A Systematic Analysis of the Malaria Situation in the Republic of Côte d'Ivoire

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Abstract

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Background: Consistent with the Global Burden of Disease, malaria in Côte d'Ivoire is ranked as the first cause of mortality for both gender and all ages, before maternal and neonatal mortalities and tuberculosis, respectively. In Côte d'Ivoire, 100% of the country's population is at risk of being exposed to the disease, specifically children under five, pregnant women, and immunocompromised individuals; malaria cases in Côte d'Ivoire represent 3% of the global malaria case incidence rate and 2% of global malaria deaths. Despite unprecedented progress in malaria prevention and control in Côte d'Ivoire, malaria incidence has been stagnating during the last five years, showing a slight increase from 260 cases per 1000 inhabitants in 2015 to 300 cases per 1000 inhabitants in 2019. The goal of this systemic analysis in Côte d'Ivoire is to provide an overall description of malaria indicators, discuss gaps in malaria control interventions, how such interventions are financed, and identify barriers for decreasing malaria trends in the country.

Methods: In this study, we used the following research terms to search for articles and deliverables: "malaria in Ivory Coast," "paludisme Côte d'Ivoire." We searched six databases and search engines; the review, selection, and validation of records were performed through title and abstract analyses. We then undertook a further review of specific themes related to malaria control in Côte d'Ivoire.

Results: For this study, the author reviewed a total of 268 peer-reviewed articles. A total of 52 articles met our inclusion criteria; in addition to these, we used 37 documents from grey literature that were validated after consultation with public health experts in Côte d'Ivoire. There was evidence of progress in malaria control in Côte d'Ivoire, however, more research on malaria burden is still needed with improved surveillance tools.

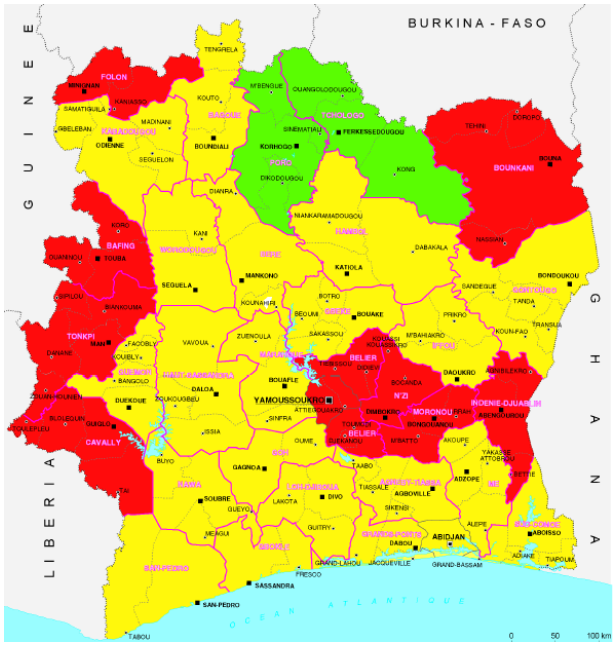
Conclusions: Malaria is endemic in Côte d'Ivoire, with high endemicity in some provinces. Due to its ubiquity, multiple actors have come together to combat the disease, including the National Malaria Control Program, international partners, and local organizations. Despite the substantial progress in vector control and case management of malaria in Côte d'Ivoire in recent years, malaria target indicators among children under five and pregnant individuals remain unachieved and stagnant. While investigating malaria burden in Côte d'Ivoire, we noticed a lack of publications that describe indicators, strategies, and gaps within malaria control interventions in the last five years. We conclude that continuing to improve the currently implemented strategies, increasing their reach, and further financing of malaria research in Côte d'Ivoire is crucial for better understanding and control of malaria in the country.

