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Impact of the COVID-19 Pandemic on the Malaria Control Program at the Epidemic Treatment Center of Regional Hospital of Kindia, Guinea

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Abstract

The impact of infectious disease outbreaks and pandemics on the health systems could be alarming especially when there is an overlap in clinical manifestations of two infectious conditions. Despite the remarkable progress in reducing the burden of malaria in Africa since 2000, the COVID-19 pandemic has impacted the malaria control program. This paper describes the impact of the COVID- 19 pandemic on the health service delivery in Guinea and its consequences on malaria control programs before and during the COVID 19 pandemic. This paper aims to assess the impact of the COVID 19 pandemic on the malaria control program between 2020 to 2021 in the Regional Hospital of Kindia and identify its deficiencies to suggest effective recommendations. The study also compares the clinical manifestation of malaria and COVID 19 disease.

Keywords: Malaria, Covid 19, Impact, Control, Recommendations.

Table of contents

Abbreviations

ABBREVIATIONS	DEFINITIONS
ACT	Artemisinin-based Combination Therapy
ANC	Antenatal Consultation
CFR	Case Fatality Rate
COVID-19	Coronavirus Infectious Disease
ETC	Epidemic Treatment Center
ITN	Insecticide-Treated Net
RDT	Rapid Diagnostic Test
RHK	Regional Hospital of Kindia
SAS	Analytical software used to perform descriptive and statistical analysis
SP	Sulfadoxine-Pyrimethamine
Sr. No	Serial number

CHAPTER 1: INTRODUCTION

Coronavirus infectious disease (COVID-19) is an outbreak caused by a novel coronavirus called severe acute respiratory syndrome. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was announced in Wuhan, China, in early December 2019, and the disease was later referred to as COVID-19 (Wei M et al., 2020). The COVID-19 disease is mainly transmitted through three principal ways of exposure: inhalation of droplets and aerosol particles, deposition of respiratory droplets and particles on exposed mucous membranes in the mouth (nose, or eye by direct splashes and sprays), and direct contact of the mucous membranes with soiled hands by virus-containing respiratory fluids or indirectly by touching surfaces with the virus on them (Wei M et al., 2020). COVID-19 symptoms appear within five days of infection and are characterized by fever, coughing, fatigue, headaches, arthralgia, myalgia, nausea, vomiting, and loss of smell. The disease can be asymptomatic sometimes (Hussein et al.,2020).

According to Rogerson and al., the COVID-19 pandemic has affected millions of people, hundreds of thousands of deaths, and led to socio-economic disruption, the limitation in the manufacturing, the supply, and the delivery of malaria control resources such as drugs, bed nets, rapid diagnostic test kits, and insecticide within Africa due to movement restrictions. These restrictions contribute to a remarkable decrease in insecticide-treated net (ITN) distribution (75%) associated with a 75% decrease in access to artemisinin combination therapies (ACT). The malaria prevalence and mortality rate were respectively estimated to be 22% and 769,000 per year including 70% of children under 5 years old in 2020 (Rogerson et al.,20 20).

In addition to the high prevalence and mortality rate, the socio-economic impacts, and the disruption of the supply chain of malaria control resources, the COVID 19 pandemic also

contributes to the limited access to primary care and hospitalization, the disruption of the workforce, health-system administrators, and logistics in Africa (Weiss et al. 2021).

Malaria disease is caused by parasites of the genus Plasmodium transmitted through the bite of infected female Anopheles mosquitoes. Malaria symptoms often appear 10-15 days after the mosquito bite and are characterized by a fever, headache, chills, sweating, fatigue, and diarrhea (Hussein et al.,2020). Malaria represents the leading cause of morbidity and mortality in sub-Sahara Africa. According to Ajayi et al. in 2020, 228 million cases and 405, 000 malaria-related deaths occurred globally with 93% of cases in Sub-Sahara Africa (Ajayi et al. 2020).

In Guinea, malaria represents the leading cause of mortality and morbidity. The incidence of malaria cases is estimated at 87 per 1,000 and the overall mortality rate of malaria is 41% for adults over 15 years (52% males, 30% females), and infants and children under five years old mortality rates are respectively 44 and 88 per 1,000 live births in 2016(Cherif et al.,2021).

Before March 13, 2020, the progress in insecticide-treated net (ITN) distribution, malaria testing, and malaria treatment programs considerably reduced the burden of malaria in Guinea (Cherif et al.,2021). From 2016 to 2019. the household ownership of at least one ITN increased from 47% to 84% while the proportion of households with at least one ITN for every two people increased from 10% to 48%. (Severe Malaria Observatory,2021). The percentage of pregnant women who received two or more doses of intermittent preventive treatment Sulfadoxine-pyrimethamine (SP) in pregnancy during their last pregnancy in the last two years increased from 49% to 62% and from 30–to 36% for those who received three or more doses. About 2.7 million courses of ACT and 3 million rapid diagnostic tests (RDT) were annually distributed (Severe Malaria Observatory,2021). These major interventions of malaria control programs reduced the

prevalence and mortality rate of malaria. The prevalence of malaria was reduced by 12.6% (from 340 to 297 per 1000 of the population at risk) and the mortality rate fell by 12% (from 0.73 to 0.64 per 1000 of the population at risk). The prevalence of malaria in children under 5 years and pregnant women was respectively estimated to be 37.3 % and 3.9 % (Severe Malaria Observatory,2021). Since the official declaration of the COVID-19 disease in Guinea on March 13, 2020, the ongoing pandemic continues to contribute to the disruption of malaria control activities affecting the burden and the treatment of malaria, the decrease in health facilities, and healthcare professional utilization in Guinea. The number of suspected malaria cases increased by 2.6% (from 3,334,355 in 2019 to 3,422,309 in 2020) and the number of RDT confirmed positive cases increased by 10.9% (1,801,694 vs 1,998,329) (Cherif et al. 2021).

