**Prevalence of unqualified sources of antimalarial drug prescription for children under the age of five: a study in 19 low- and middle-income countries**

Md Sabbir Hossain, BSc1\*, Talha Sheikh Ahmed, BSc3, Mohammad Anamul Haque, Phd1, Muhammad Abdul Baker Chowdhury1, MPH, MPS, MS, Md Jamal Uddin, PhD1,2

Md Sabbir Hossain

[bmsabbirhossainsakib@gmail.com](mailto:bmsabbirhossainsakib@gmail.com)

Talha Sheikh Ahmed

[talha76@student.sust.edu](mailto:talha76@student.sust.edu)

 Mohammad Anamul Haque

[haque-sta@sust.edu](mailto:haque-sta@sust.edu)

Muhammad Abdul Baker Chowdhury

[bakerchowdhury@gmail.com](mailto:bakerchowdhury@gmail.com)

Md Jamal Uddin

[jamal-sta@sust.edu](mailto:jamal-sta@sust.edu)

1. Biostatistics, Epidemiology and Public Health Research Team, Department of Statistics, Shahjalal University of Science and Technology, Sylhet-3114, Bangladesh

2. Department of General Educational and Development, Daffodil International University, Dhaka, Bangladesh

3. Department of Geography and Environment, Shahjalal University of Science and Technology, Sylhet-3114, Bangladesh

\* Correspondence to: Md Jamal Uddin, Professor, Department of Statistics, Shahjalal University of Science and Technology, Sylhet, Bangladesh. Email: [jamal-sta@sust.edu](mailto:jamal-sta@sust.edu)

**Keywords:** Antimalarial Drugs, Children Under Five, LMICs, MIS, Malaria, Qualified Prescription.

**Abstract**

**Background**

Antimalarial resistance poses a severe danger to global health. In Low- and Middle-Income Countries (LMICs), there is a lack of reliable information on antimalarial prescriptions for recent malarial fever in children under five. Our study aims to determine the prevalence of unqualified sources of antimalarial drug prescription for children under the age of five in 19 low- and middle-income countries.

**Methods**

We performed a cross-sectional study of the Malaria Indicator Survey (MIS) datasets (n = 106265) across 19 LMICs. The recent MIS datasets were used, and the study only included children under five who had taken an antimalarial drug for a recent malarial fever. The outcome variable was classified into two distinct categories: those who had taken antimalarial drugs for malarial fever from qualified sources and those who did not.

**Findings**

Among LMICs, we found that 87.1% of children under five received an antimalarial prescription from unqualified sources who had recently experienced malarial fever. In several LMICs (Tanzania, Nigeria, and Ghana), a substantial portion of recent antimalarial prescriptions for malaria was taken from unqualified sources (about 40%). Some LMICs (Guinea (31.8%), Mali (31.3%), Nigeria (20.4%), Kenya (2.6%), and Senegal (2.7%)) had low rates of antimalarial drug consumption even though children under five received a high percentage of antimalarial prescriptions from qualified sources for a recent malarial fever. Living in rural areas, having mothers with higher education, and having parents with more wealth were frequently taken antimalarial from qualified sources for recent malarial fever in children under five across the LMICs.

**Interpretation**

The study draws attention to the importance of national and local level preventative strategies across the LMICs to restrict antimalarial drug consumption. This is because antimalarial prescriptions from unqualified sources for recent malarial fever in children under five were shockingly high in most LMICs and had high rates of unqualified prescriptions in certain other LMICs.

**Introduction**

Malaria is a potentially fatal disease that may be prevented and treated. It is spread to people by specific mosquito species. According to the World Health Organization's (WHO) worldwide malaria program,there were 619,000 malaria-related deaths worldwide in 2020, a modest decrease from the anticipated 247 million cases in the previous year 1. Due to interruptions in crucial malaria interventions during the pandemic of COVID-19, there were 63,000 deaths between 2019 and 20212.

In Sub-Saharan African (SSA) nations, it is a significant source of infectious diseases and mortality. In the WHO African Region, malaria fatalities climbed from 544,000 to 599,000 during 2019 and 2020, while anticipated cases rose from 218 million to 232 million. Deaths fell to 593,000 in 2021, while cases rose to 234 million 3. In 2021, one region accounted for 95% of global COVID-19 cases and 96% of deaths. Over the years, there has been a notable decrease in the percentage of malaria-related deaths occurring in children under the age of five within the region. In 2005, the figure stood at 91.0%, while in recent times, it has dropped to 80%. Among the countries in the region, Nigeria takes the lead with 26.6% of cases, followed by the Democratic Republic of the Congo with 12.3%, Uganda with 5.1%, and Mozambique with 4.1%. Remarkably, these four countries collectively represent nearly half of all reported cases in the region4. Additionally, four nations- Niger (31.9%), the Democratic Republic of the Congo (12.6%), the United Republic of Tanzania (4.1%), and Nigeria (31.3%) accounted for slightly more than half of all malaria deaths worldwide. 38.4% of all malaria-related deaths in children under 5 years old occurred in Nigeria3. According to estimates, children under the age of five account for about two-thirds of deaths of which SSA countries result in 90% of cases and 97% of deaths related to malaria1,5.

Adopting new diagnostic techniques, medications, and control strategies has added interest in research on malaria. Understanding the elements that affect patient medication-seeking patterns and choices to purchase anti-malarial drugs in the private sector still has gaps6,7.It is critical to wait until a malaria diagnosis is confirmed before administering medication to those who are suspected of having the disease. In all suspected cases of malaria, where diagnostic testing is available, the WHO started urging parasitological confirmation by microscopy or rapid diagnostic test (RDT) before starting treatment in 20108. Identification of three criteria is crucial for determining how to treat malaria effectively: the species of Plasmodium that is causing the infection, the patient's clinical condition, and the parasites' responsiveness to various medications. If the patient exhibits severe malarial symptoms and clinical suspicion for malaria is high, the apparent exception is to delay treatment until confirmation9,10,11. Studies have revealed that in SSA countries, rather than using public health facilities, most families initially turn to the retail industry for the treatment of mild febrile diseases 12,13. It is more frequent due to limited access to health services14,15,16.

Correct diagnosis of the illness is crucial to attaining effective malaria outcomes because the rate between medication presumptive and occurring parasitological malaria cases can vary between 10% and 60% depending on the season, age of patients, and transmission location17,18 Incorrectly treating non-malarial fevers with burdensome artemisinin-based combination therapy (ACT, which is recommended as the first-line anti-malarial treatment strategy in SSA countries) due to medication presumptive treatment will promote the establishment of parasite resistance and risk the lives of patients and the standard of care19. According to a systematic review, neither an accurate diagnosis of malaria nor a prescription for anti-malarial medication was necessary for the patient to obtain anti-malarial medications. Moreover, they reported that drug prescription was not a highly significant predictor of an ACT drug purchase, despite the fact that the proportion of ACT drugs purchased with a prescription was higher than the proportion purchased without a prescription in Kenya, Nigeria, and Tanzania20. In low-middle income countries (LMICs), where the privately owned sector supplies patients with around 60% of their malaria drugs, these findings are crucial for the formulation of national malaria diagnosis and treatment policies21,22. They demonstrate that patients can obtain the WHO-recommended ACT treatment without utilizing public healthcare facilities, an accurate diagnosis of malaria, or a prescription for an anti-malarial medication. The techniques for prescribing medications and diagnosing malaria varied significantly among the SSA nations surveyed. It should be emphasized that some patients buy medications intended for children or buy erroneous dosages23. Children and adults were identified individually in this study, which is likely to reduce bias24. For strengthened malaria surveillance plans and strategies, it is imperative to comprehend these factors. Moreover, it is anticipated that expanding access to healthcare in both the governmental and privately owned sectors would result in advancements in fever diagnosis and treatment, regardless of whether the fever is brought on by malaria or another illness.

To our best knowledge, no study has been conducted to focus on anti-malarial drug consumption in LMIC settings without diagnosing that an individual has transmission of malaria in children under five. Therefore, the goals of our study are to identify the prevalence of unqualified sources of antimalarial drug prescription for recent malarial fever in children under the age of five. We will also provide a complete picture of antimalarial prescription by region-wise GIS map in each LMIC.

**Methods**

**Data Source**

Using the most recent malaria indicator survey (MIS) data from 2011 to 2021, we conducted a cross-sectional study in 19 malaria-endemic countries. The Monitoring and Evaluation Working Group (MERG) of Roll Back Malaria, an international collaboration intended to coordinate worldwide efforts to control malaria, established the MIS, a household survey. The MIS comprises questionnaires, manuals, and instructions based on information from the Demographic and Health Surveys (DHS). It gathers regional and national data from a representative sample of respondents. The DHS Program co-chairs the MERG Survey and Indicator Guidance Working Committee and has made significant contributions to the design of the MIS package.

The MIS is often scheduled to coincide with the peak period of malaria transmission and is carried out in close to 30 LMICs. The survey contributes to the collection of important data on the incidence of malaria, the usage and ownership of insecticide-treated mosquito nets, and the efficiency of malaria control measures. The Roll Back Malaria Alliance has created a MIS toolkit to assist with the survey's execution. It includes instructions, questions, and manuals, as well as suggested tabulations for data analysis 25.

**Study Design**

The MIS survey employs a two-stage stratified cluster sampling method. The first step was to choose specific areas or clusters. The second stage entails picking every cluster or enumeration area's (EA) household in a methodical manner. MIS surveys follow a set of standard operating procedures that include sampling, questionnaires, data collection, cleaning, coding, and analysis to facilitate cross-country comparisons. The respondents gave both verbal and written consent. The institutional review boards of ICF International and the ethics regulatory bodies of the countries for which the study is conducted normally approve MIS as being ethical.

The MIS program collects data on insecticide-treated mosquito net ownership and usage, intermittent prenatal care, blood tests to diagnose fever in children under five, and indoor residual pesticide spraying are among the indications of malaria that are widely recognized. In addition, the MIS gathers information on household demographics and possession of items like indoor plumbing, electricity, bicycles, and radios. The most vulnerable family members, such as young children and pregnant women, can also have their anemia and malaria parasite counts measured as part of the MIS. Those who qualify and provide their agreement provide a few drops of blood, which are then instantly examined on-site for anemia by specially trained interviewers. More than 60 DHS and MIS surveys have tested for anemia so far, while many more MIS surveys and several DHS surveys have tested for malaria prevalence25.

**Ethics Statement**

This research harnessed Multiple Indicator Cluster Survey (MIS) datasets sourced from the Demographic and Health Surveys program, ensuring rigorous adherence to ethical principles. MIS gained approval from ICF International's institutional review boards and conformed to ethics regulations in the respective countries of survey implementation. Attaining both verbal and written informed consent, MIS provided participants with comprehensive information about survey objectives, data collection methods, potential benefits, and risks. The paramount voluntary nature of participation was emphasized, and inquiries were encouraged. Stringent measures were adopted to uphold data confidentiality and anonymity, as all information underwent de-identification before analysis, eliminating personal identifiers and preserving participants' privacy in line with ethical standards. The MIS survey datasets are freely available for researchers across the world.

**Data Gap Analysis on Antimalarial Prescriptions**

We found that there is presently inadequate data to evaluate the efficacy of the different treatment cascades for the disease, despite the presence of nationally representative surveys with a focus on malaria, such as the MIS. This implies that malaria surveys may not adequately capture the quality of treatment.

Second, important information that would have improved access to malaria medications was missing in the survey, such as the reasons why patients rejected taking treatment. There was no information available on blood testing for four countries with malaria endemic. Just five of the 25 nations that were a part of the study supplied information on the findings of malaria tests that might help determine the optimum course of treatment for febrile children under five.