1. INTRODUCTION

According to the World Health Organization (WHO), in 2019 there was an estimated 229 million new cases of malaria worldwide, and 409,000 people died of it. Despite a large decline in the malaria case incidence rate globally, from 70 cases to 57 cases per 1000 inhabitants in 2019, the WHO milestone of 35 malaria cases per 1000 inhabitants in 2020 as promoted by the Global Technical Strategy (GTS) for malaria has not been achieved. Many countries remain endemic, especially those in the African region, where 94% of malaria cases and deaths occurred in 2019. Eleven countries in the African region have recorded an increase in malaria case incidence in 2020 compared to 2015. Côte d'Ivoire is one of the eleven countries where malaria cases have increased from 260 cases per 1000 inhabitants in 2015 to 300 cases per 1000 inhabitants in 2019. Globally, malaria in Côte d'Ivoire represents 3% of malaria cases and 2% of malaria deaths (1).

Malaria in Côte d'Ivoire is endemic across the country (Figure 1) and 100% of the country's population is at risk of being exposed to the disease. It represents a major public health challenge, as it is the primary cause of mortality during the last ten years; malaria in Côte d'Ivoire represents 16.1% of total deaths, 15.8% of total DALYs, and 21.6% of children under five mortalities (2).

Figure 1: Malaria endemicity in Côte d'Ivoire 2015(46).



The annual report of the National Malaria Control Program (NMCP) in Côte d'Ivoire stated there were more than 4 million confirmed malaria cases in 2020, and more than 2 million of these cases were children under five years old (3). In addition to its elevated rates morbidity and mortality, malaria has a major socio-economic burden in Côte d'Ivoire with a negative impact on the workplace: 37% of malaria cases in Côte d'Ivoire in 2014 were among employees, justifying 121 months of workplace absences, and an overall cost of 1.2 million euro (4).

Public health authorities, international donors, and local organizations in Côte d'Ivoire have been working for years implementing interventions and programs in an attempt to mitigate the high prevalence and impact of malaria in the country. Predominantly this has been done through malaria vector control, malaria case management, and the administration of intermittent preventive treatment to pregnant women (IPTp) (5). Despite these efforts to achieve the goals of the malaria control strategic plan, malaria disease outcomes have stagnated in recent years, with confirmed malaria deaths decreasing only from 3261 in 2013 to 3222 in 2017 (6). Furthermore, the COVID-19 pandemic and its restrictions have disrupted malaria services globally, and particularly in the African region. Malaria diagnosis, case management, and vector control mass campaigns were disrupted and delayed in Côte d'Ivoire for the year 2020. This disruption in the delivery of malaria health services likely explains the slight decrease of malaria testing in Côte d'Ivoire in 2020 (3).

To our knowledge, there has not been a published systematic analysis to examine the situation of malaria in Côte d'Ivoire for the last six years. The goal of this systemic analysis is to provide an overall description of malaria indicators and financing of malaria programs, to discuss gaps in malaria control interventions, to note what is causing delays in decreasing malaria trends in the country, and to characterize available resources to sponsor malaria control programs in the Côte d'Ivoire. A better understanding of the malaria situation in the country may open doors for future collaboration with stakeholders and help local organizations to assist in alleviating the burden of malaria in the country.

2. METHODS

The protocol for this systematic analysis was developed according to the STROBE (Strengthening The Reporting of Observational Studies in Epidemiology)(7) guidelines for the observational studies and the CONSORT guidelines (Consolidated Standards of Reporting Trials)(8) for the randomized control studies.

For the literature search we used as relevant terms: "malaria OR paludisme" AND "Côte d'Ivoire OR Ivory Coast" AND "year = 2014 – 2021." These search terms were used to query each of the databases used. We considered papers in peer-reviewed journals, governmental reports, international donors documents, epidemiological bulletins, fact sheets, deliverables from local organizations, and other relevant sources where searches were possible. We conducted a comprehensive search through scientific databases and grey literature, including Google Scholar, PubMed, ScienceDirect, ClinicalTrials.gov, WHO Global Health Observatory data repository, and Google. Additionally, we were able to partner with a local organization in Côte d'Ivoire to provide access to governmental documents that were not published or accessible from public websites.

