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The Current State of Health Care Facility Preparedness, Health Care Utilization, and COVID-19 Knowledge Amidst the COVID-19 Pandemic in the Malaria-Endemic Setting of Manicaland Province, Zimbabwe

Julia Grace Scott

THE CURRENT STATE OF HEALTH CARE FACILITY PREPAREDNESS, HEALTH CARE UTILIZATION, AND COVID-19 KNOWLEDGE AMIDST THE COVID-19 PANDEMIC IN THE MALARIA-ENDEMIC SETTING OF MANICALAND PROVINCE, ZIMBABWE

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Julia Grace Scott

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Accepted by:

Mufaro Kanyangarara, Director of Thesis

Andrew Ortaglia, Reader

Melissa Nolan, Reader

Tracy L. Weldon, Interim Vice Provost and Dean of the Graduate School

ABSTRACT

The impact of the coronavirus disease 2019 (COVID-19) pandemic has been felt worldwide, especially in Sub-Saharan Africa (SSA). With fractured health systems, disrupted supply chains, limited resources, and continued fighting of endemic diseases such as malaria, SSA is at risk for greater impact. Manicaland Province has the highest incidence rate of malaria in Zimbabwe, and a higher malaria mortality rate than the national average. Manicaland also has the third highest number of COVID-19 cases and deaths in Zimbabwe. In this study, health care facilities and households throughout Makoni, Mutare, and Buhera districts in Manicaland Province were administered cross-sectional surveys. We determined the current state of health care facilities' preparedness to diagnose and treat malaria and assessed the factors associated with preparedness. We also investigated the factors associated with health care utilization in the last 3 months and COVID-19 knowledge among of symptoms, infection, and prevention among households and heads of households. While health care facilities had many tracer items necessary to diagnose and treat malaria, there were gaps in availability of malaria treatment services and drugs. Rural location of facility was associated with greater health care facility preparedness. Household size, education, and medical aid status were significant factors included in the final model for health care utilization. However, the only significant association observed was among households larger than 4 members, which had greater odds of utilizing health care in the last 3 months. Also, ages 31-55, attending primary school or higher, and hearing about the COVID-19 pandemic and

emergency number were associated with increased COVID-19 knowledge, while age of greater than 55 was associated with decreased knowledge of COVID-19. The findings here help to assess the current state of malaria preparedness in health care facilities in Manicaland Province in the midst of the pandemic, and factors for intervention concerning health care utilization and COVID-19 knowledge in rural and malaria-endemic areas.

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LIST OF ABBREVIATIONS

CDC .... Centers for Disease Control and Prevention

COVID-19 .... Coronavirus Disease 2019

DHS .... Demographic and Health Surveys

EVD .... Ebola Virus Disease

HIV .... Human Immunodeficiency Virus

IPTp .... Intermittent Preventative Treatment During Pregnancy

IRS .... Indoor Residual Spraying

ITN .... Insecticide-treated Net

LMICs .... Low- and Middle-Income Countries

PHEIC .... Public Health Emergencies of International Concern

PPE .... Personal Protective Equipment

RDT .... Rapid Diagnostic Test

SARA .... Service Availability and Readiness Assessment

SPA .... Service Provision Assessment

SSA .... Sub-Saharan Africa

WHO .... World Health Organization

CHAPTER 1: INTRODUCTION & BACKGROUND

Global Pandemics and Pandemic Preparedness

A pandemic is defined by the World Health Organization (WHO) as the "worldwide spread of a new disease" (1). Pandemics have the potential for tremendous impact on human health and health services across the globe (2). The world is becoming more connected with increased international travel and trade, giving many emerging pathogens the potential to become a pandemic. Zoonotic pathogens are organisms that cause disease and are transmitted from animal reservoirs to humans. They are responsible for many of the world's disease outbreaks such as human immunodeficiency virus (HIV), Zika Virus, EVD, and COVID-19. Increasing interaction of humans with animal reservoirs over time has provided the means for pathogens to 'jump' to a new host (3). These emerging pathogens pose a threat to human health largely because they are novel, and therefore their epidemiology is not well-understood. The most recent of emergence of a zoonotic pathogen - COVID-19, has tested pandemic preparedness globally. COVID-19 first emerged in China in late 2019. Given that no one had prior exposure to this pathogen, the entire world population at the time was considered vulnerable to COVID-19 infection. Since then, it has spread around the world, infecting millions of people (4). The origin of COVID-19 was determined to likely have been the wet markets of Wuhan, China with the reservoir host being a bat. COVID-19 is a respiratory virus, with those infected presenting symptoms such as coughing, shortness of breath, fever, and fatigue (5). Studies have shown the reproduction number of COVID-19 ranges anywhere from 2 to 6, depending on the phase of the pandemic, giving this pathogen super-spreader potential (6).

The COVID-19 outbreak was declared a public health emergency of international concern (PHEIC) by the WHO in January of 2020 (4). The International Health Regulations articulated by the WHO in 2005 provide guidance on what constitutes a PHEIC and the necessary framework and guidelines for a coordinated international response to minimize the impact of PHEIC on economies, societies, and health care systems (7). The novel influenza A H1N1 virus pandemic of 2009 tested the preparedness of the world to handle a highly contagious virus on an international scale. The pandemic highlighted gaps in pandemic preparedness internationally, and underscored the need for improvements to research, health care, and economic development to tackle future pandemics (8). Since then, other PHEICs for Zika Virus, Polio, Ebola Virus Disease (EVD), and most recently, COVID-19 have been declared by the WHO (9). While progress has been made in addressing the gaps in global preparedness, some criticize the delay in these declarations, and impeding action toward international support, research, and mitigation. Going forward, it is vital that a more proactive and rapid response is needed in declaring PHEICs to effectively initiate proper action against future pandemics (10).

Vulnerability to Pandemics and Pandemic Preparedness in SSA

SSA has been considered the most vulnerable continent to pandemics due to conflict, political instability, and weak health care systems, among other factors (11).

Many SSA countries have limited resources such as trained health care professionals and diagnostics. Therefore, a pandemic can easily overwhelm their health care systems (12). Epidemics like EVD have demonstrated this vulnerability by impacting the health of African populations and further fracturing health care systems (13). The 2014-2016 outbreak of EVD in West Africa impacted Guinea, Liberia and Sierra Leone causing a sharp decrease in health care service access and capacity to diagnose and treat patients (14). In Liberia, over half of households indicated that it was difficult to access health care services during the outbreak. The closure of facilities, inability of facilities to accept patients, and fear of contracting EVD were the main reasons for decreased access to essential health services (15). In areas with high EVD incidence, the use of health care facilities, particularly with inpatient services dropped significantly (16). Health care workers were at greater risk for contracting the disease; many fell ill, resulting in a reduction in health care workers available to provide EVD services as well as essential health services (17).

The EVD outbreak indirectly impacted the prevention and control of other diseases such as malaria. Historically, increases in malaria morbidity and mortality through the disruption of malaria services have been observed during pandemics and outbreaks (18). During the EVD epidemic, routine malaria services suffered through the diversion of health care workers and supplies, and community members in affected areas avoided seeking treatment due to fear of contracting EVD (19). Overall, the decrease in health care facility visits for ailments unrelated to EVD resulted in an estimated 7,000 additional malaria deaths in EVD-effected countries (20). Despite calls for the continuation of malaria services, implementation of these recommendations proved difficult due to the prioritization of resources to the EVD outbreak (21). It is unclear whether the COVID-19 pandemic will have a similar impact throughout SSA, however, the disruption of health care services and shortages of resources point to similar consequences in the near future.