Finally, the information may not fully reflect the course of therapy because it was obtained from mothers' experiences with the antimalarial drugs their kids took rather than the real doctor's prescriptions. In the future, surveys will be able to follow kids both throughout the cascade and after their treatment is finished to assess the outcomes of the causality of the child's quality of malaria care. Another element that is typically missing from surveys is patient history, which should be included because a patient's ability to get treatment for malaria may be impacted by recurrent malaria.

Given these information-based gaps, our findings which are detailed in the following sections estimate antimalarial prescription patterns in areas where the data are the most complete and where reasonable assumptions can be made. This information is crucial for demonstrating whether an antimalarial prescription was given for a recent case of malarial fever in each region across 19 LMICs.

**Data Harmonization**

The most recent MIS data for 25 LMICs were collected from the website <https://dhsprogram.com/>. Only children under the age of five were included in our study, hence we used “Children Recode (KR)" datasets to conduct our analysis. Nineteen LIMCs were finally (Angola, Burkina Faso, Burundi, Ghana, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Togo, Uganda, and Zambia) selected from 25 possible LMICs. These countries were selected because they matched our inclusion criterion and provided recent MIS data. Six LMICs (Cambodia, Cameroon, Ethiopia, Gambia, Namibia, and Zimbabwe) were excluded since there were insufficient datasets and pertinent variables. It was not known how high the non-response rate was in any of the countries. The reason was that the MIS survey reports were not available to the public or in English in certain nations.

Unequal unit selection probabilities are one issue that should be considered when analyzing survey datasets. For computing standard errors, sample weights are crucial because they aid in removing bias that might result from disproportionate sampling and the effects of non-response. Consequently, omitting weights from the study might lead to estimates that are heavily biased. To ensure accurate standard error and p-value calculations, sample weights provided by the MIS survey were used in the current investigations.

Statistical software Stata introduced singleton to manage a single PSU in a stratum. Missing data is only one of the many causes that might lead to a single PSU in a stratum26. This causes several issues when studying the data, such as the inability to compute standard errors. We utilized singleton (scaled) to handle singleton PSUs in each stratum. For singleton (scaled), we used the average of the variances from the strata with different sample units as a scaling factor for singleton (certainty) for each stratum. For simplicity of interpretation and analysis, all levels of categorical explanatory variables were specified appropriately. We combined the datasets from each country after extracting the study variables.

**Outcome variable**

A dichotomous variable with the category "YES=1/NO=0" describes the outcome variable "Antimalarial Taken for Malarial Fever from Qualified Sources”. The survey asked if the children had recently had a fever or a cough. If the response was yes, we investigated whether they had recently received antimalarial medicine for treatment. Finally, the qualified sources of the prescriptions were investigated **[Figure 1]**. In contrast, non-qualified sources included pharmacies, stores, churches, traditional healers, marketplaces, drug vendors, friends/relatives, supermarkets, shops, and others. We classified any government hospitals, private hospitals, clinics, NGOs, and public health sectors as qualified sources. While they are specialists in administering medication, pharmacists in LMICs are not permitted to give antimalarials. Our classification of “pharmacy” as an unqualified supplier of antimalarials reflects this.

**Explanatory variables**

The MIS survey revealed two categories of explanatory factors: level one (individual-level variables) and level two (community-level variables). Level one included the age and sex of a child, the highest education attainment of a mother, the number of children under the age of 5 in the household, and the household wealth index. Country and place of residence (rural, urban) were level two factors. These variables were recorded to make them pertinent for analysis and interpretation. Detailed descriptions of the study variables are presented in **Supplementary table 1.**

**Statistical Analysis**

We calculated various descriptive statistics of qualified antimalarial prescriptions with respect to countries and the explanatory variables. Weighted estimations serve as the foundation for all the presented findings in the tables and figures. To provide a thorough picture of the antimalarial prescriptions from qualified sources in each region of the various LMICs, a geospatial analysis was carried out.

The STROBE Statement Checklist of things that should be included in reports of cross-sectional studies was followed in this study **[Supplementary Checklists]**. All statistical analyses were performed in Stata version 1427 and ArcGIS28.

**Results**

**Descriptives Analysis**

After combining the MIS datasets from each of the 19 LMICs, we found 106265 children under the age of five. Males make up 54035.8 of them, or 50.9%, while females make up 5229.2, or 48.1%. In addition, we identified 29,477.9 (27.7%) children under five who had a recent malarial fever had taken an antimalarial. Among these children, 9477 had taken antimalarial drugs. Ultimately, we determined that 7511.3 (87.1) % of children under five had recently received antimalarial drugs for malarial fever from qualified sources across the LMICs. **[Figure 1]**

**[Insert Figure 1 Here]**

**Figure Title: The outcome variables extraction procedure.**

**Country Descriptives**

Overall, the percentage of antimalarial drugs taken from qualified sources in children under five for recent malarial fever was very high (above 60%) in all LMICs. Among the 19 LMICs, Senegal (100%), Angola (98.7%), Mozambique (98.2%), Burkina Faso (97.2%), and Sierra Leone (96.6%) have the highest percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever. Although, Senegal has the highest percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever, but the percentage of antimalarial drug consumption was only 2.7%. On the other hand, Tanzania (59.9%), Nigeria (60.0%), Ghana (61.1%), Liberia (75.0%), and Kenya (83.4%) have the lowest percentages of antimalarial drugs from qualified sources in children under five for recent malarial fever. **[Table 1]** **[Figure 2]**

**[Insert Table 1 and Figure 2 Here]**

**Figure Title: The Overall Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in 19 LMICs*.***

***Legend:*** ***Here, the darker shades of red indicate unqualified sources of antimalarial.***

**Region Wise Descriptives of Five Countries with Highest Qualified Prescription**

In this section, we presented the region-wise prevalence of five countries with the highest antimalarial prescriptions from qualified sources for recent malarial fever in children under five.

In Angola, the overall percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was high in all regions, with the highest percentages observed in Luanda (100%) region, while the lowest percentages were observed in Mesoendemic Unstable (95.5%) region **[Figure 3]**.However, the prevalence of antimalarial drug consumption was highest in the Mesoendemic Unstable (96.3%) region and lowest in Luanda (95.5%) region **[Supplementary table 4]**.

In Burkina Faso, the overall percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was high in all regions, with the highest percentages observed in Centre, Centre Est, Centre Nord, Est, Nord, and Sud Ouest (100%) regions respectively, while the lowest percentages were observed in Hauts-Bassins (95.5%) regions. **[Figure 4]**. However, the prevalence of antimalarial drug consumption was about 100% in all regions except for the Centre (97.1%), Plateau Central (98.0%), and Sud-Ouest (98.2%) region **[Supplementary table 5]**.

In Mozambique, the overall percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was high in all regions, with the highest percentages observed in Niassa, Zambezia, Tete, Manica, Sofala, Gaza, Maputo Provincia, and Maputo Cidade regions which about 100% and the lowest percentages were observed in Cabo Delgado (93.9%) regions **[Figure 5]**. However, the prevalence of antimalarial drug consumption was 100% in all regions [**Supplementary table 14]**.

In Sierra Leone, the overall percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was high in all regions, with the highest percentages observed in Eastern (98.7%) and North regions with about 100% and the lowest percentages were observed in Southern (94.0%) regions **[Figure 6]**. However, the prevalence of antimalarial drug consumption was highest in Southern (99.9%) and lowest in Western (98.5%) regions **[Supplementary table 18]**.

In Senegal, the overall percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was high in all regions. The percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was 100% in each region, but the percentage of antimalarial drug consumption was only 2.7% **[Figure 7]**. However, the prevalence of antimalarial drug consumption was highest in Sedhiou (9.7%) and lowest in Dakar, Kaolack, Thies, and Fatick (0%) regions **[Supplementary table 17]**.

**[Insert Figure 3-7 Here]**

**Figure Title: Region Wise Prevalence of Five Countries (Angola, Burkina Faso, Mozambique, Sierra Leone, and Senegal) with Highest Qualified Prescription of Antimalarial from Qualified Sources.**

***Legend:*** ***Here, the darker shades of red indicate unqualified sources of antimalarial.***

**Region Wise Descriptives of Five Countries with Lowest Qualified Prescription**

In this section, we presented the region-wise prevalence of five countries with the lowest antimalarial prescription from qualified sources for recent malarial fever in children under five.

In Ghana, the overall percentages of antimalarial prescriptions from qualified sources in children under five for recent malarial fever were high in all regions except for Greater Accra. The highest percentages of antimalarial medicine from qualified sources were observed in Upper West (96.6%) and the lowest percentages occurred in the Greater Accra (23.1%) and Ashanti (33.5%) regions **[Figure 8]**. However, the prevalence of antimalarial drug consumption was about 100% in all regions except for the Western (98.8%) region **[Supplementary table 7]**.

In Kenya, the overall percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was high in all regions, with the highest percentages observed in Eastern, Western, and Nyanza regions about 100%, and the lowest percentages were observed in Coast (59.4%) region **[Figure 9]**. However, the prevalence of antimalarial drug consumption was highest in Northeast, Central, and Nairobi which were about 100% regions, and lowest in Eastern (15.1%) regions **[Supplementary table 9]**.

In Liberia, the overall percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was high in all regions, with the highest percentages observed in Southeastern B (93.0%) region, while the lowest percentages were observed in Greater Monrovia (61.1%) region **[Figure 10]**. However, the prevalence of antimalarial drug consumption was highest in the South Eastern (100%) region and lowest in the South Central (94.7%) region **[Supplementary table 10]**.

In Nigeria, the overall percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was high in all regions, with the highest percentages observed in Jigawa, kebbi, Plateau, and Oyo regions at about 100% and the lowest percentages were observed in Rivers (22.7%) regions **[Figure 11]**. However, the prevalence of antimalarial drug consumption was highest in Benue 73.5% region and lowest in Kebbi 0.4% region **[Supplementary table 15]**.

In Tanzania, the overall percentage of antimalarial prescriptions from qualified sources in children under five for recent malarial fever was high in all regions, with the highest percentages observed in Dodoma, Arusha, Njombe, and Dar Es Salaam regions about 100%, and the lowest percentages observed in Singida (41.6%) regions **[Figure 12]**. However, the prevalence of antimalarial drug consumption was 100%, except for the Pwani (96.9%), Tabora (95.6%), and Shinyanga (97.2%) regions **[Supplementary table 19]**.

**[Insert Figure 8-12 Here]**

**Figure Title:Region Wise Prevalence of Five Countries (Ghana, Kenya, Liberia, Nigeria and Tanzania) with Lowest Qualified Prescription of Antimalarial from Qualified Sources.**

***Legend:*** ***Here, the darker shades of red indicate unqualified sources of antimalarial.***

**Descriptives Statistics for Explanatory Variables**

Table 3 shows the descriptive statistics for several explanatory factors and antimalarial drugs taken from qualified sources for recent malarial fever in children under five.

About 86.9% of children who are male have taken antimalarial whereas 87.3% of children who are female have taken antimalarial Drugs taken from qualified sources for recent malarial fever in children under five. The percentage of antimalarial Prescription from qualified sources for recent malarial fever seems to decrease as the age of children increases (one year; 89.1 %, two years; 87.1%, three years; 87.5 %, four years; 84.3 %, and five years; 84.2%. Children who live in Rural areas received 88.1 % of antimalarial prescriptions from qualified sources, compared to urban areas with 84.3%. 82.3 % of children whose parents received higher education took antimalarial prescriptions from qualified sources for recent malarial fever, compared to children whose parents have no education with 90.8 %. The percentage of antimalarial prescriptions from qualified sources for the number of children under five in the household are One; 86.0 %, two; 89.0 %, three; 85.1%, four; 85.0%, and five; 88.4% respectively. According to the wealth index of the child’s family, the percentage of taking antimalarial from qualified sources for recent malarial fever seems to decrease from poorest to richest order (90.9% for poorest, 87.2% for poorer, 86.8% for middle, 84.4% for richer and 83.7% for richest. **[Table 2]**

**Discussion**

Few fevers are treated with effective antimalarials within 24 hours of the beginning of symptoms, even though prompt availability of effective malaria treatment is essential to the success of malaria control efforts globally29. The main barriers to reducing malaria mortality may be found in the ineffective testing of malarial fever in children and generally inefficient malaria care, the administration of antimalarial medicines without first performing blood tests for the disease, the administration of more antimalarial medicines than is suggested, or the administration of delayed antimalarial treatment30. Our study found that overall, the percentage of antimalarial prescriptions for recent malarial fever from qualified sources in children under five was very high (above 85 percent) across the LMICs. However, in several LMICs (Guinea, Mali, Nigeria, Kenya, and Senegal), the percentage of antimalarial drug consumption was low.