Published and unpublished studies, including longitudinal studies, case-control studies, cross-sectional, and randomized controlled trials (RCTs) studies, were included if they studied participants living in Côte d'Ivoire; data were included as relevant sources if they referenced malaria/paludisme in Côte d'Ivoire and offered means to both understand and evaluate the impact of the disease in the country from 2014 to 2021. Studies and data sources in French were included as well. Sources describing the same findings or duplicate data on malaria in Côte

d'Ivoire were further analyzed and only the source that was the most comprehensive and up to date was included.

The author selected studies after screening titles and abstracts through the covidence.org platform for systematic review management, where duplicates of published papers were removed automatically, and the retrieved articles were classified as accepted or rejected for this study (9). Sources considering malaria in countries other than Côte d'Ivoire, animal studies, non-English and non-French sources, thesis, single case studies, and publications published before 2014 were also excluded from this assessment. Other relevant sources retrieved from grey literature were verified with AACODS Checklist (Authority, Accuracy, Coverage, Objectivity, Date, Significance) for accuracy and significance (10).

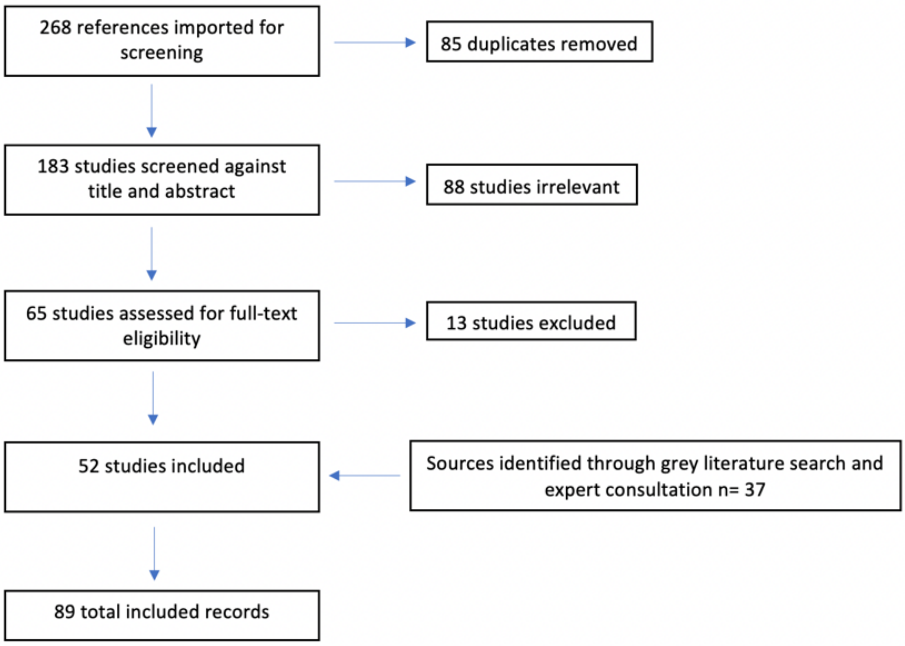
Data searches were performed initially through the advanced search option in research databases, after those sources were classified based on the inclusions criteria. The quality of the included data sources was verified with the assistance of the IRAA (Institut de Recherche et d'Action en Afrique) organization advisory team in Côte d'Ivoire. Data sources were collected and classified using Zotero 5.0 software for citations management.

Data extraction from selected sources was based on six themes: malaria vector control (i.e., long-lasting bed net distribution and indoor residual spraying), malaria case management, malaria treatment, malaria in pregnant women, behavioral change, malaria surveillance, and donors for malaria funding in Côte d'Ivoire, such as the National Malaria Control Program, The Global Funds, and U.S. President's Malaria Initiative. These themes are selected according to the WHO Global Malaria Program (11) and the sources retrieved accordingly to the aforementioned protocol.

3. RESULTS

In this study the author reviewed a total of 268 peer-reviewed articles from scientific databases. Duplicates, sources without access to full text, inaccessible databases, and non-relevant records were excluded after screening titles and abstracts, because they did not fulfill the required inclusion criteria (Figure 2). The study also included data from 52 peer-reviewed articles and 37 documents from grey literature. The reviewed records covered published data and findings on malaria vector control, malaria case management, malaria treatment, prevention of malaria during pregnancy, malaria surveillance, and malaria funding in Côte d'Ivoire from 2014 until 2021.