COVID-19 in SSA

The first case of COVID-19 in SSA was detected on February 27, 2020 in Nigeria, with the virus emerging in all SSA countries shortly thereafter (22). Roughly a quarter of African countries have global pandemic plans, however the plans are largely outdated, having been formulated in response to the H1N1 pandemic of 2009 (8). In response to the pandemic in March 2020, the Africa Centers for Disease Control and Prevention (CDC) recommended increased stocking of PPE, contact tracing, surveillance, testing, and implementation of community communication (23). Many countries underwent full lockdowns in March 2020, while others implemented lockdowns only in the most heavily affected areas (24). However, many of these lockdowns are now relaxed. International travel restrictions were also implemented to mitigate importation of COVID-19, and, as of January 2021, are being strengthening in many African countries due to the emergence of new COVID-19 variants (25).

The pandemic has imposed a heavy burden on health care systems in SSA, largely due to these restrictions and a reliance on international importation of medical resources. There have been consistent shortages in supplies and resources needed to diagnose and treat COVID-19, such as gloves, masks, and hand sanitizers (26). However, increased regional production of these commodities in the summer of 2020 started to ease the impact of supply chain disruptions in SSA (27). Also, health care workers are at higher risk for COVID-19 infection. (28). During the EVD outbreak, health care workers who become infected were instructed to self-isolate for at least 10 days after symptom onset, putting them out of work for a significant amount of time (29). Additionally, if they developed severe disease, and required hospitalization, their absence from work could extended even longer.

Malaria in SSA

Every year, SSA is responsible for over 90% of the world's malaria cases and deaths (30). In recent years, SSA has made tremendous progress in the fight against malaria due to intense and successful intervention campaigns, such as insecticide-treated net (ITN) distribution, indoor residual spraying (IRS), intermittent preventative treatment during pregnancy (IPTp) and prompt diagnosis and treatment (43). The malaria morbidity and mortality rates had reduced by roughly 30% and 60% respectively in 2018, compared to rates in 2000 (30). The progress towards elimination has been extensive, with many SSA countries on the path to malaria elimination (30). For this trend to continue, the availability and effective use of resources such as diagnostics, treatment options, and preventative measures by health care workers and individuals at risk of malaria is necessary (31). However, the re-routing of resources toward the pandemic has the potential to impact malaria supply chains and reduce the availability of antimalarial drugs and diagnostics.

COVID-19 and Malaria in Zimbabwe

Malaria is one of the leading causes of mortality and morbidity in Zimbabwe, and Manicaland Province has one of the highest malaria incidence rates in the country (32). High malaria transmission areas of Zimbabwe have been the focus of ITN distribution campaigns and IRS (33). Since 2015 Zimbabwe has seen a 40% decrease in malaria incidence and mortality rates (30). However, COVID-19 has emerged as a potential threat to this continued progress. In April of 2020, there was a sharp increase in malaria outpatient attendances compared to that of the previous year. According to the WHO, this may be due to false reporting of cases, changes in diagnostics, or increased transmission of malaria (34). Given that the peak malaria season occurs from February to May, the spike in April could be the result of increased malaria transmission in Zimbabwe at the time (35). However, May and June indicated sharp decreases in malaria outpatient attendances, indicating the final stretch of malaria peak season (34). Prior to the pandemic, Zimbabwe had a fractured system with drug shortages and inadequate amount of health care staffing, putting Zimbabweans at increased vulnerability amidst the pandemic (36). Recent reports indicate that Zimbabwe's health care system is not faring well amidst the pandemic. Presently, Zimbabwe has nearly 40,000 confirmed COVID-19 cases and over 14,000 deaths, with Manicaland Province accounting for over 3,600 of those cases and 188 deaths (37).

Factors Associated with Household Knowledge of COVID-19

Knowledge of COVID-19 is rapidly evolving for researchers, clinicians, public health organizations, and the community. Much has been learned about COVID-19 infection, symptoms, and prevention since its emergence in December 2019. COVID-19 is a respiratory virus, and therefore spreads through aerosol droplets (38). General precautions such as washing hands, social distancing, staying at home if you are sick, and wearing a mask all have been shown to help prevent COVID-19 infection. Upon infection, the most common symptoms of COVID-19 are fever, cough, difficulty breathing, body aches and fatigue. Other symptoms have been observed as well and include nausea, diarrhea, vomiting, loss of taste or smell, headache, rash, sore throat, congestion, and runny nose (39). With an emerging disease, getting this information of symptoms, infection, and prevention out to the community quickly and efficiently can be crucial in mediating disease transmission and death (40). Knowledge of symptoms, infection, and prevention helps identification of cases and take precautions avoiding further spread of COVID-19.

Several studies have assessed the current state and factors related to household knowledge of COVID-19 in SSA. In Ethiopia, most participants knew the clinical symptoms of COVID-19, but did not know that children and young adults should also take prevention measures. Factors found to be associated with COVID-19 knowledge included age, education, gender, and occupation (41,42). In Nigeria, significant gaps were found in COVID-19 prevention practices despite the majority of participants exhibiting good knowledge of COVID-19 (51,52). COVID-19 knowledge scores were positively associated with ages 21-30 and working in the medical field (43). In Cameroon, a large proportion of participants knew the main modes of transmission of COVID-19 and indicated that they practiced the primary routes of prevention such as hand washing, wearing a mask and social distancing (44). In Ghana, about 61.7% of respondents had good knowledge of COVID-19. The factors identified as influencing knowledge included age, marital status, education, employment, occupation, sufficiency of available information, channel of information, and awareness of a COVID-19 emergency contact number or facility. (45). Taken together, these studies demonstrate the existing gaps in knowledge of COVID-19 and the need for increased communication of symptoms, infection, and prevention measures to the community.

Factors Associated with Household Health Care Utilization

Health care utilization can also be further impacted by the pandemic. Individuals may be fearful of becoming exposed to COVID-19 while visiting health care facilities and of the negative stigma that may be associated with COVID-19 infection in the community (46). Also, many SSA countries invoked lockdown orders to contain community spread of COVID-19. Amidst stay at home orders and instructions to socially distance, individuals may be more inclined to avoid leaving the house to seek care (19). In Zimbabwe, a lockdown order was issued on March 30, 2020, which required public gatherings to cease and urged community members to stay at home (47). A sharp decrease in outpatient visits to health care facilities from March to June 2020 compared to levels in March to June of 2019 was observed in Zimbabwe (34). On the flipside, an uptick in "worried well" patients (those who believe they have COVID-19, but do not) may further overwhelm the facilities (46). COVID-19 mitigation efforts such as lockdowns may also result in losses of income and health insurance for households (48). Households then may not have the financial resources for health care, such as transportation and service fees (18). Lastly, closure of health care facilities may require households to travel further than the nearest facility for care, reducing their health care utilization (49).

Various studies have investigated the factors associated with health care utilization in SSA, outside the context of the COVID-19 pandemic. Among Ethiopian households, rural residence, low income, and distance from health care facility were all associated with lower odds of utilizing health care (50). In South Africa, three-quarters of residents indicated they did not utilize health services due to reduced quality. Having medical insurance was also an indicator of health care utilization, increasing the odds of utilization (51). Education level was also shown to increase health care utilization in both urban and rural Zambia (52). Other factors examined for an association with health care utilization throughout SSA include age, sex, household size, and health care availability (53). Perceptions of health care facilities and the quality of care they provide can also play a role in individual health care utilization. Health care facilities may not have adequate staffing or resources such as medication and PPE to accommodate both routine health services and COVID-19 related services. This can lead to longer wait times to see a health worker, delays in treatment, and negative experiences with facility staff. In fact, studies have shown that the behavior and treatment received from health care workers are a significant factor in the perceived quality of health care facilities (54,55). Therefore, negative experiences in the perceived quality of care can impact the choice to utilize health care in the future.

