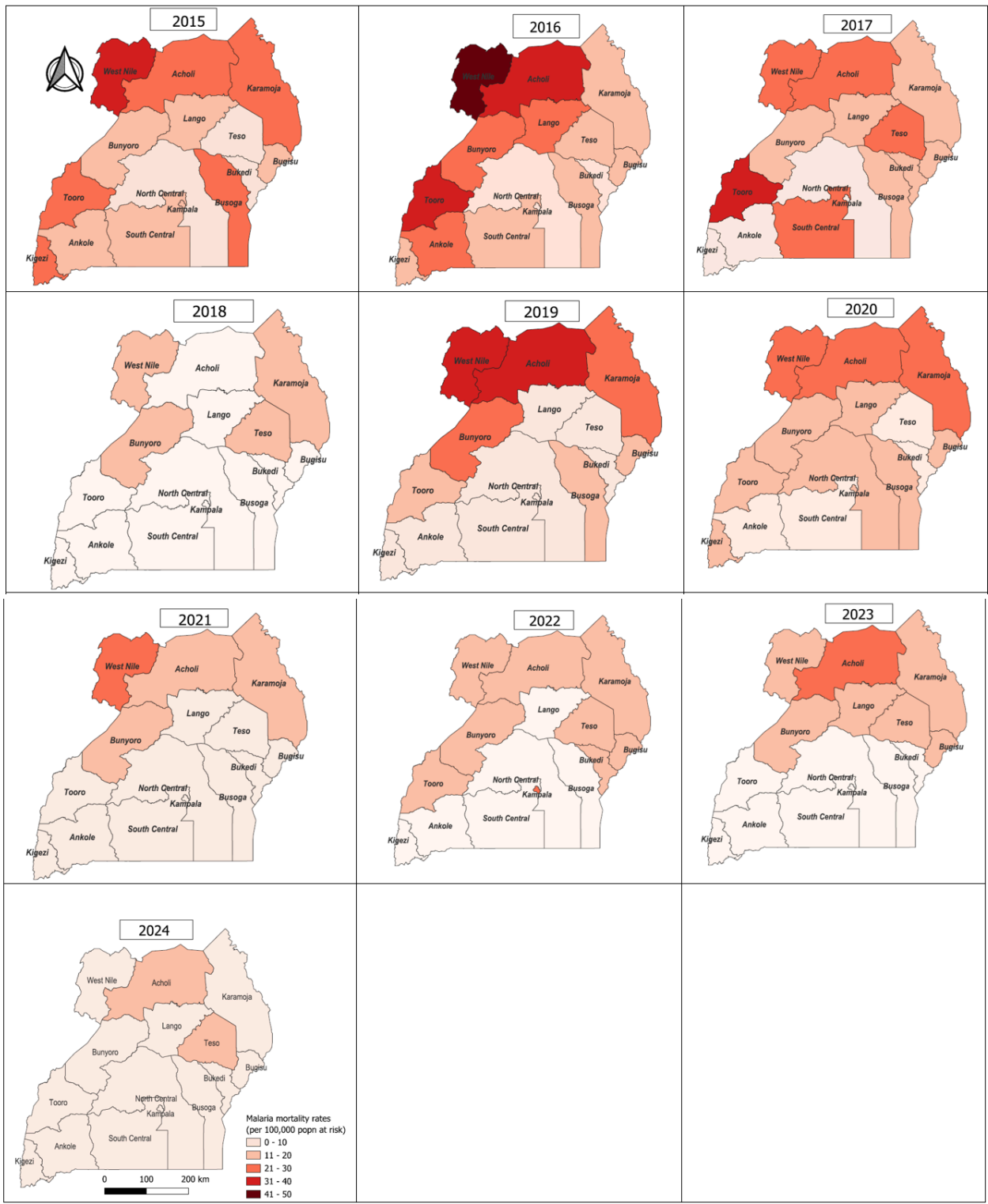


Figure 5

Geographic distribution of inpatient malaria-related mortality rates by region, Uganda, 2015–2024