Figure 2. Diagram depicting search records and data extraction



Among the included records, 24 sources described malaria vector control studies in Côte d'Ivoire, specifically studies on the distribution, ownership, and use of long-lasting insecticidal bed nets (LLINs), as well as the importance of maximizing usage of LLINs and explaining their effectiveness in reducing malaria infection for household members in Côte d'Ivoire (12–17).

Malaria vector control was based on implementing the use LLINs, these bed nets helped in reducing malaria cases in Africa by 68% and it was approved that sleeping under bed nets help in reducing malaria infection risks, especially children under five and pregnant women (54). In Côte d'Ivoire, LLINs are provided to pregnant women for free during ANC visits and to children at schools during immunization campaigns around the year. Also, the NMCP organizes a mass distribution campaign of LLINs every three years. The target of LLINs use coverage for 2020 was 80% for both pregnant women and children under five but, only 74% and 64% were achieved respectively (3). In addition to LLINs for malaria vector control, the NMCP started recently implementing IRS in collaboration with PMI, but this intervention is very limited to two health districts.

IRS is recommended with the use of LLINs by the WHO for malaria vector control in Côte d'Ivoire.There were fewer published studies on IRS. Only two peer-reviewed articles regarding IRS in the country are included in our findings (13, 18). We identified four records including studies on resistance to insecticides used for malaria vector control, environmental management to control malaria transmission, and sanitation (where lack of sanitation was related to high levels of malaria) (20–23). For malaria case management in Côte d'Ivoire, we considered including data on malaria diagnostic methods (i.e., rapid diagnostic testing,

microscopy), malaria transmission dynamics, malaria treatment, and malaria symptoms (i.e., anemia, parasitemia) (24–31).

Malaria treatment in Côte d'Ivoire is based on artemisinin-based combination therapy (ACTs) drugs. Nine articles from the selected records in this study had data on the use of ACTs, traditional medicine, and resistance to some molecules used for malaria treatment in Côte d'Ivoire (30, 32–40). Compared to other antimalarials, ACTs were reported to be highly effective for malaria treatment in high endemicity districts. ACTs were also reported to be efficacious for clearing malaria parasites rapidly in Côte d'Ivoire. However, further monitoring of their effectiveness may be needed to assess possible development of drug resistant cases.

Regarding prevention of malaria in pregnant women in Côte d'Ivoire, we identified three records describing low coverage of intermittent preventive treatment for pregnant women (IPTp) from malaria with Sulfadoxine Pyrimethamine (SP) (42–44). The NMCP in Côte d'Ivoire is adopting the last recommendation of the WHO, which is IPTp for all pregnant women at each scheduled antenatal care visit. The NMCP's target is to provide at least three doses of IPTp SP to all pregnant women across Côte d'Ivoire (45). The selected studies incorporated how much IPTp SP is effective at improving pregnancy outcomes and decreasing malaria impact on maternal and child health. It was recommended that service delivery for IPTp administration must be improved, and that high rates of ANC may not be associated with high IPTp intake.

Behavioral change towards malaria is a priority for the NMCP with a target of 80% of the population of Côte d'Ivoire to be aware of malaria symptoms and to understand that malaria treatment is completely free of charge. The NMCP communication plan focuses on three main interventions: the use of LLINs, receiving at least three doses of IPTp -SP, and malaria services free of charge for everyone in public health care facilities (46). The United States Agency for International Development (USAID) has funded a malaria behavior survey (MBS) to identify determinants of malaria. That survey was developed to better understand the impact of malaria in Côte d'Ivoire and recognize the socio-demographic characteristics associated with malaria outcomes in the country. The topics assessed in that survey included malaria among pregnant women, usage of LLINs, numbers of antenatal care visits, mass distribution campaigns of malaria bed nets, and immunization campaigns associated with malaria prevention (47).
A Multiple Indicator Cluster Survey (MICS) of UNICEF was published in 2016 describing malaria surveillance in Côte d'Ivoire. This special edition of MICS focused on malaria indicators in the country, and specifically anemia and parasitemia prevalence in children under five years of age and pregnant women (48). The NMCP releases annual reports that include achievement of malaria indicator goals, the evolution of implemented activities, the entomological monitoring of malaria vectors, insecticide resistance, and malaria treatment procurement (3). Côte d'Ivoire has a National Strategic Plan for Healthcare Services Development (NSPHD); the NSPHD of 2016-2020 described malaria as a first priority. This strategic plan has an approach for monitoring and evaluation, including monitoring and evaluating programs and interventions to tackle malaria (46).