Problem Statement and Rationale

The impact of COVID-19 on countries in SSA is not well-understood and may impact health care facility preparedness to treat and diagnose malaria. If routine services, supplies, and resources are being disrupted, the progress toward a malaria-free world may suffer. While COVID-19 is an important public health concern, the focus on this novel pathogen can take valuable attention from other public health problems such as malaria. Therefore, it is important to understand how COVID-19 is impacting malaria-endemic areas, health care utilization, and knowledge of COVID-19 symptoms, infection, and prevention. Understanding this can help avoid problems both on the malaria-control front, and the COVID-19 control front.

Study Goals and Objectives

This study will answer three main research questions in the malaria-endemic setting of Manicaland Province, Zimbabwe.

Objective 1: First, this study will assess the current state of health care facilities concerning the availability of supplies and resources to diagnose and treat malaria investigate the factors associated with preparedness of health care facilities to provide routine malaria services amidst the COVID-19 pandemic. These findings will characterize the current state of health care facilities in their preparedness to diagnose and treat malaria and identify potential gaps in preparedness.

Objective 2: Second, this study will assess the factors associated with health care utilization amidst the pandemic, when health care facilities may be overwhelmed, and individuals may be less likely to utilize heath care.

Objective 3: Lastly, this study will determine the household-level factors that are associated with head of household knowledge of symptoms, infection, and prevention of COVID-19. Determining the factors associated with head of household COVID-19 knowledge will add to the body of literature concerning COVID-19 knowledge in SSA.

The findings here will further aid in understanding how health care facilities in SSA are affected by the pandemic, and how this impact affects day to day care, such as malaria services. Findings will also provide insight into the state of health care utilization and knowledge of COVID-19, and their associated factors in the context of the COVID-19 pandemic.

CHAPTER 2: METHODOLOGY

Study Setting

Manicaland Province is located in eastern Zimbabwe on the border with Mozambique. It is the second most populous province in Zimbabwe with a population of over 1,780,000, with most of the population residing in rural areas (33). Manicaland Province has the highest incidence rate of malaria in Zimbabwe, with peak malaria season occurring from February to May (35). The province has 277 health care facilities, with nearly 90% being clinics and rural health facilities (56). The districts of Mutare, Makoni, and Buhera were included in this study and provided variation in malaria transmission with high, medium, and low transmission rates respectively (57). Mutare has both rural and urban areas, with most health facilities sampled from the rural region in this study. Mutare has the largest population with nearly 450,000 residents, followed by Makoni just over 270,000, and Buhera with around 245,000. In each district, roughly 15% of the population never attended school, with a majority of the population working in agriculture (58).

As of February 23, 2021, Manicaland Province had recorded 3,686 cases and 188 deaths of COVID-19, with a case fatality rate nearly twice the national average (37). Zimbabwe implemented a nation-wide lockdown in March 2020, which was relaxed in April in conjunction with increased testing and enforcement of curfews (59). Manicaland Province as of 2014, has 277 total health care facilities, with the majority being clinics and rural health centers (56). The outpatient department visit rate for health care facilities in Manicaland was 19 visits per 100 people as of 2014, similar to the national average (56).

Study Design and Implementation

Health care facilities throughout Manicaland Province were administered cross-sectional surveys from August to September 2020. A total of 100 health facilities were randomly and proportionately selected from Makoni, Mutare, and Buhera districts using a comprehensive list including government, private, and faith-based facilities. Hospitals were oversampled and all hospitals in the three districts were included in data collection. Cross-sectional survey questionnaires were administered to health care facility representatives. The questionnaire was adapted from the Service Provision Assessment (SPA) and the Service Availability and Readiness Assessment (SARA), developed by the Demographic and Health Surveys (DHS) program and the WHO, respectively. The questionnaire collected information on the availability of basic amenities and equipment, standard precautions for infection prevention, malaria services, COVID-19 services, laboratory diagnostic capacity and guidelines for malaria, trained staff, medications, and commodities.

A total of 547 households were randomly selected from the Makoni, Mutare, and Buhera districts using an enumeration area frame, based on the 2012 Population Census. Heads of selected households were included in the household survey if the following inclusion criteria were met: individual was head of household, willing and able to provide consent, and 18 years or older. Once written informed consent was obtained, the household survey was administered. Households were visited and administered the survey between August and September 2020. This survey collected data on demographics, socio-economic status, knowledge of malaria (including transmission, prevention, and treatment), use of malaria prevention measures (such as ITNs and IRS), health care utilization, and awareness and consequences of COVID-19.

Objective 1: Health Care Facility Preparedness to Diagnose and Treat Malaria

The first objective was to assess the preparedness of health care facilities to diagnose and treat malaria, and examine the various factors associated with preparedness. To assess the current state of preparedness of health care facilities to diagnose and treat malaria, descriptive statistics of health care facility demographics by preparedness score were included. The preparedness score outcome was based on the following tracer items: availability of basic amenities, equipment, malaria medication and commodities, and guidelines and health care worker training for malaria diagnosis and treatment. Health care facilities received a score of 1 for each item available or observed, which were added together into a total preparedness score. The preparedness score outcome was divided into two categories: prepared and unprepared. A facility preparedness score of 90% and above was considered prepared to treat and diagnose malaria, while a score of less than 90% was considered not prepared. We did not expect all the tracer items to diagnose and treat malaria to be available at all health care facilities, therefore an arbitrary cutoff of 90% was used here. Given that we did not have a well-established cutoff for preparedness, the 90% cutoff was used for ease of interpretability of estimates. Chi-squared or Fisher's Exact Test statistics, where applicable, and p-values were obtained to assess for a relationship between health care facility characteristics and preparedness to diagnose and treat malaria. An alpha of less than 0.05 was considered statistically significant.

We then assessed the factors associated with preparedness of health care facilities to provide malaria services using two methods. Ideally, to adequately provide malaria services, health care facilities should have all tracer items. However, it is likely that very few health care facilities included here would have all tracer items. To account for this, we considered two approaches to classifying health facilities as "prepared" to treat and diagnose malaria. First, the preparedness score outcome was considered binomial, divided into prepared and unprepared with a 90% cutoff, as used in the descriptive portion of the analysis. Univariable and multivariable logistic regression was used to obtain unadjusted and adjusted odds ratios and corresponding 95% confidence intervals for the relationship between the factors assessed and preparedness to provide malaria services. A final multivariable model was obtained through backwards elimination from a full model, including significant factors ($p \leq 0.1$). An alpha of less than 0.05 was be considered statistically significant.

Second, the malaria preparedness score outcome was treated as continuous variable, without setting an arbitrary cutoff for preparedness. The most prepared health facilities had higher scores, indicating availability of more tracer items, with the least prepared facilities having lower scores, indicated less tracer items. The maximum possible score was 12. Univariable and multivariable linear regression was used to obtain unadjusted and adjusted betas and corresponding 95% confidence intervals for the relationship between the factors assessed and preparedness to provide malaria services. A final multivariable model was obtained through backwards elimination from a full model, including significant factors ($p \leq 0.1$). An alpha of less than 0.05 was be considered statistically significant.