The reasons for the high percentages of qualified prescriptions of antimalarial for recent malarial fever in children under five across the LMICs are manifold. Firstly, the main factor that forces higher percentages of qualified prescriptions across the LMICs is industry influences. According to several studies, the pharmaceutical business has a significant impact on information and incentives, and doctors from both public and private institutions mentioned the industry as their main source of knowledge regarding drugs 31,32,33,34. Pharmaceutical corporations reportedly put pressure on Indian physicians and pharmacists to use or sell pharmaceuticals, particularly newer brands, and gave incentives31. A study of doctors in Pakistan revealed that while public sector doctors were more likely to have issues with medicine supply, private sector doctors were (reportedly) more vulnerable to patient demand and the fear of losing patients to rival providers35. In Laos, clinicians in rural settings were more likely than those in district and central hospitals to get information from pharmaceutical corporations36. They discovered that some doctors had contracts with pharmaceutical corporations to split the revenues of additional sales in their research of healthcare worker incentives in China37.

Secondly, research has revealed various cultures of care that have an impact on prescription. This may be oversimplified to assume that prescribers and sellers are mainly affected by stock and profits. Indian physicians recommended antibiotics as preventative measures since their patients were vulnerable to illness due to inadequate sanitation and filthy living circumstances. In addition to that, Indian pharmacists claimed that selling medications to underprivileged people is a means of social work. Furthermore, some pharmacists were reluctant to contest prescriptions even when they were unneeded to undermine the authority of doctors 38,39.

Thirdly, Patients' demands, according to providers in both the public and private sectors, played a major role in their prescription decisions. Doctors frequently believe that patients want medicines because they are unaware of their illnesses. For instance, doctors in Nigeria claim that when the public pays for healthcare services, such as at private hospitals, they anticipate seeing medicines on their bills40,31,37,38,41,35,39,42.

Bangladesh has failed to uphold the innovative and highly regarded National Drug Policy of 1982. Regulatory bodies in the country lack the necessary power to effectively control drug pricing or curb the excessive usage of generic medicines. As a result, the availability of generic drugs is limited, leading to a significant markup in prices. Additionally, essential medications for common ailments like cough and fever are being sold in an unregulated manner.

Fourthly, Several LMICs have failed to uphold the innovative and highly regarded National Drug Policy of 1982. For instance, regulatory bodies in Bangladesh lack the necessary power to effectively control drug pricing or curb the excessive usage of generic medicines. As a result, the availability of generic drugs is limited, leading to a significant markup in prices. Inconsistencies in national policy frameworks were brought to light by a policy analysis in Namibia. There was no overarching guideline for drug use, even though treatment guidelines for various diseases (such as HIV, malaria, tuberculosis, etc.) included recommendations about drugs. In addition, many of the drugs listed on the primary and secondary health list were not included in the treatment guidelines 43,44.

Finally, Insufficient adherence to the ICMI guidelines was discovered in a study looking at the appropriateness of treatment in Papua New Guinea. 40% of children were not treated appropriately in terms of receiving drugs. In particular, 29% of them received drugs when they should not have and the remaining 11% were not receiving them when they should have. Rapid diagnostic tests for malaria in feverish patients were found to have a significant impact on the prescription of drugs: in children who met the criteria for mild pneumonia and needed treatment, only 40% received antibiotics when the malaria RDT was positive compared to 76% when the test was negative. The management of malarial infections is not properly guided as most of health professionals are largely focused on RDT findings and disregard other clinical signs. Several studies highlight the shortcomings of ostensibly straightforward approaches (such as fever charts or RDTs) to properly manage fevers and drug usage at the community level45,46,47.

Moreover, several studies that found various factors that influence high rates of qualified prescriptions are insufficient diagnostic services, a lack of antibiotic guidelines, difficulty in monitoring patient progress, unsatisfactory intensive care facilities in rural areas, patient demand for immediate relief, apparent patient anticipations from prior prescriptions, using up production, and apprehension about losing patients to competition38,37,31.

The standard of malaria treatment is still subpar and varies greatly among endemic LMICs. There are several reasons for unqualified prescriptions of antimalarial for recent fever in some of the LMICs (Tanzania, Nigeria, and Ghana). Medications are frequently administered regardless of the findings of a malaria test, indicating that presumptive diagnosis is still frequently used in situations of probable malaria instead of the WHO's advice to “test and treat” 48. The major causes of inappropriate prescriptions of antimalarial medications, according to a systematic review in SSA regions, include limited diagnostic competence, dependence on clinical symptoms too much, noncompliance with treatment recommendations, and a lack of access to health facilities49.

Furthermore, traditional, and herbal remedies tend to be the preferred alternative to antimalarial medication in areas where malaria is endemic. According to WHO, 80% of people in third world countries, rely on herbal remedies to prevent malaria50. Moreover, the high antimalarial prescription rates from unqualified sources are caused by inadequate healthcare infrastructure. The healthcare system has several challenges, including limited healthcare facilities and inadequate funds to address healthcare needs. As a result, it is less likely that those in need of antimalarial medications will be able to obtain them from qualified sources 51,52,53.

There are several factors that cause some variations in antimalarial prescription for recent malarial fever in children under five.

Children in rural areas typically receive a more qualified prescription of antimalarial for recent malarial fever than those in urban areas. There are several reasons for low qualified prescriptions in urban areas. As urban residents are more informed and have a basic understanding of drugs for common childhood illnesses, they purchase medicines for their children without first seeing a physician54,55. Second, there are more pharmacies in cities than in rural regions, which encourages people to buy antibiotics without prescriptions56. Lastly, long wait times in metropolitan government hospitals are another reason why individuals avoid seeking treatment from government health providers for frequent and recurrent children’s illnesses57.

Children with mothers who had higher education are likely to get better qualified antimalarial prescriptions for recent malarial fever than children with mothers who have no education. Effective antimalarial usage in young children is linked to caregiver education 58. In Zambia, children with caregivers who had some education were less likely to abuse anti-malarial drugs59. According to Ugandan research, education may have an impact on patients' comprehension of clinic instructions, the quality of their connection with their healthcare practitioner, and their capacity to comprehend visual instructions60. Alongside education, the wealth index also affects the rate of antimalarial prescriptions from qualified sources for recent malarial fever in children under five.  Children from wealthier families are more likely to get better antimalarial care than those from underprivileged backgrounds. The cause is like the situation in education. Hospital and healthcare facility visits by wealthy people are significantly higher than those by impoverished people.

Regardless of whether the antimalarials are obtained from qualified sources or not, overprescribing them might lead to the development of antimalarial resistance. Antimalarial resistance can also develop and spread as a result of other reasons, including the abuse of antimalarial medications, poor care, and ineffective preventative strategies 61,18,62. Over-prescription of antimalarial drugs and the emergence of resistance have been linked, according to several studies. Almost 80% of children with fever were given antimalarials, according to a study done in Kenya, and this over-prescription was connected to the emergence of chloroquine resistance63. Another study in Tanzania discovered that more than 80% of patients with symptoms similar to malaria were prescribed antimalarials, and this overprescribing was linked to the emergence of resistance to antimalarial prescriptions 64. Quite apart from the fact that prescribing too many antimalarial drugs might contribute to the establishment and spread of resistance, it is essential to tackle all these causes. To lessen the impact of malaria and stop the emergence of resistant strains, proper antimalarial usage and the execution of preventative measures are crucial65,66.

**Recommendations**

Most often, the LMICs had high antimalarial prescription rates for recent malarial fever from qualified sources, according to our analysis. However, certain LMICs (Tanzania, Nigeria, and Ghana) have a high antimalarial prescription rate from unqualified sources for recent malarial fever. To tackle the problem of antimalarial resistance, it is essential that antimalarials are administered and used correctly. Health personnel should be trained to undertake diagnostic tests for the presence of malaria before giving out antimalarial drugs. Moreover, they need to be trained in prescribing the appropriate antimalarial depending on the patterns of local drug resistance. Targeted interventions that include health education programs, free healthcare services, and expanded access to ACT should be implemented to support underprivileged populations (children with illiterate mothers and children from homes with lower wealth indices). To lower the prevalence of malaria and the demand for antimalarial medications, the use of prevention strategies such as insecticide-treated bed nets, and indoor residual spraying should be promoted.

**Strength**

To the best of the authors' knowledge, this is the first study on the antimalarial prescription for recent malarial fever in children under five. We were able to explore a comprehensive and detailed picture of antimalarial prescriptions from qualified sources in each of the 19 LMICs with endemic using geospatial analysis. The region-wise GIS map allows local and national officials to easily get a complete view of antimalarial prescriptions.

**Limitations**

The results of malaria tests performed on children under the age of five are absent from the MIS databases of most countries. Hence, we considered children under the age of five who have recently had malaria in LMICs. Finally, we focused on children under five. However, there is a need for more studies in areas where malaria is endemic, including studies for all age groups.

**Conclusion**

According to our study, even though LMICs were getting high antimalarial prescriptions from qualified sources, certain LMICs were getting high antimalarial prescriptions from unqualified sources for recent malarial fever (Tanzania, Nigeria, and Ghana). Children under the age of five who live in rural areas, have mothers with better education levels, and have more affluent parents, are more frequently to receive antimalarial drugs from qualified sources for malaria treatment. The study focuses on the use of antimalarial prescriptions for recent malarial fever in children under five in LMICs. We found that greater health infrastructure with checks and balances among antimalarial drugs should be implemented. According to the researchers, the goal of this study is to alert the local authorities to this dreadful situation and recommend need-based support services at the individual level.

**Acknowledgment**

We gratefully acknowledge the MIS Program for granting access to the LMICs datasets.

**Funding Information**

There is no funding for this study.

**Authors Contributions**

MSH and TSA cleaned, compiled, and analyzed the dataset. MSH and MAH wrote the original draft. TSA performed geospatial analysis. MABC gave feedback on data analysis and manuscript structure, and reviewed, and edited the first draft. MJU conceptualized, commented, and supervised the study. All authors reviewed the study numerous times.

**Data Availability Statements**

Data is available via request.

**Conflict of Interest**

The Author declares no conflict of interest.

**References**

1. Fact sheet about malaria. https://www.who.int/news-room/fact-sheets/detail/malaria.

2. World malaria report 2021. https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2021.

3. World malaria report 2020. https://www.who.int/publications-detail-redirect/9789240015791.

4. World malaria report 2022. https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022.

5. Fever and its treatment among the more and less poor in sub-Saharan Africa | Health Policy and Planning | Oxford Academic. https://academic.oup.com/heapol/article/20/6/337/651847.

6. Hemingway, J. *et al.* Tools and Strategies for Malaria Control and Elimination: What Do We Need to Achieve a Grand Convergence in Malaria? *PLOS Biol.* **14**, e1002380 (2016).

7. Biting Back at Malaria – Self-Medication, Traditional Healers, and the Public Sector by Alfredo R. Paloyo, Arndt R. Reichert :: SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=2278840.