Based on the health facilities' utilization, the COVID-19 pandemic contributes to a decrease of 71.1% (320 patients) in consultation and 75% (35 patients) in hospitalization in the cardiology service of the Ignace Deen National Hospital of the Conakry University Hospital, Guinea from March to April 2020 (Barry et al., 2021).

In the Regional Hospital of Kindia, the high mortality and morbidity from malaria during the COVID-19 pandemic is due to poor quality of equipment, poor access to diagnosis, treatment, healthcare services, and professionals. This paper aims to assess the impact of the COVID-19 pandemic on the burden of malaria disease, evaluate and identify the deficiencies of malaria control programs during COVID-19 pandemic restrictions, and suggest effective recommendations that could improve malaria control programs based on the literature.

Specific aims
Aim 1: Describes malaria-related outcomes during the pandemic and compares them to historical patterns for malaria services performance.

Aim 2: Assess access to and provision of malaria-related services during the COVID-19 pandemic and compares them to the historical patterns of malaria services performance

Aim 3: Apply analytic outputs to identify potential areas for malaria program improvement in the pandemic setting

Significance

The scientific premise of this research has been based on the concern of the overlap of COVID-19 symptoms and malaria leading to delay in treatment, the limited equipment and resources for healthcare workers, inadequate infrastructure to address malaria, and other infectious diseases, poor access to healthcare services and health professionals during the pandemic, and the lack of scientific study related to such topic at the Regional Hospital of Kindia.

CHAPTER 2: METHODOLOGY

This study is a retro-prospective descriptive analysis. The data used in this study were collected during routine public health reporting from the Regional Hospital of Kindia. This constituted monthly, aggregate reports of de-identified information including malaria, and COVID-19 cases.

Dependent variables

Dependent variables included at-risk classification (age $\leq$ 5 years, age >5, pregnant women), the number of malaria cases (outpatients, hospitalized persons, deaths), the number of COVID-19 cases(at Kindia and nationally), the number of ITN distributed, the number of SP received by pregnant women, the number of people reached by the awareness sessions (awareness rate), the number of first antenatal consultations, the number of cases tested positive by microscopy and those positive(Microscopy +), the number of cases tested by RDT positive and those positive, respiratory infections identified (cough, cough > 2 weeks, pneumonia and severe pneumonia), and medical supplies consumed(ACT, Quinine, RDT).

Independent Variables: Date expressed in year-month format.

Inclusion criteria

Eligibility criteria included participants received in the Regional Hospital of Kindia with all malaria positive cases (suspected and confirmed) before the COVID-19 pandemic (March 1, 2019, through February 29, 2020) and during the COVID-19 pandemic (April 1, 2020, through March 31, 2021); all COVID -19 positive cases that were received from April 1, 2020, through March 31, 2021.

Data collection

For the analysis, data were collected from March 1, 2019, to March 31, 2021, so that a sufficient period both before (March 1, 2019, through February 29, 2020, representing 366 days of observation) and during the COVID-19 crisis (April 1, 2020, through March 31, 2021, representing 365 days of observation). March 2020 was excluded from analyses because that was the month in which the pandemic was recognized in Guinea, and to avoid overlap. Data collection included 17,403 malaria cases before the COVID-19 pandemic, and 32,467 malaria cases during the pandemic based on positive results from both microscopic and RDT performed on pregnant women, children ≤ 5 years, and patients over 5 years old.

Study Procedure

To assess the impact of the COVID-19 pandemic on the malaria control program in the regional hospital of Kindia, a descriptive analysis was conducted on each variable over time (monthly) and examined individually and as an aggregate. Multiple time series were constructed to understand the burden of reported malaria cases across the time and COVID-19 cases or case rates (as reported). Descriptive and summary statistics were conducted to describe malaria service, prevention, and malaria treatment utilization before and after the onset of COVID-19. In addition, the Wilcoxon Signed Rank Test was employed to analyze the changes observed between the period before COVID-19 and during the COVID-19 pandemic. Statistical significance was defined as $P < 0.05$ and SAS version 9.4 was used for statistical analysis.

FACILITIES

Kindia Region is limited to the northwest by the region of Boké, to the northeast by the region of Labe and Mamou, to the southeast by Sierra Leone, and the southwest by the Conakry region, and by the Atlantic Ocean (Figure 1). Regional Hospital Kindia (HRK) called « Hospital

Regional Alpha Oumar Diallo de Kindia » is a public hospital located in the Kindia Region 135-kilometer squares from Conakry, the capital of Guinea. HRK covers three other hospitals (Foreciah, Coyah, Telimele, Dubreka). The Regional Hospital of Kindia has a capacity of 120 beds distributed to four medico-techniques and six medical structures including the Epidemic Treatment Center (ETC). ETC of Kindia with a capacity of 15 beds is constituted of one trial center, three hospitalization rooms, a consultation room, and the annex that includes toilettes, laundry, a mortuary room, and an incinerator. This facility has three objectives: research, healthcare services, and training. The TC has seven (07) staff that include two (02) physicians, four (04) nurses, and one (01) maintenance person.