Objective 2: Factors Associated with Household Health Care Utilization

The second objective was to determine the factors associated with household health care utilization. The outcome of utilizing health care was be based on the question "When was the last time you or another member of your household visited the health care facility for care?". Responses were categorized into two groups: $\leq$ 3 months ago and > 3 months ago. Observations where the respondent answered "Don't know" to the health care utilization question were excluded from the analysis. After excluding of heads of households who responded "Don't know" to the health care utilization question, and the perceptions of health care facility questions, 505 households were included in the analysis. Factors examined for association with this outcome are listed in Table 2.1.

A household wealth index was calculated using principal components analysis, based on asset ownership (radio, television, refrigerator, cellphone, solar panels, computer, stereo, cows, mules, goats, pigs, bicycle, car, motorcycle), source of drinking water, type of toilet and main source of energy. The resulting index was then divided into wealth tertiles to represent the poorest, middle, and wealthiest households.

Table 2.1. Factors assessed for an association with health care utilization and COVID-19 knowledge among heads of households in Manicaland Province.

Factors Assessed	Categories	Analysis
Head of Household Demographics		
Age Category	18-30 years 31-40 years 41-54 years	Health care utilization and COVID-19 knowledge

	$\geq$55 years	
Marital Status	Married/Co-habiting Not Married	Health care utilization and COVID-19 knowledge
Education Level	Never attended Primary School Secondary School or Higher	Health care utilization and COVID-19 knowledge
Occupation	Farmer Unemployed Other	Health care utilization and COVID-19 knowledge
Medical Aid	Yes or No	Health care utilization
Household Demographics		
Wealth Tertile	Poorest Middle Wealthiest	Health care utilization and COVID-19 knowledge
Number of Household Members	$\leq$ 4 members > 4 members	Health care utilization
Transportation to Health Care Facility	Walking Other	Health care utilization
Travel Minutes to Health Care Facility	Continuous	Health care utilization
Head of Household Perceptions of Health Care Facility		
Time You Waited to See a Provider was a Problem	Problem No Problem	Health care utilization
Ability to Discuss Problems or Concerns about Your Health was a Problem	Problem No Problem	Health care utilization
Amount of Explanation You Received about the Problem or Treatment was a Problem	Problem No Problem	Health care utilization
Privacy from Having Others See the Examination was a Problem	Problem No Problem	Health care utilization
Privacy from Having Others Hear Your Consultation Discussion was a Problem	Problem No Problem	Health care utilization
Availability of Medicines at this Facility was a Problem	Problem No Problem	Health care utilization
Availability of Personnel at this Facility was a Problem	Problem No Problem	Health care utilization
Hours of Service at this Facility was a Problem	Problem No Problem	Health care utilization
Number of Days Services are Available was a Problem	Problem No Problem	Health care utilization

Cleanliness of the Facility was a Problem	Problem No Problem	Health care utilization
Treatment by Staff was a Problem	Problem No Problem	Health care utilization
Cost of Services or Treatments was a Problem	Problem No Problem	Health care utilization
Concerned about COVID-19 Spread in Community	Concerned Not Concerned	Health care utilization
Concerned about COVID-19 Infection	Concerned Not Concerned	Health care utilization
Heard About COVID-19 Pandemic	Yes or No	COVID-19 knowledge
Seen/Heard COVID-19 Messages in Last 6 Months	Yes or No	COVID-19 knowledge
Heard of COVID-19 Emergency Number	Yes or No	COVID-19 knowledge

Univariable and multivariable logistic regression was used to obtain unadjusted and adjusted odds ratios and corresponding 95% confidence intervals for the relationship between the factors assessed and household health care utilization. A final multivariable model was obtained through backwards elimination from a full model, including only significant factors ($p \leq 0.1$). An alpha of less than 0.05 was considered statistically significant.

Objective 3: Factors Associated with Head of Household COVID-19 Knowledge

The outcome assessed in this analysis was head of household knowledge of COVID-19. Scores for each head were compiled based on the responses to the questions: "What are common symptoms of coronavirus (COVID-19) infection?", "Which of the following statements are true about the Coronavirus (COVID-19) infection?", and "Which of the following actions can reduce the risk of being infected?". Multiple responses were allowed for each question. Each correct response was given a score of 1, while incorrect answers was given a score of zero. The score for overall COVID-19 knowledge was treated as a continuous variable and was based on the summed scores of the participant's knowledge of COVID-19 symptoms, infection, and prevention measures. The maximum possible score for knowledge was 30. Factors assessed for an association with household knowledge of COVID-19 included head of household age, education, marital status, and occupation, household wealth tertile, and whether the head of household had heard about the COVID-19 pandemic or emergency number and had seen or heard messages about COVID-19 (Table 2.1).

Univariable and multivariable linear regression was used to obtain unadjusted and adjusted betas and corresponding 95% confidence intervals for the relationship between the factors assessed and head of household COVID-19 knowledge. An assessment of normality was performed through residual analysis. A final multivariable model was obtained through backwards elimination from a full model, including significant only factors ($p \leq 0.1$). An alpha of less than 0.05 was considered statistically significant.

Potential Biases

Due to the cross-sectional nature of this study, these data do not capture trends over time. Rather the data are only indicative of conditions among households and health care facilities at the time of survey administration. Also, the household survey responses were self-reported, therefore potentially influenced by social desirability and recall bias. Lastly, some questions required heads of households to recall events in the past, sometimes months prior, which can lead to potential recall bias.

Ethical Considerations

Ethics approval was obtained from the Medical Research Council of Zimbabwe. Prior to enrollment in the study and completion of any study procedures, written informed consent was obtained from the head of household.

Statistical Software

All analyses in this study were completed using SAS University Edition (SAS/STAT®, SAS Institute Inc, NC, USA).

CHAPTER 3: RESULTS

Characteristics of Health Care Facilities

The 100 health care facilities were evenly sampled across the three districts, with 34% located in Mutare, 34% located in Makoni, and 32% located in Buhera (Table 3.1). Most health care facilities were health centers or clinics (95%), under government or public management (91%) and located in a rural setting (91%). (Table 3.1)

Table 3.1. Characteristics of health care facilities in Manicaland Province (N=100).

	n (%)
District	
Mutare	34 (34.0)
Makoni	34 (34.0)
Buhera	32 (32.0)
Type of Facility	
Hospital	5 (5.0)
Health Center/Clinic	95 (95.0)
Managing Authority	
Government/Public	91 (91.0)
Private, Mission/Faith-based, Other	9 (9.0)
Location of Facility	
Urban	9 (9.0)
Rural	91 (91.0)

Objective 1: Health Care Facility Preparedness to Diagnose and Treat Malaria

A majority of health care facilities had many of the preparedness tracer items except for malaria treatment available every day (59%), and pediatric coartem or other anti-malaria drugs (72%) (Table 3.2). About 40% of facilities indicated that they did not provide malaria treatment every day, however, almost all (97%) health facilities had a health care worker available 24 hours a day. Almost 20% of facilities indicated that providers were not trained for malaria diagnosis and treatment. Concerning pediatric coartem and other anti-malaria drugs, almost 30% of health care facilities did not have these tracer items observed. (Table 3.2)

Table 3.2. Descriptive statistics of variables for health care facility preparedness to diagnose and treat malaria in Manicaland Province, Zimbabwe (N=100).