8. Organization, W. H. *Basic Malaria Microscopy*. (World Health Organization, 2010).

9. An Update on Drug-Induced Pigmentation | SpringerLink. https://link.springer.com/article/10.1007/s40257-018-0393-2.

10. Nanomedicines for Malaria Chemotherapy: Encapsulation vs. Polymer Therapeutics | SpringerLink. https://link.springer.com/article/10.1007/s11095-018-2517-z.

11. Gimenez, A. M., Marques, R. F., Regiart, M. & Bargieri, D. Y. Diagnostic Methods for Non-Falciparum Malaria. *Front. Cell. Infect. Microbiol.* **11**, (2021).

12. Mukadi-Bamuleka, D. *et al.* Field performance of three Ebola rapid diagnostic tests used during the 2018–20 outbreak in the eastern Democratic Republic of the Congo: a retrospective, multicentre observational study. *Lancet Infect. Dis.* **22**, 891–900 (2022).

13. Retail supply of malaria‐related drugs in rural Tanzania: risks and opportunities - Goodman - 2004 - Tropical Medicine &amp; International Health - Wiley Online Library. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1365-3156.2004.01245.x.

14. Healthcare-seeking Behaviour for Common Infectious Disease-related Illnesses in Rural Kenya: A Community-based House-to-house Survey - PMC. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3075057/.

15. Reviewing the literature on access to prompt and effective malaria treatment in Kenya: implications for meeting the Abuja targets | Malaria Journal | Full Text. https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-8-243.

16. Okeke, T. A. & Uzochukwu, B. S. Improving childhood malaria treatment and referral practices by training patent medicine vendors in rural south-east Nigeria. *Malar. J.* **8**, 260 (2009).

17. Kizito, J., Kayendeke, M., Nabirye, C., Staedke, S. G. & Chandler, C. I. Improving access to health care for malaria in Africa: a review of literature on what attracts patients. *Malar. J.* **11**, 55 (2012).

18. Ippolito, M. M., Moser, K. A., Kabuya, J.-B. B., Cunningham, C. & Juliano, J. J. Antimalarial Drug Resistance and Implications for the WHO Global Technical Strategy. *Curr. Epidemiol. Rep.* **8**, 46–62 (2021).

19. Scaling-up malaria treatment: a review of the performance of different providers | Malaria Journal | Full Text. https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-11-414.

20. Examining characteristics, knowledge and regulatory practices of specialized drug shops in Sub-Saharan Africa: a systematic review of the literature | BMC Health Services Research | Full Text. https://bmchealthservres.biomedcentral.com/articles/10.1186/1472-6963-12-223.

21. Improvements in access to malaria treatment in Tanzania following community, retail sector and health facility interventions -- a user perspective | Malaria Journal | Full Text. https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-9-163.

22. Utilization of public or private health care providers by febrile children after user fee removal in Uganda | Malaria Journal | Full Text. https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-8-45.

23. Antimalarial drug resistance in Africa: key lessons for the future - Takala‐Harrison - 2015 - Annals of the New York Academy of Sciences - Wiley Online Library. https://nyaspubs.onlinelibrary.wiley.com/doi/full/10.1111/nyas.12766?casa\_token=uaHMuVH-mekAAAAA%3A6KEFK2Zoh1YYzCarh\_HOBSfVzjP99je8a4v-b9uN\_vlO1QEIvsWr6qqJIm0xqxShiSvY6tFU0qSxCRbD.

24. Kisia, J. *et al.* Factors associated with utilization of community health workers in improving access to malaria treatment among children in Kenya. *Malar. J.* **11**, 248 (2012).

25. The DHS Program - Malaria Indicators Survey (MIS). https://dhsprogram.com/methodology/survey-types/mis.cfm.

26. Documentation | Stata. https://www.stata.com/features/documentation/.

27. Stata 14 | Stata. https://www.stata.com/stata14/.

28. ArcGIS Desktop 10.7.1 quick start guide—ArcMap | Documentation. https://desktop.arcgis.com/en/arcmap/10.7/get-started/setup/arcgis-desktop-quick-start-guide.htm.

29. Chuma, J., Okungu, V. & Molyneux, C. Barriers to prompt and effective malaria treatment among the poorest population in Kenya. *Malar. J.* **9**, 144 (2010).

30. Feachem, R. G. A. *et al.* Malaria eradication within a generation: ambitious, achievable, and necessary. *The Lancet* **394**, 1056–1112 (2019).

31. Shankar, P. R. Developing and sustaining a medical humanities program at KIST Medical College, Nepal. *Indian J. Med. Ethics* **10**, 51–3 (2013).

32. Oa, A. & Ao, I. AN EVALUATION OF DOCTORS’ PRESCRIBING PERFORMANCE IN NIGERIA.

33. Giri, B. R. & Shankar, P. R. Learning How Drug Companies Promote Medicines in Nepal. *PLOS Med.* **2**, e256 (2005).

34. Hailu, W., Srikanth Bhagavathula, A., Admassie, E., Patel, I. & Khan, T. M. Retraction: Knowledge, attitude and practices towards adverse drug reaction reporting in Gondar, Ethiopia. *J. Pharm. Health Serv. Res.* **6**, 111 (2015).

35. Hussain, S. *et al.* Pharmacoepidemiological studies of prescribing practices of health care providers of Pakistan: A cross- sectional survey. *Afr. J. Pharm. Pharmacol.* **5**, 1484–1493 (2011).

36. Quet, F. *et al.* Antibiotic prescription behaviours in Lao People’s Democratic Republic: a knowledge, attitude and practice survey. *Bull. World Health Organ.* **93**, 219–227 (2015).

37. Reynolds, L. & McKee, M. Factors influencing antibiotic prescribing in China: An exploratory analysis. *Health Policy* **90**, 32–36 (2009).

38. Irrational use of antibiotics and role of the pharmacist: an insight from a qualitative study in New Delhi, India - Kotwani - 2012 - Journal of Clinical Pharmacy and Therapeutics - Wiley Online Library. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2710.2011.01293.x?casa\_token=hdKQyDJMzbUAAAAA%3Al5EixdqG4GYSG1X-EsHqg9b1RV4XJJNxvOPljvRAT0TV8JtTWbrP4YGr85ZCx09UdvnShpnpv6my2ncH.

39. Kotwani, A., Wattal, C., Katewa, S., Joshi, P. C. & Holloway, K. Factors influencing primary care physicians to prescribe antibiotics in Delhi India. *Fam. Pract.* **27**, 684–690 (2010).

40. Bai, Y. *et al.* Factors associated with doctors’ knowledge on antibiotic use in China. *Sci. Rep.* **6**, 23429 (2016).

41. What motivates antibiotic dispensing in accredited drug dispensing outlets in Tanzania? A qualitative study | Antimicrobial Resistance & Infection Control | Full Text. https://aricjournal.biomedcentral.com/articles/10.1186/s13756-015-0073-4.

42. Antibiotic overuse for acute respiratory tract infections in Sri Lanka: a qualitative study of outpatients and their physicians | BMC Primary Care | Full Text. https://bmcprimcare.biomedcentral.com/articles/10.1186/s12875-017-0619-z.

43. Ahmed, S. M. & Islam, Q. S. Availability and Rational Use of Drugs in Primary Healthcare Facilities Following the National Drug Policy of 1982: Is Bangladesh on Right Track? *J. Health Popul. Nutr.* **30**, 99–108 (2012).

44. An analysis of policies for cotrimoxazole, amoxicillin and azithromycin use in Namibia’s public sector: Findings and therapeutic implications - Kibuule - 2017 - International Journal of Clinical Practice - Wiley Online Library. https://onlinelibrary.wiley.com/doi/full/10.1111/ijcp.12918?casa\_token=oxJ5FS4KSHEAAAAA%3ASjwcbsIOqm3Sl41YIHjeLDUHiuCPY-rmfbbpYjPOzV1SarVulWQseiykZUq4GVmZdJHwDQxEAyItmCiX.

45. Kazaura, M., Lugangira, K. & Kalokola, F. Prescription practices for non-malaria febrile illnesses among under-fives in the Lake Zone, Tanzania. *Asian Pac. J. Trop. Dis.* **6**, 759–764 (2016).

46. Biswas, R., Dineshan, V., Narasimhamurthy, N. S. & Kasthuri, A. S. Integrating hospital-acquired lessons into community health practice: Optimizing antimicrobial use in Bangalore. *J. Contin. Educ. Health Prof.* **27**, 105–110 (2007).

47. Senn, N. *et al.* Use of Antibiotics within the IMCI Guidelines in Outpatient Settings in Papua New Guinean Children: An Observational and Effectiveness Study. *PLOS ONE* **9**, e90990 (2014).

48. Macarayan, E., Papanicolas, I. & Jha, A. The quality of malaria care in 25 low-income and middle-income countries. *BMJ Glob. Health* **5**, e002023 (2020).

49. Bastiaens, G. J. H., Bousema, T. & Leslie, T. Scale-up of Malaria Rapid Diagnostic Tests and Artemisinin-Based Combination Therapy: Challenges and Perspectives in Sub-Saharan Africa. *PLOS Med.* **11**, e1001590 (2014).

50. Traditional medicine strategy 2002–2005 | LIS. https://pesquisa.bvsalud.org/portal/resource/pt/lis-7042.

51. Ocan, M. *et al.* Household antimicrobial self-medication: a systematic review and meta-analysis of the burden, risk factors and outcomes in developing countries. *BMC Public Health* **15**, 742 (2015).

52. Torres, N. F., Chibi, B., Middleton, L. E., Solomon, V. P. & Mashamba-Thompson, T. P. Evidence of factors influencing self-medication with antibiotics in low and middle-income countries: a systematic scoping review. *Public Health* **168**, 92–101 (2019).

53. Ocan, M. *et al.* Persistence of chloroquine resistance alleles in malaria endemic countries: a systematic review of burden and risk factors. *Malar. J.* **18**, 76 (2019).

54. Giles-Corti, B. *et al.* What next? Expanding our view of city planning and global health, and implementing and monitoring evidence-informed policy. *Lancet Glob. Health* **10**, e919–e926 (2022).

55. Knowledge and beliefs about antibiotics among people in Yogyakarta City Indonesia: a cross sectional population-based survey - PubMed. https://pubmed.ncbi.nlm.nih.gov/23176763/.

56. Leat, S., Ahrens, K., Krishnamoorthy, A., Gold, D. & Rojas-Fernandez, C. The legibility of prescription medication labelling in Canada: Moving from pharmacy-centred to patient-centred labels. *Can Pharm J Ott* **147**, 179–87 (2014).

57. Healthcare seeking practices and barriers to accessing under-five child health services in urban slums in Malawi: a qualitative study | SpringerLink. https://link.springer.com/article/10.1186/s12913-016-1678-x.

58. Denis, M. B. Improving compliance with quinine + tetracycline for treatment of malaria: evaluation of health education interventions in Cambodian villages. *Bull. World Health Organ.* **76**, 43–49 (1998).

59. Depoortere, E. *et al.* Adherence to the combination of sulphadoxine–pyrimethamine and artesunate in the Maheba refugee settlement, Zambia. *Trop. Med. Int. Health* **9**, 62–67 (2004).

60. Fogg, C. *et al.* Adherence to a six-dose regimen of artemether-lumefantrine for treatment of uncomplicated plasmodium falciparum malaria in Uganda. (2004).

61. Talisuna, A. O. *et al.* Mitigating the threat of artemisinin resistance in Africa: improvement of drug-resistance surveillance and response systems. *Lancet Infect. Dis.* **12**, 888–896 (2012).

62. Report on antimalarial drug efficacy, resistance and response: 10 years of surveillance (2010-2019). https://www.who.int/publications-detail-redirect/9789240012813.