Figure 1: Geographic Situation of Regional Hospital of Kindia

CHAPTER 3: RESULTS

1-MALARIA SERVICE UTILIZATION BEFORE AND DURING THE COVID-19
PANDEMIC

Malaria service utilization across the study period is shown in Figure 2 below. The

multiple times series plots show an increase in the number of consultations (overall malaria

cases) with multiple fluctuations before the COVID-19 pandemic (from January 2019 through

February 2020) while the number of hospitalized patients slightly increases from April 2019 to

December 2019. During the COVID-19 pandemic, the number of consultations drastically

decreased from March 2020 to Jun 2020 and then increased while hospitalizations were

relatively stable but higher from Nov 2020-Mar 2021 compared to Mar -Oct 2020 period.
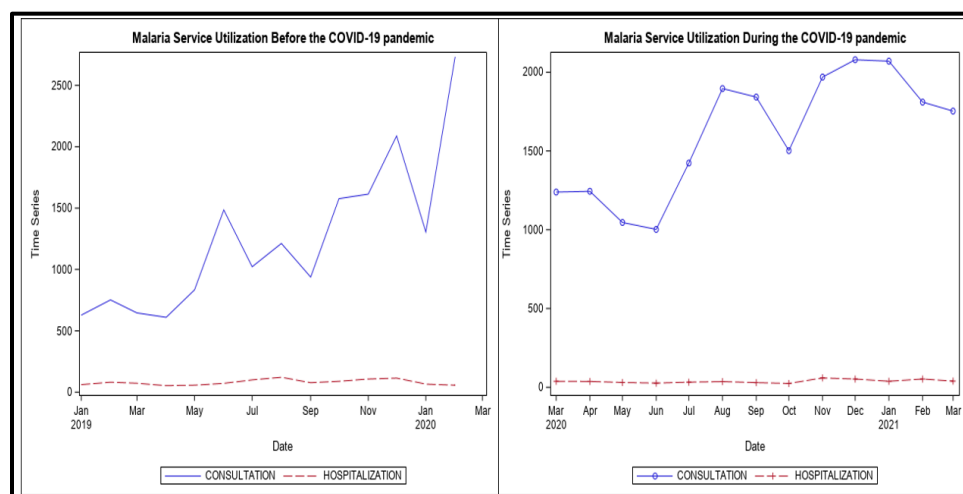
Figure 2: Malaria Sevice utilization before and during the COVID-19 pandemic.

2- MALARIA AT-RISK CLASSIFICATION BY CATEGORY

In total, combining both microscopic and RDT results 17,403 malaria cases were

confirmed before the COVID-19 pandemic, and 32,467 malaria cases were confirmed during the

pandemic. This represents a test positivity rate of 93% (17,403/18,683) in the pre-pandemic

period and 99.86% (32,467 /32,512) in the pandemic period. Before the COVID-19 pandemic,

6178 (35%) of malaria cases occurred in children aged 5 years or younger, 9,002 (52%) among

patients over 5 years old, and 2,223 (13%) in pregnant women. During the COVID-19 pandemic, 6,743 (21%) malaria cases occurred in children aged 5 years or younger, 643 (2%) among patients over 5 years of age, and 25,081(77%) occurred in pregnant women. Malaria-related deaths of both patients aged 5 years or younger, and over 5 years increased from 27 (42%) to (38 46%), and 25 (38%) to 33 (40%) respectively. However, the number of pregnant women who died from malaria declined from 13(20%) to 11(13%). The case fatality rate (CFR) in patients over 5 years was 5.13%. Patients ≤ 5 years and pregnant women had a CFR equal to 0.56% and 0.04% respectively (Table 1). To test the statistical significance of the changes in malaria cases and deaths among at-risk populations in Kindia, a Wilcoxon Signed Rank Test was performed. This study revealed a statistically significant increase in malaria cases diagnosed among pregnant women (Z=2.21, P=0.03). However, the change observed among patients aged 5 years or younger (Z=1.12, P=0.26) and older than 5 years (Z=1.43, P=0.15) did not reach statistical significance. A statistically significant change was observed in malaria-related deaths among both patients aged 5 years or younger (z=2.72, P=0.01) and those over 5 years of age (z=2.4015, P=0.02). Nevertheless, no statistically significant differences were observed among pregnant women (Z=0.34, P=0.74).

Table 1**:** Malaria case counts and distribution by age and Pregnancy status

Date	At-risk Classification	Cases	Percentage	Deaths(%)	CFR(%)
Before COVID-19	≤ 5 years	6,178	6,178(35%)	27(42%)	0.44
	Over 5 years	9,002	9,002(52%)	25(38%)	0.28
	Pregnant women	2,223	2,223(13%)	13(20%)	0.58
During COVID-19	≤ 5 years	6,743	6,743(21%)	38(46%)	0.56
	Over 5 years	643	643(2%)	33(40%)	5.13
	Pregnant women	25,081	25,081(77%)	11(13%)	0.04

3-MALARIA TESTING AND TREATMENT UTILIZATION

In malaria testing and treatment utilization activities, the disruption of malaria service was assessed both before and during the COVID-19 pandemic. There was an increase in the distributions of ACT (449 vs 672), Quinine (110 vs 476), and RDT (223 vs 350) during the COVID-19 pandemic. Using Wilcoxon signed-rank test, statistically significant increases in the ACT (Z=2.40, P=0.0162) and Quinine consumption (Z=3.70, P=0.0002) were observed during COVID-19. Nevertheless, the change in RDT consumption did not reach statistical significance (Z=1.73, P=0.08) (Table3).