Variable	N (%)
24 Health Care Worker Available at Facility	
Yes	97 (97)
No	3 (3)
Malaria Treatment Available Every Day at Facility	
Yes	59 (59)
No	41 (41)
Providers Diagnose Malaria at Facility	
Yes	99 (99)
No	1 (1)
Facility Provides RDT Diagnosis for Malaria	
Yes	99 (99)
No	1 (1)
RDT Kit Observed in Facility	
Yes	95 (95)
No	5 (5)
RDT Out of Stock in the Past 4 Weeks	
Yes	98 (98)
No	2 (2)
Facility Prescribes Treatment for Uncomplicated Malaria	
Yes	97 (97)
No	3 (3)
Observed Guidelines for Diagnosis and Treatment of Malaria in Facility	
Yes	91 (91)
No	9 (9)
Facility Providers Trained for Malaria Diagnosis and Treatment	
Yes	83 (83)
No	17 (17)
Anti-Malaria Drugs	
Observed Artemether-Lumefantrine (Coartem)	
Yes	94 (94)
No	6 (6)
Observed Doxycycline (oral)	
Yes	95 (95)

No	5 (5)
Observed Pediatric Coartem (or other anti-malaria drugs)	
Yes	72 (72)
No	28 (28)

Table 3.3. Distribution of continuous outcome of preparedness to diagnose and treat malaria (N=100).

Outcome	Mean	Standard Deviation	Minimum	Maximum
Continuous	10.79	1.08	6.00	12.00

Preparedness score based on availability of tracer items necessary to diagnose and treat malaria. Outcome is continuous, with higher scores indicating greater preparedness.

Health care facilities on average had a preparedness to diagnose and treat malaria score of 10.79 (standard deviation=1.08). The minimum score among facilities was 6, while the highest score was 12 (Table 3.3). The descriptive analysis revealed that a total of 69 health care facilities were considered prepared to diagnose and treat malaria in the binary analysis (Table 3.4). A significant association was observed between the binary preparedness score and location (p=0.02). Almost 96% of prepared health care facilities were located in a rural area, while nearly 20% of unprepared health care facilities were located in an urban area. No other significant associations were found in the descriptive analysis (Table 3.4).

Table 3.4. Preparedness of health care facilities to diagnose and treat malaria by health care facility characteristics (N=100).

	Prepared	Unprepared	
	N (%)	N (%)	
Total	69 (69)	31 (31)	p-value
Variable			
District of Facility			
Mutare	20 (29.0)	12 (38.7)	0.1[a]
Makoni	21 (30.4)	13 (41.9)	
Buhera	28 (40.6)	6 (19.4)	
Type of Facility			
Hospital	2 (2.9)	3 (9.7)	0.2[b]
Health center/clinic	67 (97.1)	28 (90.3)	
Facility Managing Authority			

Government/public	64 (92.8)	27 (87.1)	0.5[b]
Private, mission/faith- based/other	5 (7.2)	4 (12.9)	
Location of Facility			
Urban	3 (4.4)	6 (19.4)	**0.02[b]**
Rural	66 (95.6)	25 (80.6)	
Average Hours Facility is Open per Day			
24 hours	68 (98.5)	29 (93.5)	0.2[b]
Less than 24 hours	1 (1.5)	2 (6.5)	

[a] Chi-squared Test performed. [b] Fisher's Exact Test performed. Bolded p-values indicate alpha $\leq$ 0.05.

Using univariable logistic regression, location was the only identified significant factor (Table 3.5). The final model from the multivariable analysis indicated district and location as significant factors. Both Makoni and Buhera had a 70% reduction in odds of preparedness to diagnose and treat malaria compared to Mutare, however, neither of these associations reached significance for district. Rural facilities, as compared to urban, had almost 6 times the odds of being prepared to diagnose and treat malaria (95% CI 1.28,26.91). Type of facility, facility managing authority, and average hours the facility was open per day were not significant factors in either the univariable or multivariable logistic regression models (Table 3.5).

Table 3.5. Factors associated with health care facility preparedness to diagnose and treat malaria in Manicaland Province, Zimbabwe using univariable and multivariable logistic regression (N=100).

	Univariable		Multivariable	
Variable	OR (95% CI)	P-value	aOR (95% CI)	P-value
District of Facility				
Mutare	Reference		Reference	
Makoni	0.35 (0.11,1.06)	0.06	0.34 (0.11,1.09)	0.07
Buhera	0.36 (0.12,1.11)	0.08	0.32 (0.10,1.03)	0.06
Type of Facility				
Hospital	Reference			
Health center/clinic	3.59 (0.57,22.66)	0.2		
Facility Managing Authority				
Government/public	Reference			
Private,	0.53 (0.13,2.12)	0.4		

mission/faith-based/other				
Location of Facility				
Urban	Reference		Reference	
Rural	5.28 (1.23,22.74)	**0.02**	5.87 (1.28,26.91)	**0.02**
Average Hours Facility is Open per Day				
24 hours	Reference			
Less than 24 hours	0.21 (0.02,2.45)	0.21		

Bolded p-values indicate alpha $\leq$0.05. aOR: Adjusted Odds Ratio. 95% CI: 95% Confidence Interval. Preparedness score based on availability of tracer items necessary to diagnose and treat malaria. Outcome is binary, with a score of 90% considered prepared.

Location was identified as the only significant factor in both the univariable and multivariable linear regression models (Table 3.6). In rural facilities compared to urban, the average score for preparedness to diagnose and treat malaria increased by 1.09 (95% CI 0.18,2.00). District, type of facility, facility managing authority, and average hours the facility was open per day were not significant factors either the univariable or multivariable linear regression models. (Table 3.6)

Table 3.6. Factors associated with health care facility preparedness to diagnose and treat malaria in Manicaland Province, Zimbabwe using univariable and multivariable linear regression (N=100).

	Univariable	
Variable	β (95% CI)	P-value
District of Facility		
Mutare Rural	Reference	
Makoni	-0.41 (-1.05,0.23)	0.2
Buhera	-0.63 (-1.28,0.03)	0.06
Type of Facility		
Hospital	Reference	
Health center/clinic	0.91 (-0.31,2.12)	0.14
Facility Managing Authority		
Government/public	Reference	
Private, mission/faith-based/other	0.85 (-.07,1.77)	0.07
Location of Facility*		
Urban	Reference	
Rural	1.09 (0.18,2.00)	**0.02**
Average Hours Facility is Open per Day		
24 hours	Reference	

Less than 24 hours	-1.37 (-2.91,0.18)	0.08

Bolded p-values indicate alpha $\leq$ 0.05. aβ: Adjusted Beta. 95% CI: 95% Confidence Interval. *Location was only significant factor remaining after backwards elimination. Preparedness score based on availability of tracer items necessary to diagnose and treat malaria. Outcome is continuous, with higher scores indicating greater preparedness.

Demographics of Households and Heads of Households

Among the 547 heads of households included in this study, most were married (72.7%), had attended secondary education or higher (60.2%), were either farmers (33.1%) or unemployed (36.4%), resided in a rural location (88.5%) and did not have medical aid (96.0%) (Table 3.7). Heads of households were evenly distributed among the age categories, however, slightly more households had greater than four members (58.5). (Table 3.7)

Table 3.7. Demographics of households and heads of households in Manicaland Province (N=547).

	n (%)
Head of Household Demographics	
Age Group	
18-30 years	149 (27.2)
31-40 years	144 (26.3)
41-55 years	136 (24.9)
>55 years	118 (21.6)
Marital Status	
Married/Co-habiting	398 (72.7)
Not Married	149 (27.3)
Education	
Never Attended	16 (2.9)
Attended Primary	180 (32.9)
Attended Secondary or Higher	351 (60.2)
Occupation	
Farmer	181 (33.1)
Unemployed	199 (36.4)
Other	167 (30.5)
Medical Aid	
Yes	22 (4.00)
No	525 (96.0)

Household Demographics	
Area of Residence	
Urban	63 (11.5)
Rural	484 (88.5)
Number of Household Members	
≤ 4	227 (41.5)
> 4	320 (58.5)
Wealth Index	
Poorest	185 (33.8)
Middle	182 (33.3)
Wealthiest	180 (32.9)

Objective 2: Factors Associated with Household Health Care Utilization

Among the 505 households included in the health care utilization analysis, over 75% utilized health care 3 months or less prior to survey administration (Table 3.8). Those who utilized health care in the last 3 months were more likely to have attended secondary school or higher (68.4%) and were less likely to be older than 55 years of age (18.0%). Households that utilized health care in the last 3 months were more likely to have greater than 4 members (60.8%) (Table 3.8).