63. Ochola, L., Vounatsou, P., Smith, T., Mabaso, M. & Newton, C. The reliability of diagnostic techniques in the diagnosis and management of malaria in the absence of a gold standard. *Lancet Infect. Dis.* **6**, 582–588 (2006).

64. Mmbando, B. P. *et al.* A progressive declining in the burden of malaria in north-eastern Tanzania. *Malar. J.* **9**, 216 (2010).

65. Global technical strategy for malaria 2016-2030, 2021 update. https://www.who.int/publications-detail-redirect/9789240031357.

66. Lindblade, K. A. *et al.* Supporting countries to achieve their malaria elimination goals: the WHO E-2020 initiative. *Malar. J.* **20**, 481 (2021).

**Tables 1-2**

**Table 1:** Weighted Descriptive Statistics of Antimalarial Prescription from Qualified Sources in Children Under Five for Recent Malarial Fever in 19 LMICs.

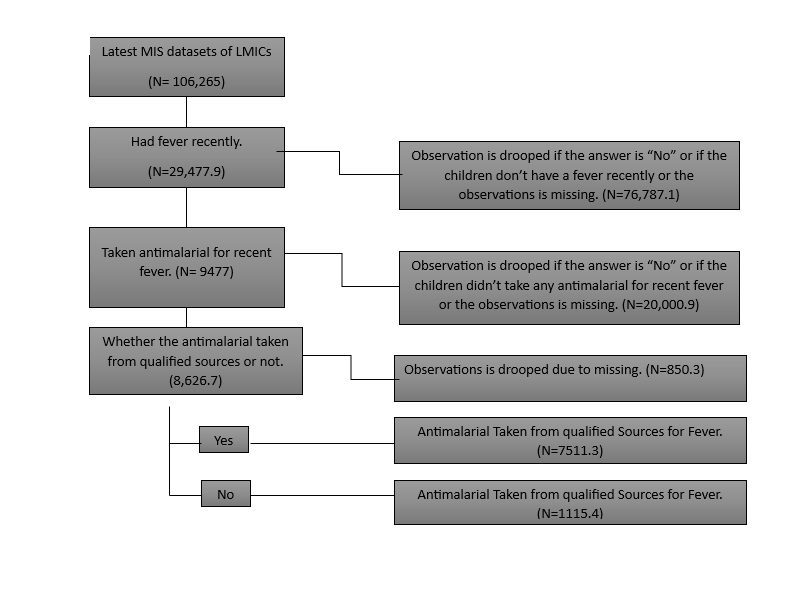
|  |  |  |  |
| --- | --- | --- | --- |
| **Country** | **Had Fever Recently, Weighted N (%)** | **Antimalarial taken for Malaria, Weighted N (%)** | **Antimalarial taken from Qualified Sources, Weighted N (%)** |
| Angola | 2632 (34.4) | 706.1 (95.0) | 656.3 (98.7) |
| Burkina Faso | 1176 (20.3) | 600.2 (99.7) | 556.8 (97.4) |
| Burundi | 1806 (35.5) | 455.4 (98.2) | 404.4 (92.1) |
| Ghana | 811.5 (30.1) | 370.2 (99.8) | 197.8 (61.1) |
| Guinea | 909.9 (23.3) | 289.7 (31.8) | 235.8 (91.5) |
| Kenya | 559.2 (17.4) | 14.78 (2.6) | 11.51 (83.4) |
| Liberia | 1011 (40) | 642.2 (97.0) | 446.4 (75.0) |
| Madagascar | 1087 (16.1) | 68.33 (61.7) | 51.36 (87.8) |
| Malawi | 1038 (40.7) | 305.4 (99.8) | 247.7 (92.4) |
| Mali | 2494 (27.3) | 779.7 (31.3) | 684.2 (93.3) |
| Mozambique | 1458 (31.3) | 1458 (100) | 422.3 (98.2) |
| Nigeria | 3917 (36.8) | 799.5 (20.4) | 394.8 (60.0) |
| Rwanda | 884.1 (31.1) | 884.1 (100) | 153.3 (92.0) |
| Senegal | 1654 (30.0) | 44.0(2.7) | 44 (100) |
| Sierra Leone | 1535 (27.1) | 868.2 (99.4) | 763.9 (96.6) |
| Tanzania | 1429 (20.6) | 504.8 (99.3) | 254 (59.9) |
| Togo | 747.5 (24.4) | 225.2(98.4) | 190.1 (94.6) |
| Uganda | 1715 (27.1) | 1074 (98.8) | 883.4 (87.8) |
| Zambia | 2616 (21.4) | 1081 (99.5) | 924.4 (93.2) |

**Table 2:** Weighted Descriptive Statistics of Socio-economic Variables Associated with Antimalarial Prescriptions from Qualified Sources for Recent Malarial Fever in the Pooled data.

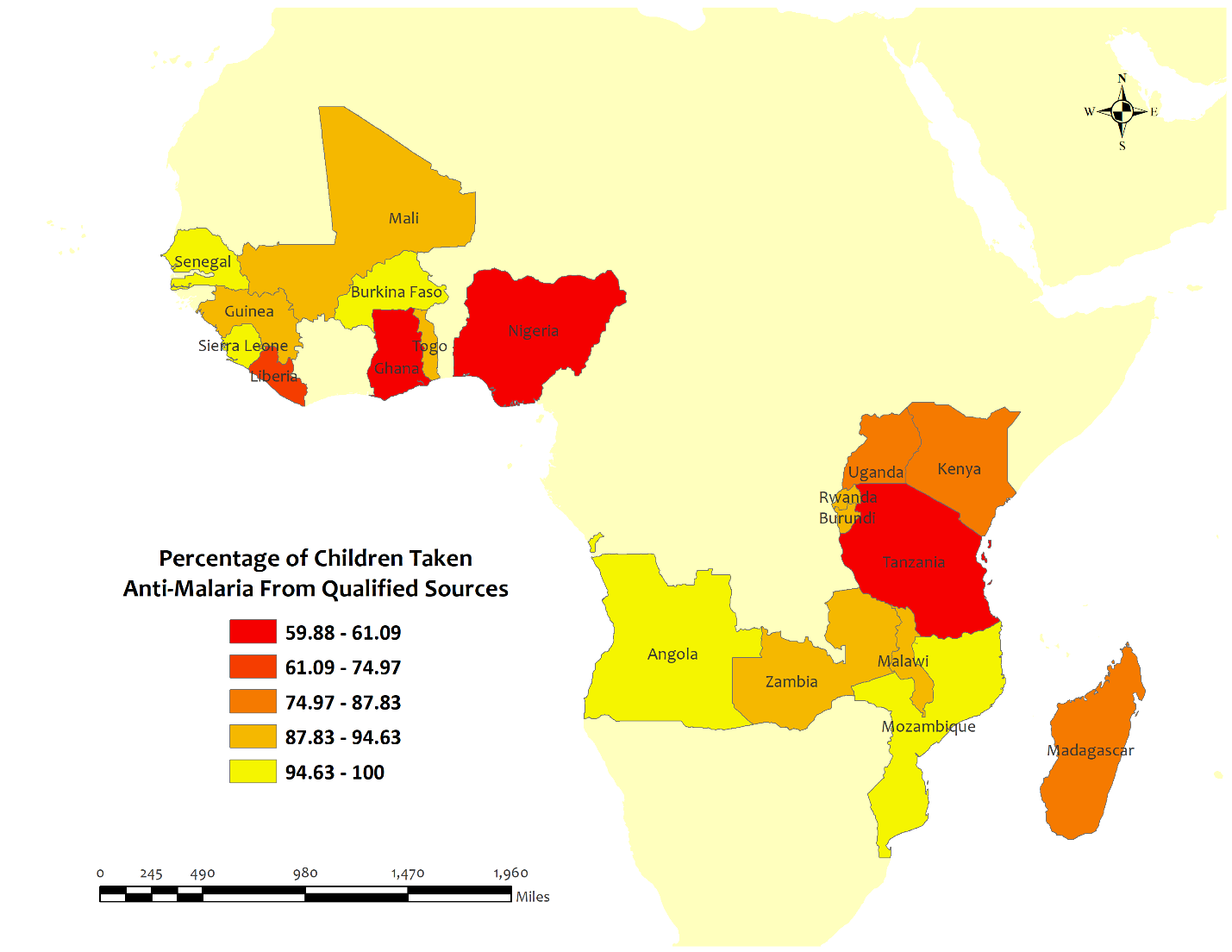
|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Category** | **Antimalarial Taken for Recent Fever, Weighted N (%)** | **Missing percentages (%)** |
| Child’s age | One year old | 1198 (89.1) | 7.9 |
| Two years old | 1807 (87.1) |
| Three years old | 1588 (87.5) |
| Four years old | 1301 (84.3) |
| Five years old | 986.9 (84.2) |
| Sex of the Child | Male | 3795 (86.9) | 0 |
| Female | 3716 (87.3) |
| Type of place of residence | Urban | 1743 (84.3) | 1.4 |
| Rural | 5674 (88.1) |
| Highest educational level of Mother’s | No education | 2772 (90.8) | 0 |
| Primary | 3132 (87.5) |
| Secondary | 1412 (80.5) |
| Higher | 195.4 (82.3) |
| Number of children under 5 in the household | One | 2483 (86.0) | 0 |
| Two | 3042 (89.0) |
| Three | 1159 (85.1) |
| Four | 398.9 (85.0) |
| Five or above | 428 (88.4) |
| Wealth index combined | Poorest | 1911 (90.9) | 0 |
| Poorer | 1732 (87.2) |
| Middle | 1663 (86.8) |
| Richer | 1283 (84.4) |
| Richest | 922 (83.7) |

**Figures 1 -12**

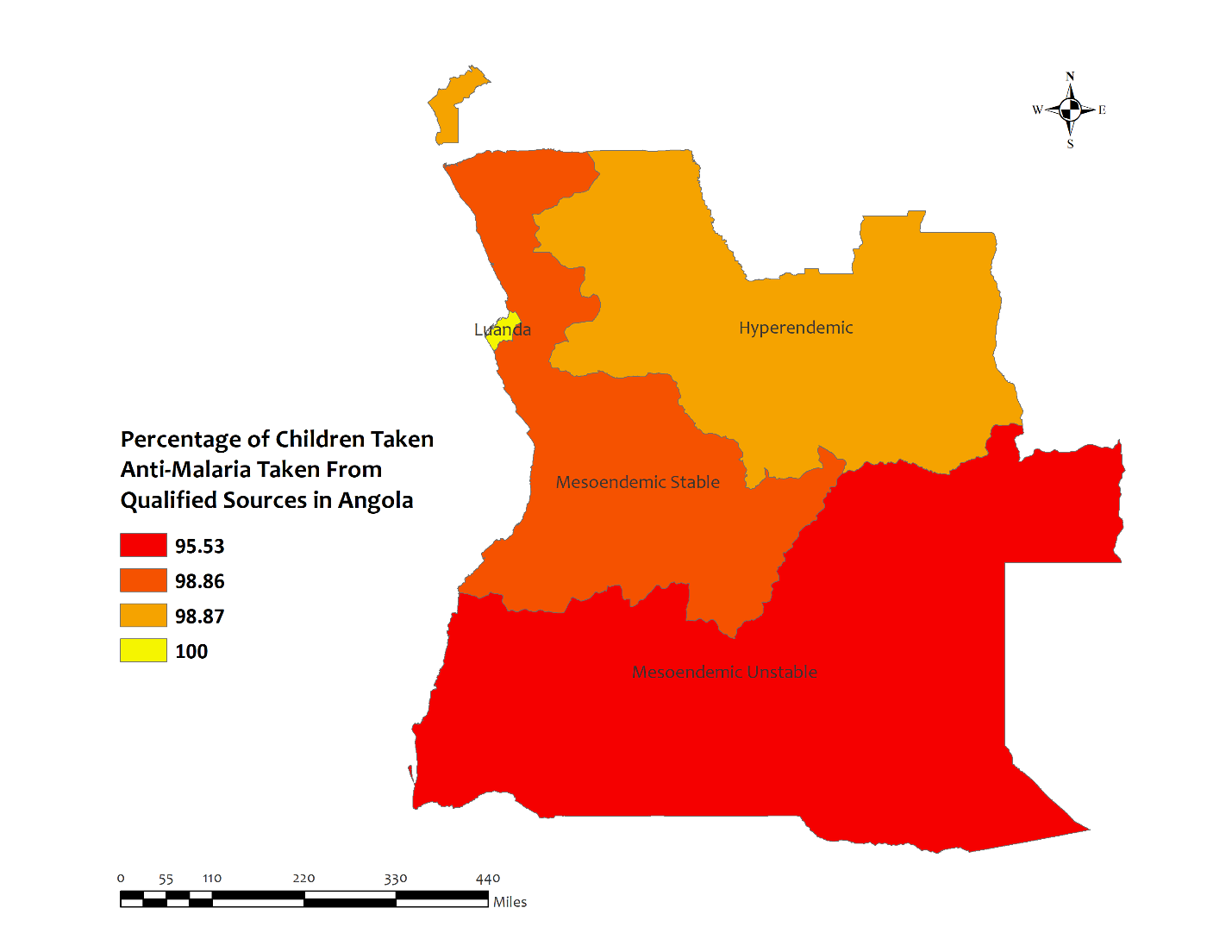
**Figure 1:** The outcome variables extraction procedure