Table 3: Malaria Diagnostic and Treatment Supplies Consumed by Month

Date	Items	Months	Minimum	Mean	Maximum
Before COVID-19	ACT	14	67.00	448.50	820.00
	Quinine	14	0.00	110.14	430.00
	TDR	14	58.00	223.29	427.00
During COVID-19	ACT	13	120.00	671.54	1102.00
	Quinine	13	160.00	475.38	1290.00
	TDR	13	82.00	349.46	1190.00

4-PREGNANCY AND MALARIA PREVENTION

A malaria service disruption was assessed based on the number of ITNs distributed, the number of SPs distributed, awareness rates, and the first ANC. Results indicate that awareness rates decreased (593 vs 552) the number of ITNs decreased (113 vs 90), and the first ANC decreased (165 vs129) during the COVID-19 pandemic. Also, we noted a decrease in the number of pregnant women receiving SP in each of the four groups: 1 dose of SP distribution (140 vs139), 2 doses of SP distribution (112 vs 109), 3 doses of SP distribution (101 vs 93), and 4 doses of SP distribution (from 77 vs 68). The Wilcoxon Signed Rank Test was used to determine whether COVID-19 affected awareness rates, ITN distribution, SP distribution, and the first. The test revealed a statistically significant decrease in 3 doses of SP distribution (101 vs 93) (Z=-1.99, P= 0.05), and the first ANC (165 vs129) (Z=-3.26, P=0.001) (Table 2, Figure 5). However,

there was a statistically non-significant decline in ITN distribution (Z=-1.24, P= 0.22), awareness

rate (Z=-1.34, P=0.18), one dose of SP (Z=-1.14, P= 0.25), two doses of SP (Z=-1.04, P= 0.30),

and four doses of SP distribution (Z=-0.85, P= 0.40).

Table 2: Pregnancy and Malaria Prevention

| Date	Variable	Months	Minimum	Mean	Maximum
Before COVID-19	First ANC	14	134.00	165.43	190.00
	Awareness rate	14	413.00	592.64	694.00
	ITNs distributed	14	20.00	112.79	203.00
	1 dose of SP	14	29.00	139.86	179.00
	2 doses of SP	14	42.00	112.00	146.00
	3 doses of SP	14	25.00	101.29	123.00
	4 doses of SP	14	23.00	77.43	111.00
During COVID-19	First ANC	13	35.00	128.92	168.00
	Awareness rate	13	356.00	551.54	688.00
	ITNs distributed	13	46.00	90.46	128.00
	1 dose of SP	13	96.00	139.08	157.00
	2 doses of SP	13	90.00	109.23	123.00
	3 doses of SP	13	72.00	93.08	115.00
	4 doses of SP	13	40.00	68.38	123.00
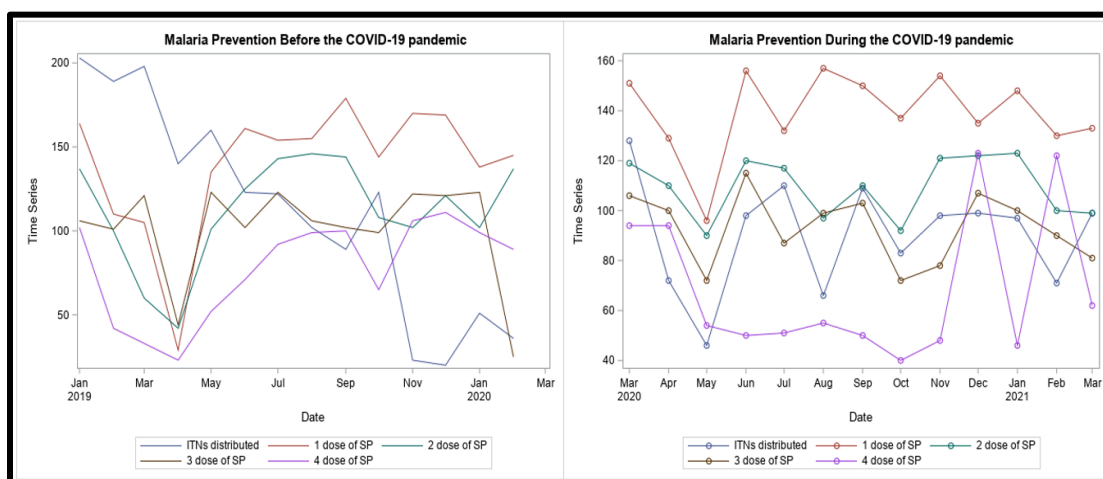
Figure 5: Pregnancy and Malaria Prevention

5-COMPARISON OF MALARIA CASES TO COVID -19 CASES

The graph shows a slight increase in the number of malaria cases from March 2020 to April 2020 and then drastically decreased from April 2020 to Jun 2020 while the number of COVID-19 cases increased. From April 2020 to February 2021, the number of COVID-19 cases decreased with multiple fluctuations (Figure 3).
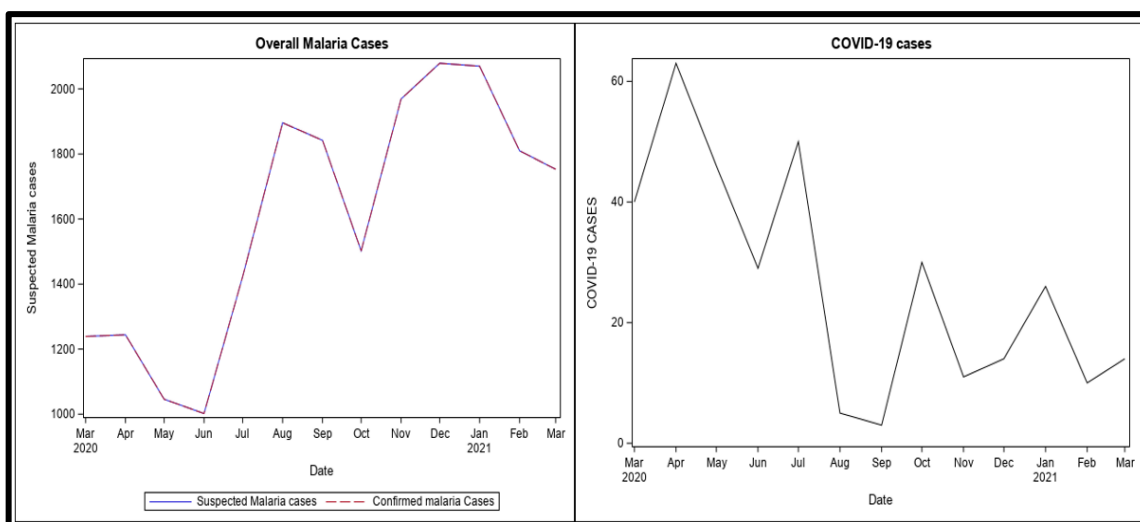