Table 3.8. Descriptive statistics of household and head of household demographics by health care utilization.

	≤ 3 months	> 3 months	p-value
	N (%)	N (%)	
Total	383 (75.8)	122 (24.2)	
Head of Household Demographics			
Age Group			
18-30 years	110 (28.7)	27 (22.1)	**0.04**
31-40 years	112 (29.2)	28 (23.0)	
41-55 years	92 (24.0)	32 (26.2)	
>55 years	69 (18.0)	35 (28.7)	
Marital Status			
Married/Co-habiting	287 (74.9)	86 (70.5)	0.3
Not Married	96 (25.1)	36 (29.5)	
Education			
Never Attended	11 (2.9)	4 (3.3)	**0.01**

Attended Primary	110 (28.7)	52 (42.6)	
Attended Secondary or Higher	262 (68.4)	66 (54.1)	
Occupation			
Farmer	124 (32.4)	41 (33.6)	0.7
Unemployed	125 (32.6)	43 (35.3)	
Other	134 (35.0)	38 (31.1)	
Medical Aid			
Yes	14 (3.7)	8 (6.6)	0.2
No	369 (96.3)	114 (93.4)	
Household Demographics			
Number of Household Members			**0.01**
$\leq$ 4	150 (39.2)	64 (52.5)	
> 4	233 (60.8)	58 (47.5)	
Wealth Index			
Poorest	115 (30.0)	43 (35.3)	0.5
Middle	135 (35.3)	39 (31.9)	
Wealthiest	133 (34.7)	40 (32.8)	

Significant p-values are bolded.

Among the 42 excluded heads of households, most were married or co-habiting (59.5%), attended primary (42.8%) or secondary education or higher (54.8%), did not have medical aid (100%), and had greater than 4 members living within their household (69.0%) (Table 3.9). Fewer than 10% of excluded household heads were in the 31-40 year age group. Also, most excluded heads of households fell into the poorest wealth index category (57.1%) (Table 3.9).

Table 3.9. Descriptive statistics of excluded heads of households for the health care utilization analysis (N=42).

	N (%)
Total	42 (100)
Head of Household Demographics	
Age Group	
18-30 years	12 (28.6)
31-40 years	4 (9.5)
41-55 years	12 (28.6)
>55 years	14 (33.3)

Marital Status	
Married/Co-habiting	25 (59.5)
Not Married	17 (40.5)
Education	
Never Attended	1 (2.4)
Attended Primary	18 (42.8)
Attended Secondary or Higher	23 (54.8)
Occupation	
Farmer	16 (38.1)
Unemployed	11 (26.2)
Other	15 (35.7)
Medical Aid	
Yes	0 (0)
No	42 (100)
Household Demographics	
Number of Household Members	
≤ 4	13 (31.0)
> 4	29 (69.0)
Wealth Index	
Poorest	24 (57.1)
Middle	11 (26.2)
Wealthiest	7 (16.7)

Univariable logistic regression indicated that age and household size were significantly associated with utilizing health care at 3 months or less prior to survey administration (Table 3.10). The odds of utilizing health care 3 months or less prior to the survey, for those aged older than 55 years was 50% less compared to those aged 18-30 (95% CI 0.27,0.87). Households with more than 4 members compared to those with less than 4 members had 1.71 (95% CI 1.10,2.08) times the odds of utilizing health care 3 months or less prior to survey administration (Table 3.10).

Significant factors identified by the multivariable logistic regression analysis included education, medical aid, and household size (Table 3.10). Those that attended secondary school or higher had 1.50 times the odds of utilizing health care within the last 3 months compared to those who had never attended school. However, this association did not reach statistical significance (95% CI 0.46,4.91). Those who had medical aid, compared to those who did not, had over twice the odds of utilizing health care within the last 3 months. This association also did not reach statistical significance (95% CI 0.92,5.74). The multivariable logistic regression indicated that household size greater than 4 was associated with significant increased odds of utilizing health care within the last 3 months, compared to households with 4 members or less (aOR 1.71, 95% CI 1.13,2.59) (Table 3.10).

Table 3.10. Factors associated with households utilizing health care within the last 3 months in Manicaland Province, Zimbabwe using logistic regression (N=505).

	Univariable		Multivariable	
Variable	OR (95% CI)	P-value	aOR (95% CI)	P-value
Head of Household Demographics				
Age category				
18-30 years	Reference			
31-40 years	0.98 (0.54,1.77)	0.95		
41-55 years	0.71 (0.39,1.26)	0.2		
> 55 years	0.48 (0.27,0.87)	**0.01**		
Marital Status				
Married/Co-habiting	Reference			
Not Married	0.80 (0.51,1.26)	0.3		
Education completed by head of household				
Never attended	Reference		Reference	
Primary school	0.77 (0.23,2.53)	0.7	0.76 (0.23,2.53)	0.7
Secondary school or higher	1.44 (0.45,4.68)	0.5	1.50 (0.46,4.91)	0.5
Occupation				
Unemployed	Reference			
Farming	0.86 (0.52,1.42)	0.6		
Other	0.82 (0.50,1.36)	0.4		
Have Medical Aid	1.85 (0.76,4.52)	0.2	2.29 (0.92,5.74)	0.08
Household Demographics				

Household wealth				
Wealthiest	Reference			
Middle	1.04 (0.63,1.72)	0.9		
Poorest	0.80 (0.49,1.32)	0.4		
Household size				
≤4 members	Reference		Reference	
>4 members	1.71 (1.14,2.58)	**0.01**	1.71 (1.13,2.59)	**0.01**
Transportation to health care facility				
Personal or Public Transport	Reference			
Walking	0.34 (0.04,2.74)	0.3		
Travel minutes to health care facility	1.00 (0.99,1.00)	0.3		
Head of Household Perceptions of Health Care Facility				
Time You Waited to See a Provider was a Problem	0.91 (0.55,1.53)	0.7		
Ability to Discuss Problems or Concerns about Your Health was a Problem	1.08 (0.57,2.04)	0.8		
Amount of Explanation You Received about the Problem or Treatment was a Problem	1.20 (0.65,2.20)	0.6		
Privacy from Having Others See the Examination was a Problem	1.32 (0.69,2.51)	0.4		
Privacy from Having Others Hear Your Consultation Discussion was a Problem	1.19 (0.63,2.23)	0.6		
Availability of Medicines at this Facility was a Problem	0.93 (0.61,1.42)	0.7		
Availability of Personnel at this Facility was a Problem	1.22 (0.71,2.10)	0.5		
Hours of Service at this Facility was a Problem	1.19 (0.63,2.23)	0.6		
Number of Days Services are Available was a Problem	1.17 (0.52,2.63)	0.7		
Cleanliness of the Facility was a Problem	1.12 (0.36,3.47)	0.8		
Treatment by Staff was a Problem	1.64 (0.92,2.94)	0.09		
Cost of Services or Treatments was a Problem	1.12 (0.67,1.88)	0.7		

Concerned about COVID-19 Spread in Community	0.87 (0.58,1.31)	0.5		
Concerned about COVID-19 Infection	1.13 (0.74,1.71)	0.6		

Bolded p-values indicate alpha $\leq$ 0.05. aOR: Adjusted Odds Ratio. 95% CI: 95% Confidence Interval.