****

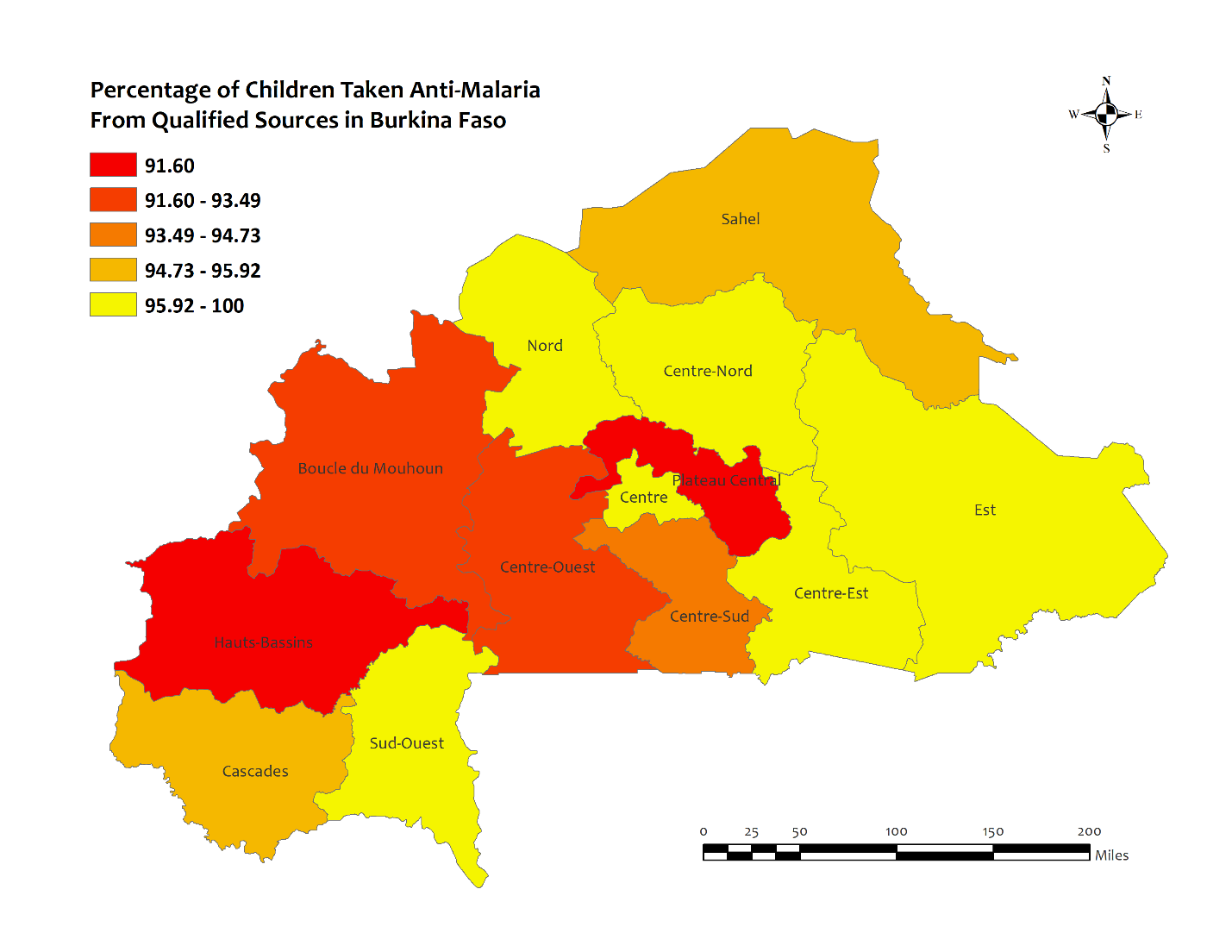
**Figure 2** The Overall Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in 19 LMICs.

****

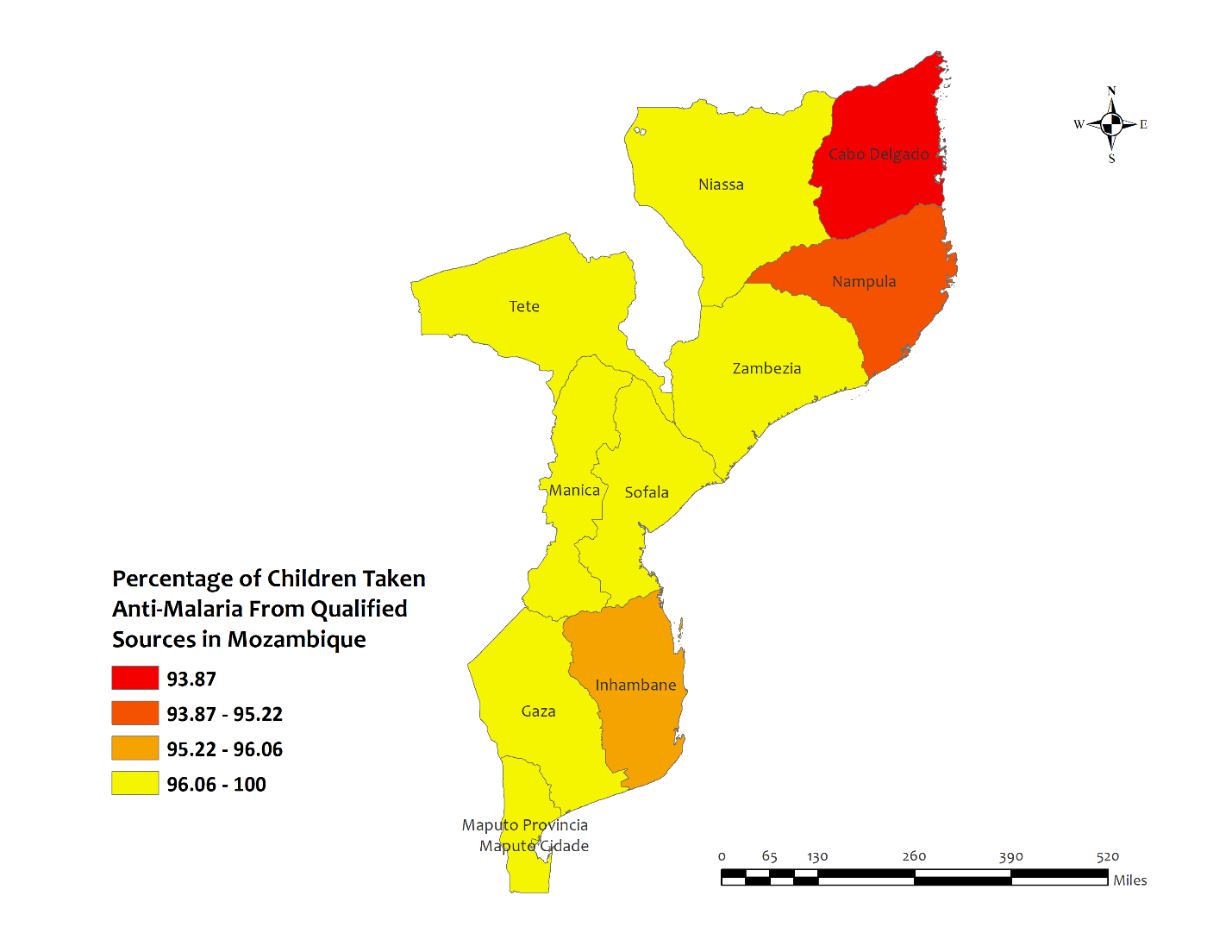
**Figure 3:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Angola

****

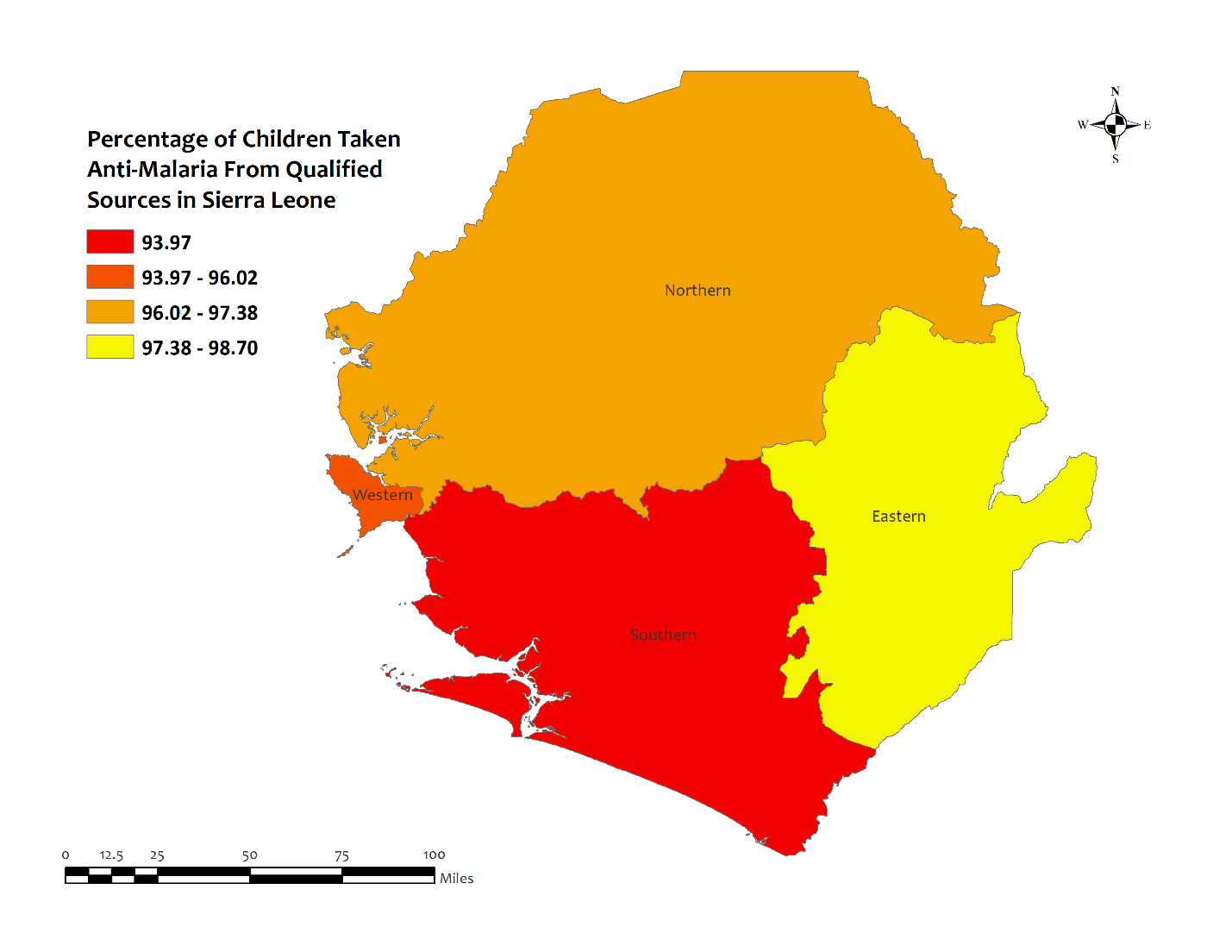
**Figure 4:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Burkina Faso