Figure 3: Comparison of Overall Malaria cases to COVID-19 cases

6-DISTRIBUTION OF RESPIRATORY INFECTIONS

The descriptive statistics indicated an increase in respiratory infections between the pre and during the COVID-19 pandemic. According to the data, the number of coughs, coughs >2 weeks, pneumonia, and severe pneumonia respectively increased (2 vs 4), (1vs 3), (0 vs 2), and (5 vs 8) (Table 4). The Wilcoxon Signed-Rank Test revealed statistically significant positive changes in cough >2 weeks (Z=3.50, P=0.0005), and in pneumonia (Z=2.5860, P=0.01). In contrast, the change in cough (Z=1.85, P=0.06) and severe pneumonia (Z=1.22, P=0.22) was not statistically significant.

Table 4: Descriptive Statistic of Respiratory Infections

Date	Variables	N	Minimum	Mean	Maximum
Before COVID-19	Cough	14	1.00	2.43	3.00
	Cough > 2 weeks	14	0.00	1.21	2.00
	Pneumonia	14	0.00	0.14	2.00
	Severe Pneumonia	14	0.00	4.93	12.00
During COVID-19	Cough	13	1.00	3.62	7.00
	Cough > 2 weeks	13	2.00	2.62	4.00
	Pneumonia	13	0.00	1.62	5.00
	Severe Pneumonia	13	0.00	7.85	20.00

7- COMPARISON OF KINDIA COVID-19 CASES TO NATIONAL COVID-19 CASES

Both Kindia COVID-19 and National COVID-19 cases increase exponentially from March 2020 to April 2020 and then the number of Kindia COVID-19 cases decreases drastically with multiple fluctuations while the number of National COVID-19 cases continues to increase (Figure 4).
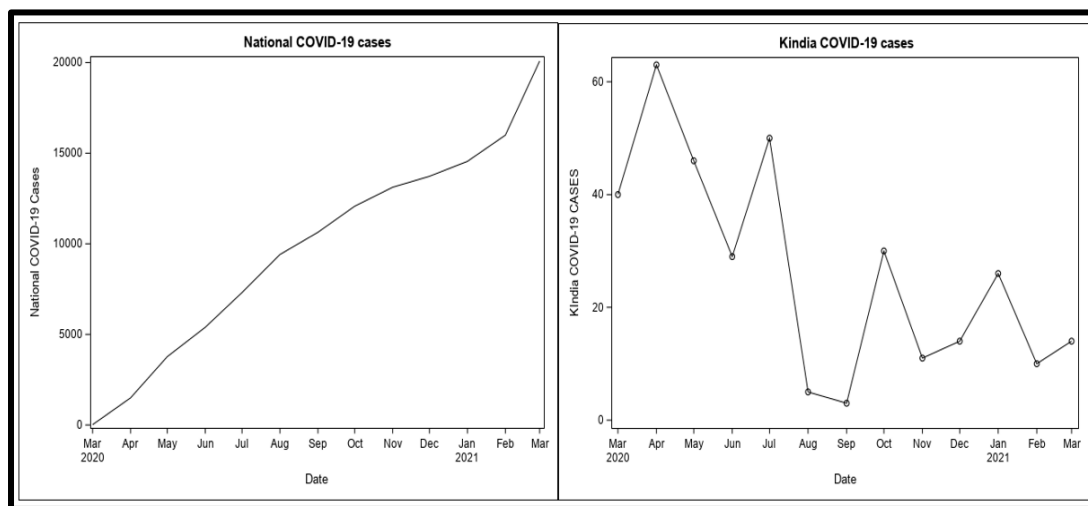

Figure 4: Comparison of Kindia COVID-19 cases to National COVID-19 cases

CHAPTER 4: DISCUSSION

In this study, we sought to assess the impact of the COVID-19 pandemic on the burden of malaria, evaluate and identify the deficiencies of malaria control programs and suggest effective recommendations based on the literature. In our study, we observed an increase in total malaria cases (overall consultations) with multiple fluctuations in the period before the COVID-19 pandemic (from January 2019 through February 2020) while hospital stays increased slightly from April to December. During the COVID-19 pandemic, malaria cases decreased drastically from March 2020 to June 2020 and then increased while hospitalizations were relatively stable but higher from Nov 2020 to Mar 2021 compared to Mar -Oct 2020 period (Figure 2). In 2021, Barry et al. also noted that the number of consultations and hospitalizations decreased during the COVID-19 pandemic at Ignace Deen National Hospital Conakry (Barry et al., 2021). A decrease in hospital admissions might be explained by two factors. On the one hand, people may fear getting sick from the virus of COVID-19 after visiting health care facilities. On the other hand, Guinea has a sad history of the Ebola epidemic that led to more than 2,544 deaths in 2014 (Migliani et al., 2016).