Another key aspect of this study was to characterize available resources for malaria control programs. Funding for malaria treatment and prevention in Côte d'Ivoire was documented in grey literature including most updated annual reports and documents of the main donors for

interventions and programs to tackle malaria in Côte d'Ivoire. The Global Fund is the first donor of the NMCP in Côte d'Ivoire and has allocated eighteen grants to control malaria in the country since 2003. The Global Fund provides about 40% of the funds allocated to tackle the malaria burden in Côte d'Ivoire. It has different budget documents for governmental financing projects and independent organizations involved with the NMCP. It should be noted that grants allocated by the Global Fund are not usually fully disbursed (49).

The Global Fund supports the strategy of the NMCP and sponsors the Save the Children Organization, which collaborates with other local organizations. Côte d'Ivoire was selected as a partner of the U.S. President's Malaria Initiative (PMI) in the fiscal year 2017, which was officially announced in 2018. In addition to the support of the NMCP interventions, PMI also started implementing IRS in various high malaria endemicity health districts in Côte d'Ivoire (50). The Ivoirian government allocates an annual budget for the NMCP.

4. DISCUSSION

This study reflects a systematic analysis of the scientific and grey literature to describe the malaria situation during the last several years and to understand interventions of the major actors working on malaria control in Côte d'Ivoire.

The author's search revealed that there was fewer number of identified records on IRS compared to LLINs, which can be explained by the fact that this strategy for malaria vector control has not been conducted on a wide scale in Côte d'Ivoire. IRS was only implemented in two districts in 2020, which were areas of high malaria transmission (19). To improve vector control, the results suggest the need for an urgent scale-up of IRS in all endemic districts in Côte d'Ivoire to enforce malaria control and reduce malaria vector transmission (55).

The different NMCP policies and partner support suggested that, for malaria case management, almost all studies and data focused on the importance of malaria diagnostics, including rapid diagnostic tests, blood sampling for microscopy, and serology. Malaria diagnostic tools are recommended for individuals presenting clinical signs or without clinical signs. For malaria case management strategy, the NMCP is prioritizing the use of RDT as a cost-effective malaria diagnostic tool and making it available at the first line of public health care services and Community Health Workers (CHWs) (53). For the population of Côte d'Ivoire, an estimated 6.7 million RDTs are needed every year and they are all funded by the Global Fund and PMI (50). The microscopy diagnostic test for malaria diagnostic is only available at reference health care facilities because only trained technicians are able to perform this test adequately (5). The NMCP needs to work more on implementing microscopy and train more technicians to be able to quantify malaria parasitemia in health districts with a lower prevalence of malaria. Malaria case management in Côte d'Ivoire is totally free of charge. However, according to malaria behavioral survey (MBS), 73% of CHWs in Côte d'Ivoire have charged parents for malaria treatment medication meant for children (47). An emphasis on free malaria treatment is crucial and a national communication plan can be included within the NMCP strategy.

The WHO associates malaria infection in pregnant women with severe symptoms and adverse birth outcomes including low birth weight, premature delivery, miscarriage, and neonatal mortality (41).The intersectionality between the NMCP and NPMCH can be the reason for the

low coverage of pregnant women with three doses of IPTp. For a target of 80%, only 51% achieved of pregnant women who received at least three IPTp doses in 2020. IPTp coverage has known small progress since its implementation and the number of ANC is not associated with IPTp administration (43,49). Targets of indicators like the coverage of IPTp need to be more realistic and the NMCP must collaborate more with other national health programs to harmonize malaria control interventions when interventions are interdependent. Malaria surveillance was missing in our study, except for a few documents describing achievements of strategic plan indicators.