Objective 3: Factors Associated with Head of Household COVID-19 Knowledge

Among the 547 heads of households, mean knowledge score for COVID-19 symptoms was 3.51, with the minimum score being 0 and the maximum score being 9.00 (Table 3.11). The mean knowledge score for COVID-19 infection was slightly higher with 3.77. The minimum score for knowledge of infection was 0 with the maximum being 5.00. The mean knowledge score for COVID-19 prevention was over double the other knowledge scores, at 8.08. The minimum score was 1.00 and the maximum was 12.00. The mean knowledge score for the total COVID-19 knowledge was 15.36. The minimum score obtained was 1.00, while the maximum score obtained was 22.00 (Table 3.11).

Table 3.11. Distribution of COVID-19 knowledge scores among heads of households in Manicaland Province, Zimbabwe (N=547).

Outcome	Mean	Standard Deviation	Minimum	Maximum
Knowledge of COVID-19 Symptoms Score	3.51	1.65	0	9.00
Knowledge of COVID-19 Infection Score	3.77	1.24	0	5.00
Knowledge of COVID-19 Prevention Score	8.08	2.12	1.00	12.00
Total COVID-19 Knowledge Score	15.36	3.69	1.00	22.00

The univariable logistic regression indicated that age category, marital status, education, wealth, and whether the head of household had heard of the COVID-19 pandemic and emergency number were significantly associated with COVID-19 knowledge (Table 3.12). The mean score for knowledge increased by 1.21 (95% CI 0.39,2.02) and 1.42 (95% CI 0.59,2.25) for those aged 31-40 and 41-55 years, respectively compared to those aged 18-30. Mean knowledge decreased by 1.14 (95% CI -2.00,-0.27) for those aged older than 55 years compared to those aged 18-30. For those not married, mean knowledge decreased by 0.82 (95% CI -1.52,-0.13) compared to those married or co-habiting. When compared to those who never attended school, mean knowledge increased for both primary (β 3.55, 95% CI 1.69,5.42) and secondary or higher education (β 4.00, 95% CI 2.07,5.72). Mean knowledge score decreased by 2.49 (95% CI -3.20,-1.78) for the poorest households compared to the wealthiest. Hearing about the COVID-19 pandemic, compared to not hearing about it, increased mean knowledge by 5.20 (95% CI 1.98,8.44). Lastly, mean knowledge increased by 1.19 (95% CI 0.57,1.81) for those who heard about the COVID-19 emergency number compared to those who had not (Table 3.12).

The multivariable linear regression model indicated that age, wealth, whether the head of household had heard of the COVID-19 pandemic and emergency number were significantly associated with COVID-19 knowledge (Table 3.12). Mean knowledge increased by 0.78 (95% CI 0.02,1.54) for those aged 31-40 and 1.15 (95% CI 0.38,1.92) for those aged 41-55 years, and decreased by 0.85 (95% CI -1.66,-0.04) for those aged greater than 55 years, compared to those aged 18-30 years. For heads of households that completed primary (aβ 2.74 95% CI 1.05,4.44) and secondary or higher education (aβ 2.05 95% CI 0.27,3.83), mean knowledge score increased compared to those who never attended. Mean knowledge also increased for the middle wealth households (aβ 0.74, 95% CI 0.05,1.42), but decreased for the poorest households (aβ -2.13, 95% CI -2.82,-1.44) when compared to the wealthiest households. Hearing about the COVID-19 pandemic (aβ 5.93, 95% CI 3.03,8.83) and the COVID-19 emergency number (aβ 0.99, 95% CI 0.42,1.57) increased the mean knowledge score (Table 3.12).

Table 3.12. Factors associated with knowledge of COVID-19 symptoms, infection, and prevention among heads of households in Manicaland Province, Zimbabwe (N=547).

	Univariable		Multivariable	
Variable	β (95% CI)	P-value	aβ (95% CI)	P-value
Head of Household Demographics				
Age category				
18-30 years	Reference		Reference	
31-40 years	1.21 (0.39,2.02)	**0.004**	0.78 (0.02,1.54)	**0.045**
41-55 years	1.42 (0.59,2.25)	**0.0008**	1.15 (0.38,1.92)	**0.004**
> 55 years	-1.14 (-2.00,-0.27)	**0.001**	-0.85 (-1.66,-0.04)	**0.04**
Marital Status				
Married/Co-habiting	Reference			
Not Married	-0.82 (-1.52,-0.13)	**0.02**		
Education Completed				
Never attended	Reference			
Primary school	3.55 (1.69,5.42)	**0.0002**	2.74 (1.05,4.44)	**0.002**
Secondary school or higher	3.90 (2.07,5.72)	**<0.0001**	2.05 (0.27,3.83)	**0.02**
Occupation				
Unemployed	Reference			
Farming	0.09 (-0.67,0.85)	0.8		
Other	-0.14 (-0.90,0.62)	0.7		
Heard about COVID-19 Pandemic	5.20 (1.98,8.44)	**0.002**	5.93 (3.03,8.83)	**<0.0001**
Seen/Heard COVID-19 Messages in Last 6 Months	3.13 (-0.50,6.76)	0.09		
Heard of COVID-19 Emergency Number	1.48 (0.87,2.10)	**<0.0001**	0.99 (0.42,1.57)	**0.0007**
Household Demographics				
Household Wealth				
Wealthiest	Reference		Reference	
Middle	0.58 (-0.12,1.29)	0.1	0.74 (0.05,1.42)	**0.03**

Poorest	-2.49 (-3.20,-1.78)	**<0.0001**	-2.13 (-2.82,-1.44)	**<0.0001**
Household Size				
≤4 members	Reference			
>4 members	0.48 (-0.14,1.11)	0.1		

Bolded p-values indicate alpha ≤ 0.05. aβ: Adjusted Beta. 95% CI: 95% Confidence Interval.

CHAPTER 4: DISCUSSION

Here, we first aimed to assess the current state of health care facilities to diagnose and treat malaria, as well as the factors associated with health care facility preparedness. We found that most health care facilities had the necessary tracer items to diagnose and treat malaria. However, there were some gaps in availability of malaria services, malaria diagnosis training, and anti-malarial drugs. Having proper training of health care workers is crucial in prompt malaria diagnosis and treatment, which has been a focus throughout Zimbabwe in recent years (57). Without proper training and guidelines, the quality of diagnosis and treatment provided by the facility can be of poor quality (60). Proper treatment of malaria requires the availability and adequacy of anti-malarial drugs, and ensuring the patient uses the drugs properly. With observed resistance to anti-malarial drugs throughout SSA and Zimbabwe, having a diverse set of drug options is crucial to progress toward malaria elimination (61). However, it cannot be assumed that many health care facilities in this study would have all anti-malarial drugs. For example, hospitals should have certain essential anti-malarial drugs tailored toward complicated and severe cases, while rural health centers and clinics should have drugs tailored to treatment of uncomplicated malaria (62).