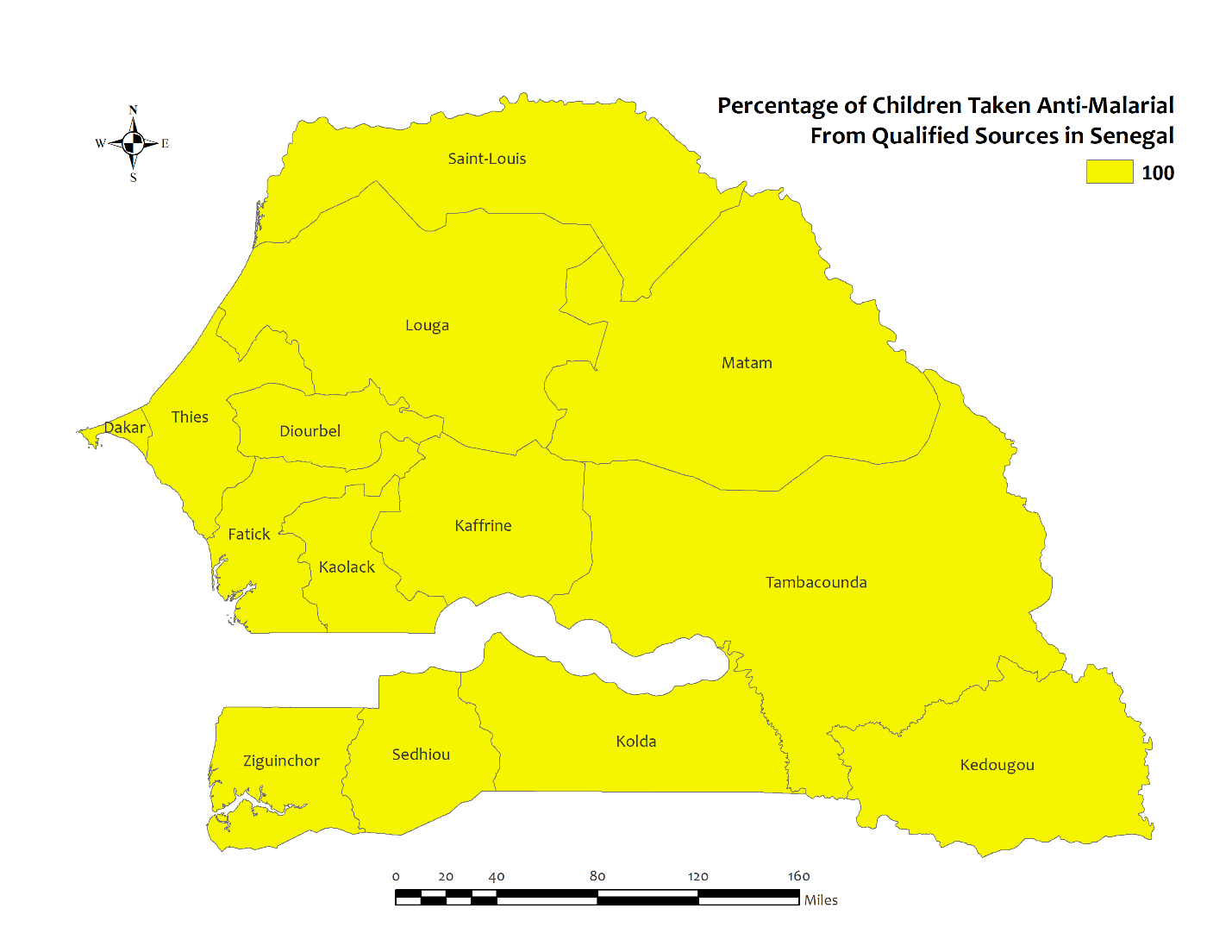
**Figure 5:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Mozambique



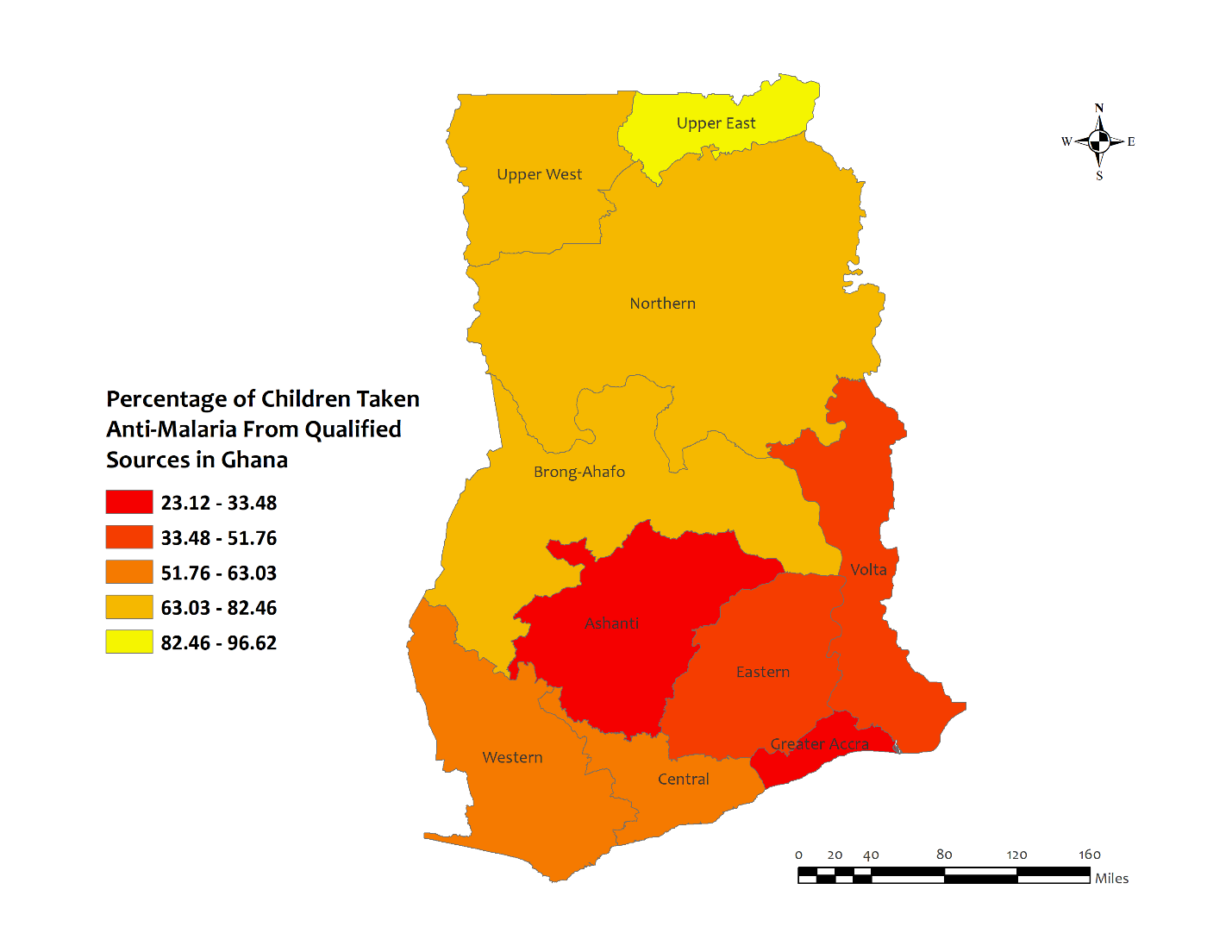
**Figure 6:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Sierra Leone



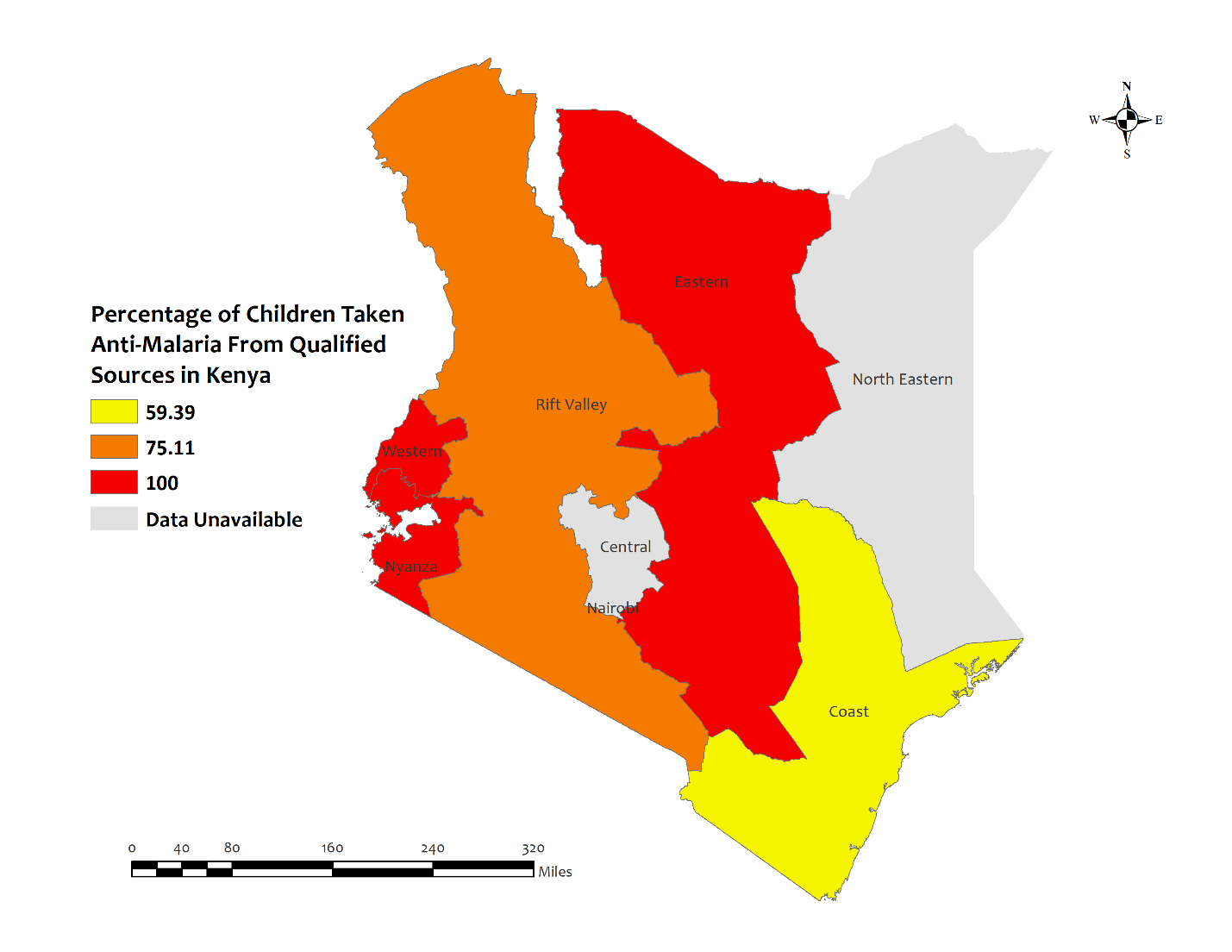
**Figure 7:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Senegal