In this study, malaria cases among pregnant women increased significantly(P=0.0272). During the COVID-19 pandemic, pregnant women experienced an increase in malaria cases from 2,223 (13%), to 25,081 (77%). The number of malaria cases diagnosed among patients under 5 years or younger and over 5 years respectively decreased from 6,178(35%) to 6,743(21%), and 9,002(52%) to 643(2%). The number of malaria-related deaths of both patients aged 5 years or younger, and those over 5 years increased from 27 (42%) to 38 (46%), and 25 (38%) to 33 (40%) respectively. In our study, across time points malaria cases and deaths were higher among children aged 5 and younger than those aged over 5 years of age, though there

appears to be a severe negative observation bias among those aged over 5 years in the COVID-19 period. Also, relative burden of malaria-related deaths among pregnant women declined from 20% to 13% of total malaria mortality burden, In our study, we found that the CFR was higher in patients over 5 years compared to those ≤ 5 years (Table 1). Weiss et al. 2020, estimated an increase in malaria cases by 21.5% (16.3/27.9 and malaria-related deaths by 328.7(311.6/350.2) because of the COVID-19 pandemic in 2020 (Weiss et al. 2021). Heuschen et al. found that there were 46,693 malaria cases confirmed in pregnant women increased by 39% in 2021 (Heuschen et al., 2021). While reasons for the high number of malaria cases and deaths in children aged 5 years or younger compared to patients over 5 years are difficult to extrapolate in the setting of severe observation bias, that under 5 years mortality is high in malaria is well established. Furthermore, after several episodes of malaria, patients over 5 years old can develop immunity to the disease (Abossie et al.,2020). Not knowing the distribution of ages among those patients over 5 years makes extrapolations regarding underlying conditions difficult (Onder et al., 2020). While pregnant patients after 26 weeks of intra-uterine pregnancy are often considered to be at higher risk for consequences from infectious diseases, the disruption of women's access to and delivery of ANC services allowing prevention may account for this.

Based on the malaria testing and treatment service utilization activities between and during the COVID-19, we found an increase in the ACT, Quinine, and RDT consumption during the COVID-19 pandemic (Table 3). Similarly, Afai et al. found that the number of people tested with RDT for malaria increased by 39% (190,370/266,733) during COVID-19 (Afai et al., 2020). Contrary to Namuganga and al. 2021, the number of malaria cases tested with RDT decreased from 85.4% to 80.3 % during the COVID-19 crisis (Namuganga et al.,2021). In this instance, the high availability of ACTs and RDTs can be explained by the fact that the Regional Hospital of

Kindia benefited from important free RDT supplies and so stockpiling provided by the U.S.

President's Malaria Initiative Program before the COVID-19 pandemic occurrence.

Our findings indicate that malaria prevention measures decreased substantially during the

COVID-19 pandemic. We found a statistically significant decrease in the 3 doses of SP

distribution and the number of 1st ANC. We also observed a statistically non-significant decline

in the distribution of ITNs, awareness rate, 1 dose of SP, 2 doses of SP, and 4 doses of SP. These

findings are consistent with the study conducted by Seboka et al. in 2020 which also indicated a

decrease in ITN distribution in 2021 (Seboka et al., 2020). In contrast, Weiss et al. observed an

increase in ITN distribution in 2021, from 32.5% to 72.7% (Weiss et al., 2021). On the one hand,

this decrease can be explained by the fact that limited resources (including human resources) for

malaria control were allocated to COVID-19 pandemic management, leaving a relatively small

number of resources to address essential public health measures during the pandemic. On the

other hand, Guinea did not hold a mass ITN campaign in 2020. In addition, the routine

distribution of ITNs during antenatal consultations (ANC) was disrupted by the COVID-19

pandemic due to the fear of getting it, as well as the initial disruption of information about the

disease and intermittent preventive treatment.

In this study, we found an exponential increase of both Kindia COVID-19 and National

COVID-19 cases from March 2020 to April 2020, and then the number of Kindia COVID-19

cases drastically decreased with multiple fluctuations while the number of National COVID-19

cases continue to increase (Figure 4). The decrease of Kindia COVID-19 cases at ETC can be

explained by the fact that the local ETC frequently evacuated all severe COVID-19 cases to the

National ETC due to the lack of adequate equipment and qualified staff for serious COVID-19

cases treatment. This study revealed major challenges in determining the demographic

characteristics of malaria patients. Therefore, future community-based studies are essential to better understand the impact of the pandemic on malaria burdens and to evaluate how the structure and staff function.

There are two major strengths of this study: well-delineated descriptive analytics of data correlation with the existing literature. The current study has limitations that should be taken into consideration when interpreting its results. In the first place, the data set did not allow gender or other non-age demographic information to be assessed as variables. Second, the dataset was driven by reporting practices that might incorporate observation and misclassification biases, particularly in the setting of suspect malaria cases and COVID-19 cases. However, we believe our findings will greatly enhance our understanding of the impact of COVID-19 on malaria control programs.

<u>CONCLUSION</u>

In conclusion, this study shows that the COVID-19 pandemic negatively impacted the malaria control programs in the Regional Hospital of Kindia, which caused a decrease in awareness rate, ITN, SP distribution, and the first ANC after the pandemic occurrence. Further, the pandemic also impacted malaria service utilization through the low number of consultations and the number of hospitalizations. However, the COVID-19 pandemic had not significantly impacted malaria treatment and testing utilization. Interventions and strategies focused on reducing and controlling the malaria disease burden, mainly in the malaria-endemic settings, must seriously be considered during a pandemic response. A continued malaria service during and after the pandemic represents a necessity for an effective malaria control program.