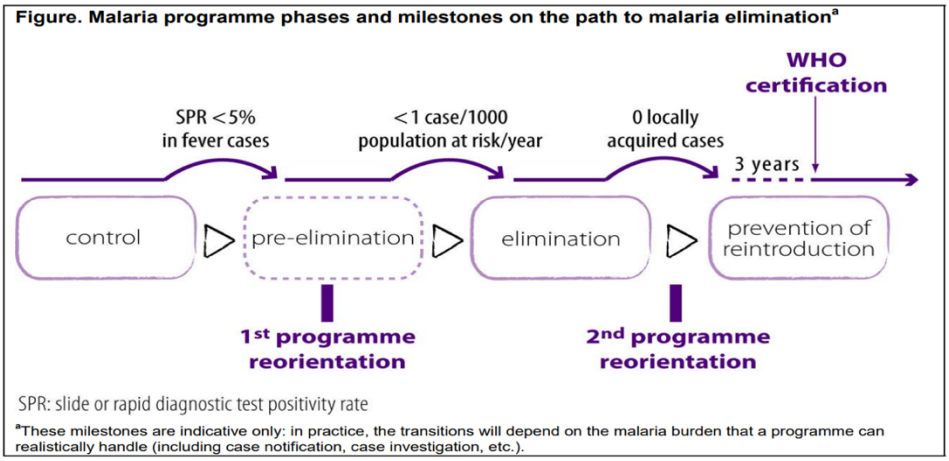
Despite the substantial progress in declining malaria in Sub-Saharan Africa and the increase of malaria control financing since the year 2000 , malaria remains a leading cause of morbidity and mortality in many countries including Côte d'Ivoire (51). However, most malaria research investment in Sub-Saharan Africa was focused only on a minority of countries. Tanzania and Kenya received, respectively, 170 and 148 research awards for malaria research, compared to 11 awards for malaria research in Côte d'Ivoire, and at a substantially lower level of funding. Smaller amounts of malaria research are also associated with low funding for malaria control from the international community and big donors. Research investment for malaria control in Côte d'Ivoire was limited despite the high malaria-related burden of disease, thus neglecting malaria research in Côte d'Ivoire could delay the achievement of malaria control objectives and the transition of the country from control phase to pre-elimination of malaria phase (52).

With regard to funding for malaria control in Côte d'Ivoire, the three main sources in order of magnitude are the Global Fund, PMI, and Côte d'Ivoire government. With the Global Fund, only 33% of the allocated grants were disbursed in 2019, indicating an availability of more resources for control. This study has several limitations, including data collected from governmental authorities in which authors have an interest in reporting achievements and success of interventions, possibility of missing articles, unpublished analyses by the NMCP and non-governmental organizations. Data collected in this study could have been more complete in entomological surveillance and the impact of climate change on malaria burden in Côte d'Ivoire. Further studies including interviews with NMCP officials or donors to understand some of the more subtle issues behind decisions regarding malaria control policies, implementation, and funding. Also, COVID-19 pandemic has limited our communication with authors of relevant documents and responsible at the NMCP and its partner's representatives in Côte d'Ivoire.

5. CONCLUSION

This systematic analysis will help to better understand the malaria situation and key actors in Côte d'Ivoire and how to improve strategies to reduce malaria burden in the country. The NMCP has made significant progress towards malaria control, however, this progress has slowed down or stagnated during the last years. Working on malaria research in Côte d'Ivoire is critical for a better assessment of malaria gaps and to explain why targets are becoming difficult to achieve. Also, malaria in Côte d'Ivoire should be a public health priority to move the country from a malaria control status to pre-elimination status in the next years (Figure 3). Furthermore, funding can be available to local organizations so they could be involved as major players in malaria projects and help fill the gap regarding the lack of research on local malaria problematics to develop local solutions.

Figure 3 The WHO classification phases of the progress in malaria elimination (56).



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