This study found that location of health care facility (urban or rural) was associated with preparedness to diagnose and treat malaria. We found that a greater proportion of rural facilities were prepared to diagnose and treat malaria than urban facilities. This observation reflects the findings in a Ghanaian study, in which rural health facilities were found to have a higher quality of health care and patient safety standards compared to urban health facilities (63). Conversely, hospitals, typically located in more urbanized areas, may have better access to resources for the diagnosis and treatment of complicated malaria, given that rural health facilities often refer these cases to district hospitals (64). The materials for diagnosis and treatment of complicated malaria are different than that of uncomplicated malaria. Diagnostics such as microscopy and antimalarials such as intravenous artesunate are used in the event of complicated malaria and would not typically be found at a rural health facility (62). Here, we focused on the tracer items needed to diagnose and treat uncomplicated malaria, given that our sample consisted of mostly rural health care facilities. Therefore, our findings may be attributable to the criteria and health care facility demographics.

Second, we aimed to assess the factors associated with household health care utilization amidst the COVID-19 pandemic. We identified several factors associated with utilizing health care in the last 3 months, including education, medical aid, and household size. Although education and medical aid were significant factors included in the final model, none of the assessed associations reached a significance level below 0.05. Various other studies have observed a positive association between level of education and increased health care utilization (52,65). Other studies have demonstrated increased odds of utilizing health care when the head of household has insurance or medical aid (51,66). We found significant increased odds of utilizing health care within the last 3 months among households larger than four members. This finding has been inconclusive in the literature, with studies finding no association, and others finding increased health care utilization among smaller households (67). This may be attributable to differences in population composition and average household size. Manicaland Province has an average household size of 4.2, with each district included here having an average slightly higher than the provincial average (58). Also, the increased probability of a household member needing to utilize health care among larger households compared to smaller may play a role in this finding.

Third, we aimed to assess the factors associated with head of household COVID-19 knowledge of symptoms, infection, and prevention. COVID-19 knowledge was found to be associated with head of household age, hearing about the COVID-19 pandemic and COVID-19 emergency number, and household wealth. Our results indicate a positive relationship with the middle age categories (31-54 years) and COVID-19 knowledge when compared to those aged 18-30. However, individuals 55 years and older had lower knowledge scores compared to those aged 18-30. A Ghanaian study observed this similar relationship between knowledge and age, with decreased knowledge for younger individuals, higher knowledge for middle ages, followed by decreased knowledge for older ages (45). Education was also found to be associated with increased COVID-19 knowledge here, similar to findings in other studies (45,68,69). Not surprisingly, hearing about the pandemic and the COVID-19 emergency number were both associated with increased COVID-19 knowledge. Simply engaging with information about the pandemic and having access to a reliable information source such as the emergency number, provides individuals with crucial knowledge of infection and prevention measures. This ultimately can encourage behaviors to curtail the impact of the pandemic in SSA and throughout the world (69).

There are several limitations within this study. First, the cross-sectional nature of the study design prevented us from observing changes over time among health care facilities and households. We also were unable to determine a baseline state prior to the pandemic for the relationship between variables and outcomes assessed here. Given that the COVID-19 pandemic is a rapidly evolving public health problem, the impact it has on facilities and households may change over time. Second, health care utilization varies throughout the year, especially for malaria. Due to a larger malaria case load and higher transmission rates occurring during the rainy season, more individuals will utilize health care for malaria during this time. However, data for this study were collected during the dry season. Data during the rainy season could provide further insight into how the COVID-19 pandemic impacts health care utilization at the height of malaria transmission. Third, it is unclear whether the categorization of the outcome of preparedness to diagnose and treat malaria in the logistic regression analysis is meaningful. However, in order to address the arbitrariness of the categorization, an additional analysis where the outcome was treated as continuous was performed. Fourth, the COVID-19 knowledge score may not properly identify individuals who are adequately knowledgeable concerning COVID-19 symptoms. Heads of households were not prompted with COVID-19 symptoms to identify correct responses. Instead, they were given the freedom to respond with however many symptoms they could identify on their own. COVID-19 information channels such as infographics, public announcements, and fact sheets typically list 3-5 of the most common symptoms of COVID-19. Therefore, an individual who responded with the three most common COVID-19 symptoms (including fever, cough, and shortness of breath) generally should not be considered less knowledgeable than someone who was able to list more of the uncommon symptoms (such as nausea and loss of taste or smell). Lastly, the results of this study are only generalizable to primarily rural areas where malaria is endemic. However, research concerning the pandemic's impact on health care facilities and households in these settings is very limited, highlighting the need for additional studies in these settings.

There are various public health implications to this study. The Zimbabwean government and other stakeholders in the region such as The Global Fund and the National Malaria Control Program should work to fill the gaps in malaria services and anti-malarial drug availability. Continued prioritization toward malaria elimination efforts is essential, while adapting to the conditions of the pandemic to avoid a malaria outbreak, similar to that of April 2020 (70). The increased odds of health care utilization by households with greater than 4 members points to the effectiveness of Zimbabwean health system reforms. The reforms, which include increasing health care access through the offering of certain free health services reduce the financial burden associated with utilizing health services (71). Continued attention toward cost reduction among health services should be pursued. Public health organizations throughout Zimbabwe such as Zimbabwean Ministry of Health and Childcare should also work to increase the dissemination of COVID-19 information, while diversifying the method of information delivery. Increased focus on the most popular information sources such as television, WhatsApp, and radio to target individuals with low education, and those who are younger than 30 years and older than 55 years should be pursued (72). Our results revealed that awareness of the COVID-19 emergency number increased COVID-19 knowledge. Further development and promotion of this resource should also be pursued. Future research should investigate preparedness to diagnose and treat malaria, and factors associated with health care utilization and COVID-19 knowledge in other malaria-endemic LMICs. Future research should also seek to investigate urban health care facilities' preparedness, taking into account the tracer items needed for diagnosis and treatment of complicated malaria.

This study adds to the limited body of knowledge surrounding the COVID-19 pandemic and its impact on malaria-endemic countries in SSA. Prior to the pandemic, many of these countries had malaria control or elimination efforts in place. Now that the COVID-19 pandemic has impacted these countries, control and elimination efforts may be in jeopardy if supplies and resources for malaria diagnosis and treatment are not regularly available. This study also provides insight into what factors are associated with households utilizing health care, and household knowledge of COVID-19. Utilizing health care and increased knowledge of COVID-19 both play roles in the mitigation of both COVID-19 and malaria in Zimbabwe.

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APPENDIX A: VARIABLES FOR PREPAREDNESS SCORE

Table A.1. Variables considered for scoring preparedness of health care facilities to treat and diagnose malaria.

Variables Considered for Preparedness Score	Categories
24 Health Care Worker Available at Facility	Yes or No
Providers Diagnose Malaria at Facility	Yes or No
Malaria Treatment Available Every Day at Facility	Yes or No
Facility Provides RDT Diagnosis for Malaria	Yes or No
RDT Kit Observed in Facility	Yes or No
RDT Out of Stock in the Past 4 Weeks	Yes or No
Facility Prescribes Treatment for Uncomplicated Malaria	Yes or No
Observed Guidelines for Diagnosis and Treatment of Malaria in Facility	Yes or No
Facility Providers Trained for Malaria Diagnosis and Treatment	Yes or No
Observed Artemether-Lumefantrine (Coartem)	Yes or No
Observed Doxycycline (oral)	Yes or No
Observed Pediatric Coartem (or other anti-malaria drugs)	Yes or No