****

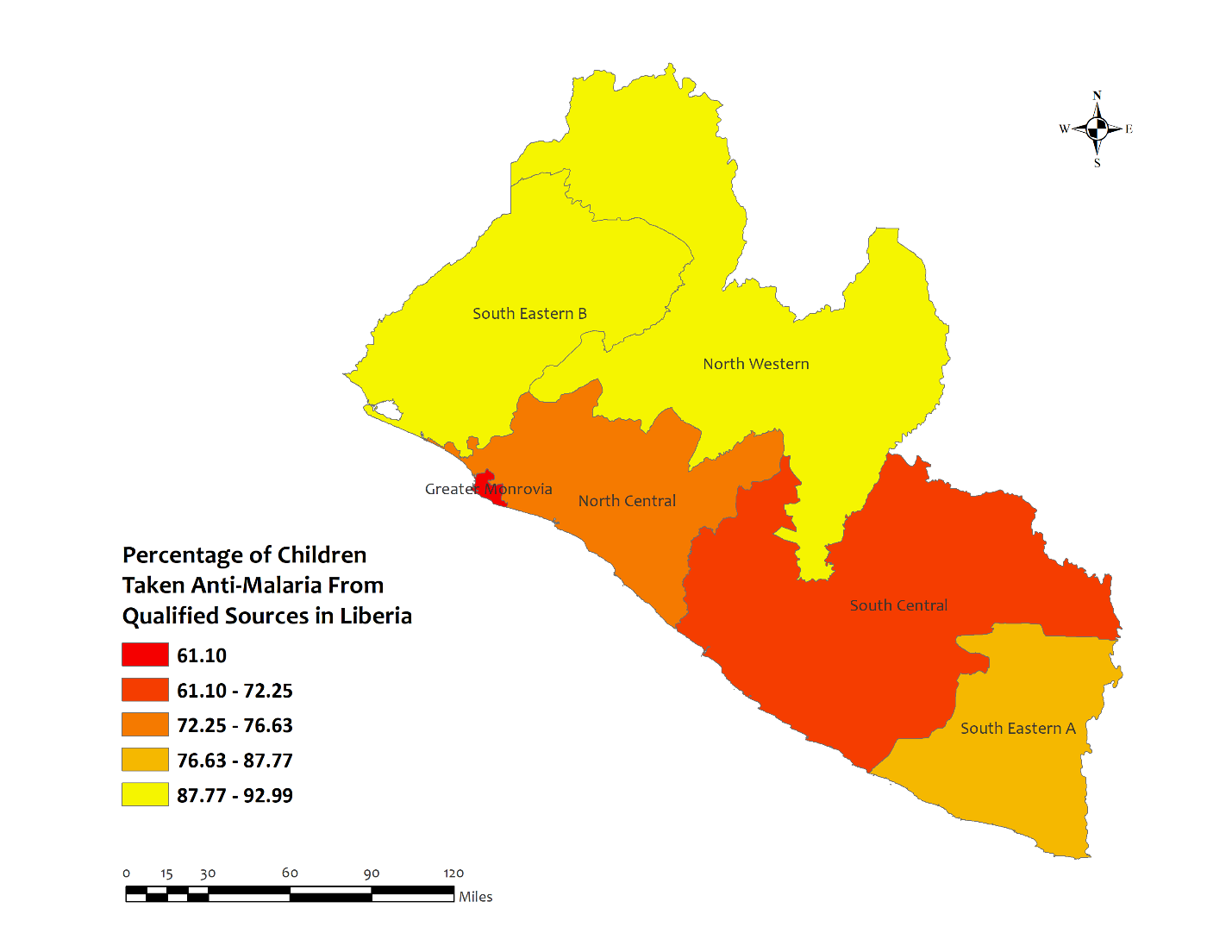
**Figure 8:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Ghana

****

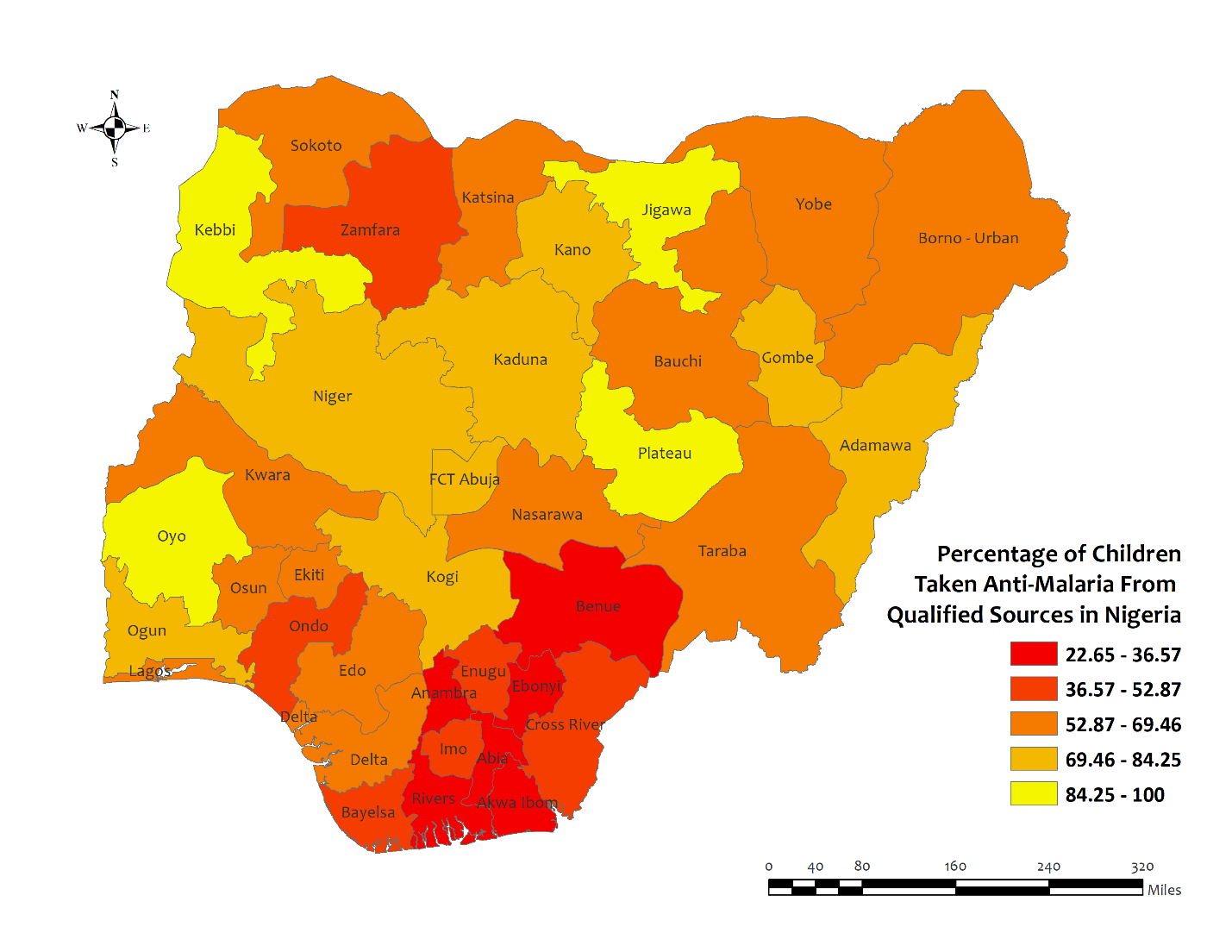
**Figure 9:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Kenya

****

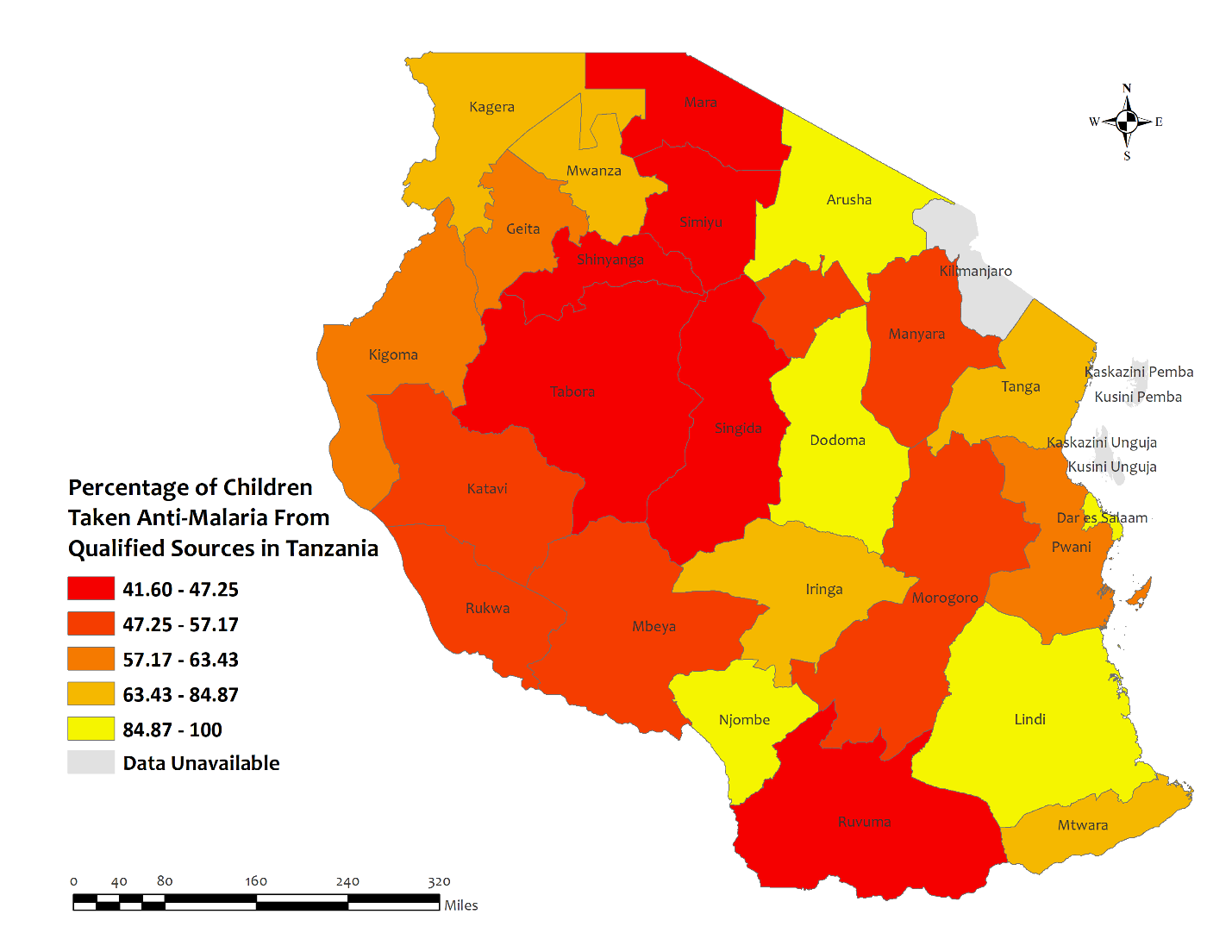
**Figure 10:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Liberia

****

**Figure 11:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Nigeria

****

**Figure 12:** Region-wise Prevalence of Qualified Prescription of Antimalarial from Qualified Sources in Tanzania

****