RECOMMENDATION

This study revealed that malaria prevalence and malaria-related deaths were high among pregnant women, patients aged 5 years or younger, and those over 5 years. To reduce malaria transmission, malaria control programs should ensure that at-risk populations have access to ITNs and utilize them effectively. If mass ITN distribution campaigns cannot be carried out as planned, priority should be given to areas with the highest malaria burden (Alliance for Malaria Prevention, 2020). To integrate COVID-19 with malaria control, existing systems need to be supported: door-to-door distribution of ITNs or integration with economic palliatives distribution to reach a larger number of people. Distributors need to be provided with protective measures against the COVID-19. The distribution of malaria commodities in rural and hard-to-reach areas can be accomplished using the existing infrastructure used for the distribution of COVID-19 supplies. To ensure global health security, proactive surveillance for COVID-19 should be used to enhance surveillance of malaria and other diseases (Ajayi et al., 2020). Provide periodic malaria chemoprevention (SMCP) and intermittent preventive treatments to all children aged 5 years or younger during malaria season and intermittent preventive care with sulfadoxine-pyrimethamine (SP) to pregnant women to reduce malaria prevalence and mortality (WHO,2020). In addition, we noticed that pregnant women have difficulty accessing ANC services in the pandemic setting. The government should support pregnant women to remotely access the ANC during the COVID-19 pandemic by providing access to mobile devices and establishing regulations to maintain their privacy (Uwambaye et al.,2020). Furthermore, the study revealed a reduction in hospital admissions. Education and engagement of the community are crucial to reinforce messages about malaria prevention, diagnosis, and treatment. Providing prompt diagnosis and treatment of malaria requires the establishment of adequate health services

and the training of health workers to ensure a safe working environment and appropriately resourced facilities (Rogerson et al., 2020). There were major challenges in identifying the demographic characteristics of malaria patients in this study. Future community-based studies are recommended to better understand the impact of the COVID19 pandemic on malaria burdens and to assess how the structure and staff function.

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APPENDIX A: SUMMARY OF LITERATURE

Title: Commonalities, Intersections, and Implications for Sustaining Malaria Control.

Authors: Ajayi, I. O., Ajumobi et al.

Abstract: In this article, the authors describe the consequences of the infectious disease outbreak of COVID 19 pandemic on the health system in Afrique du in presence of several health conditions The paper focuses on the consequences of Ebola and COVID 19 pandemic on the malaria control program in West and Central African countries respectively between 2014 and 2016 and between 30 January 2020 and March 11, 2020. The purpose of this study is to compare the COVID19 pandemic and malaria and discuss implications and recommendations to improve malaria control programs during the ongoing COVID-19 pandemic.

Keywords: COVID-19; consequences; integrated control; malaria; pandemic.

Title: Malaria epidemiology and anti-malarial drug efficacy in Guinea: a review of clinical and molecular studies

Authors: Cherif, M.et al.

Abstract: This study describes the mortality and morbidity of malaria and its transmission in Guinea. This study provides strong evidence of the effectiveness of the treatment against the Plasmodium falciparum as the primary parasite species based on Chloroquine (CQ) as the first-line drug in the past for uncomplicated P. falciparum in Guinea until 2005, and then artemisinin-based combination therapy (ACT) as of current therapy. This study reviewed the therapeutic efficacy of CQ and artemisinin-based combinations and found against CQ, a failure rate of 27% (12/44) was reported in a study in 1992; a median failure rate of 15.6% [range: 7.7–28.3; 8

studies] was observed during 1996–2001, and 81% (17/21) of the patients failed to clear parasitemia in a study conducted in 2007. In addition, the study describes the impact of the COVID 19 pandemic on the malaria control program.

Keywords: Malaria, Guinea, Resistance, Artemisinin-based combination therapy, Efficacy, Plasmodium falciparum

Title: African malaria deaths set to dwarf covid-19 fatalities as pandemic hits control efforts, WHO warns

Authors: Dyer, O

Abstract: This study alerts the possible increase in the mortality rate of malaria due to the impact of COVID 19 on its prevention and treatment efforts in sub-Saharan Africa. The paper related that 1.5 billion malaria cases and 7.6 million deaths have been averted since 2000 and compared malaria's mortality rate to the mortality related to the COVID 19 pandemic. The purpose of this article is to describe the consequences of COVID 19. The author also stated the prospective vaccination in the second quarter of 2021.

Keywords: Malaria, Mortality, COVID 19, Consequences, Vaccination.

Title: Indirect effects of the COVID-19 pandemic on malaria intervention coverage, morbidity, and mortality in Africa: a geospatial modeling analysis.

Authors: Weiss, D., Bertozzi-Villa, et al.

Abstract: The study describes the burden of malaria in Africa since 2000 and the impacts of the COVID 19 pandemic on the malaria control program. The study has for purpose to evaluate the incidence and mortality of malaria during the COVID 19 pandemic.

Keywords: Malaria, Incidence, Mortality, COVID 19, Intervention.

Title: Malaria death toll to exceed COVID-19 in sub-Saharan Africa

Authors: Kelland, K.

Abstract: The study describes the mortality of malaria and its transmission during the COVID 19 pandemic in sub-Saharan Africa.

Keywords: Death, Malaria, COVID-19, transmission.

Title: Malaria facts and Situation in Guinea

Authors: Severe Malaria Observatory

Abstract: The article provides evidence of the burden of malaria between 2016 and 2019 and found that the case burden for malaria fell by 12.6% (from 340 to 297 per 1000 of the population at risk), while deaths fell by 12% (from 0.73 to 0.64 per 1000 of the population at risk. The authors also describe the progress made in malaria prevention among vulnerable populations based on the use of insecticide-treated nets (ITNs), and sulfoxide-pyrimethamine (SP).

Keywords: Malaria, Burden, prevention, Death.

Title: Identifying and combating the impacts of COVID-19 on malaria

Authors: Rogerson, S.J. et al.

Abstract: This article describes the occurrence of infections and mortality rates related to COVID -19 pandemic restrictions. The purpose of this study is to demonstrate how the pandemic impacted the treatment, prevention, and control of malaria

Keywords Infections, malaria, COVID 19, mortality, prevention

Title: Impact of the COVID-19 pandemic on the activities of the cardiology service of the Ignace Deen National Hospital of the Conakry University Hospital.

Authors: Barry IS, et al.

Abstract: The purpose of this descriptive retrospective study is to assess the impact of the COVID-19 pandemic on the activities of the cardiology service of the Ignace Deen National Hospital of the Conakry University Hospital. The study focused on the consultation and hospitalization activities in the cardiology service of the Ignace Deen National Hospital of the Conakry University Hospital. The study compares the frequency of consultations and

hospitalizations before (January and February 2020) and during (March to April 2020) pandemic Impact of the COVID-19 pandemic on the activities of the cardiology service of the Ignace Deen National Hospital of the Conakry CHU. Impact of the COVID-19 pandemic on the activities of the cardiology service of the Ignace Deen National Hospital of the Conakry CHU Impact of the COVID-19 pandemic on the activities of the cardiology service of the Ignace Deen National Hospital of the Conakry CHU

APPENDIX B: APPLICATION OF PUBLIC HEALTH COMPETENCIES

MPH Foundational Competency

MPHF4. Interpret results of data analysis for public health research, policy or practice

The findings obtained from the descriptive analysis and any undertaken tests were placed in context to discuss potential lessons learned regarding malaria control in emergencies.

MPH Concentration Competencies: Epidemiology

EPIMPH1. Determine the strengths and weaknesses of the scientific literature and synthesize the evidence to inform public health practice.

Findings from this work will be compared with related examples from the literature to improve malaria control programs in the target population based on the literature.

EPIMPH4. Utilize analytical approaches to describe, summarize and interpret epidemiologic data.

Time series descriptive analysis helped me analyze the monthly collected quantitative data and describe malaria cases over time. In malaria control programs, the proc means procedure helps evaluate the effectiveness of the program by tracking changes in key indicators. These different statistical methods helped me become more adept at describing, summarizing, and interpreting epidemiological data related to specific health issues. My present research and analytical skills have also enhanced my ability to make decisions and address public health needs that could affect large populations of people in my future career.

APPENDIX C: BIOGRAPHY AND CURRICULUM VITAE

Biography

Mohamed is a student at the College of Public Health concentrating in the field of Epidemiology at the University of Nebraska Medical Center in 2022. He is a general medical doctor who graduated from the University Gamal Abdel Nasser of Conakry in 2008. He worked as an epidemiologist at Great Plains Tribal Chairmen's Health Board, Department of Epidemiology Center. He also worked as a pediatrician at the Regional Hospital of Kindia from 2008 to 2014. He taught a pediatric class at the Regional Nurses school of Kindia from 2008 to 2014. He dreams to pursue a Ph.D. after his MPH degree.

Curriculum Vitae

EDUCATION

Master of Public Health- Epidemiology

The University of Nebraska-Medical Center   Expected May 2022

Courses: Epidemiology, Planning, and Evaluation, Leadership and Advocacy, Biostats I, Biostats II, Epidemiological Methods, Intro to SAS Programming, Emergency Preparedness: Response and Recovery, Applied Epidemiology, Chronic Epidemiology, Infectious Disease Epidemiology, Human Health, and Disease, Epidemiological Methods in Infectious Disease Outbreak Investigation.

Capstone: Impact of COVID-19 on Malaria control Program at the Epidemic Treatment Center of Regional Hospital of Kindia between March 1, 2019, 2019, to March 31, 2021.

Public Health Certificate: May 2019

Indiana University Purdue University   Indianapolis, IN

MD: General Doctor   September 2008

Gamal Abdel Nasser University   Conakry, GN

PROFESSIONAL EXPERIENCE

Applied Experience – Internship

The Great Plains Tribal Leaders' Health Board (GPTLHB   August – December 2021

Department   Epidemiology Center   Rapid City, South Dakota

Evaluated and conducted the National Survey on Drug Use and Health (NSDUH) training.

Evaluated and conducted training on US Census Data.

Documented 94 data sources/systems for Great Plains Area Tribes to reference: served as a repository of publicly available data sources that tribal public health programs may reference to augment program activities, education materials, and funding opportunities. Data catalog that serves as an invaluable tool for tribal programs to identify data sources that will help secure funding and monitor the health status of tribal communities

Trained the staff on the Data Catalog User Manual which provides a reference for consumers on how to use the data catalog and allows them to advocate for tribal health

CERTIFICATIONS/AWARDS

FEMA Incident Command System (ICS-100) certified

Johns Hopkins University: Certified in COVID-19 Case Investigator/Contact Tracing

UNICEF-Guinea: Malnutrition in Children

United States Agency International Development (USAID): Effective teaching Clinical Skills

Panafric Organization (OPALS): Prevent mother-to-Child transmission of HIV

Centers for Disease Control and Prevention: Diabetes in Children.