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INVESTIGATION OF A CHOLERA OUTBREAK IN MANICALAND IN 2023

BY

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A RESEARCH PROPOSAL SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF MEDICAL LABORATORY SCIENCES IN THE COLLEGE OF HEALTH, AGRICULTURE AND NATURAL SCIENCES

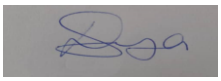
ABSTRACT

Cholera, caused by the bacterium *Vibrio cholerae* is a water borne disease that has caused various outbreaks in Zimbabwe and other countries for centuries. This study was done to investigate the 2023 cholera outbreak in the seven districts of Manicaland province in Zimbabwe. The aim was to establish the socio- economic and socio-demographic factors that were associated with this outbreak. In addition, the laboratory information regarding the particular biotypes associated with the outbreak as well as the antibiotic resistance patterns were also noted. This was done as a retrospective cross-sectional study. The results showed that the *Vibrio cholera* biotype responsible for the 2023 Cholera Outbreak in Manicaland was El Tor. Mutare district had the most cholera cases with 55% and Nyanga had the least with 0.5% of the cholera culture-confirmed cases. The results also showed that the age group 20-69 years for both males and females had the highest numbers of cholera cases with 67.8% each. The least affected age group was the <2years with 2.8% and 1.5% for males and females respectively. It was found that lack of treated water, poor personal hygiene and overcrowding were the socio-economic demographic factors highly associated with the outbreak. Of all the cultured isolates of *V. cholerae*, 100% of them were susceptible to Tetracycline, Azithromycin and Ciprofloxacin. However, Ciprofloxacin was out of stock more than 6 out of the 8 months under this study. There was 100% resistance observed in Cotrimoxazole and Ampicillin. From the results obtained in can be recommended also that there is need for health education to improve personal and communal hygiene including hand washing with soap and water.

DECLARATION

This proposal is the original work of Amos Chinheya it has been prepared in accordance with the guidelines for dissertations in the Africa university. It has not been submitted to Africa University or any other universities.

Name of student: Amos Chinheya

Signature:  Date: 28 March 2024

Declaration by supervisor

I, having supervised and read this project, am satisfied that this is the original work of the author in whose name it is being presented.

Supervisor: Mr. Z. Chiwodza

Signature: 

Date: 26 April 2024

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LIST OF ABBREVIATIONS

AST-Antimicrobial Susceptibility Testing

AUREC-Africa University Research Ethics Committee

CDC -Centers for Disease Control

CFR-Case Fatality Ratio

CTC-Cholera Treatment Centre

DCD-Disease Control Directorate

EHT-Environmental Health Technician

FCH-Family Child Health

IDP-Internally Displaced People

IHR-International Health Regulations

ISO-International Organisation for Standardization

MoHCC-Ministry of Health and Child Care

OI-Opportunistic Infections Department

OPD- Outpatient Department

PCR-Polymerase-chain reaction

PMD-Provincial Medical Director

RIDA-Rural Infrastructure Development Agency

RRT-Rapid Response Team

SADCAS-Southern African Community Accreditation services

SPSS-Statistical Package for Social Sciences

TCBS-Thiosulfate Citrate Bile Salts agar

UNICEF-United Nations Children`s Fund

UNDP-United Nations Development Programme

VCPH-Victoria Chitepo Provincial Hospital

VCPHL-Victoria Chitepo Provincial Hospital Laboratory

VIP-Ventilated Improved Pit

WASH-Water Sanitation and Hygiene Project Model

WHO-World Health Organisation

ZIMSTAT-Zimbabwe National Statistical Agency

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CHAPTER 1

INTRODUCTION

1.0 Introduction.

This chapter is focusing on the background to the cholera disease from the context of Manicaland and Zimbabwe. The chapter will discuss the probable causes of the continued prevalence of Cholera in Zimbabwe. It looked at the why we need to do the study, when and where the study will be done as well as the limitations associated with this particular study.

1.1 Background to the study.

Britain had the worst Cholera outbreak in history. The worst single year of cholera was 1854; 23,000 died in Great Britain alone (UNDP, 2023). The fourth and fifth cholera pandemics (beginning in 1863 and 1881, respectively) were generally considered to have been less severe than the previous ones. This showed that the country was more prepared to deal with the outbreaks. Although it is considered a medieval disease, cholera continues to be a major public health threat with a global presence. Across the globe, an estimated four million cholera cases and over 140,000 deaths are reported each year. Africa sees a large number of these cases with 17 countries affected by cholera with over 150,000 cases, resulting in 3000 deaths (He et.al, 2021). Zimbabwe is among those impacted by the scourge of cholera with outbreaks following a somewhat cyclical pattern, coinciding with the rainy season. However, in 2008 to 2009, Zimbabwe suffered a cholera outbreak with over 90,000 cases reported in 60 out of 62 districts,

resulting in about 4,300 deaths (WHO, 2022). Other neighboring southern African states, such as Malawi, South Africa, and Mozambique, also frequently experience cholera outbreaks (He et.al, 2021). The last 10 years have seen two major outbreaks, one in 2008/09 which resulted in over 100,000 cases including over 4,000 deaths, and another in 2018/19, where there were 10,000 cases with 69 deaths across the 21 cholera hotspot districts in the country, with the nation's capital Harare, among the worst affected (WHO, 2023). As at April 2023, about 579 confirmed cases confirmed by culture have been identified with at least nine who succumbed to cholera (WHO, 2023). However, the roadmap for Zimbabwe to eliminate cholera in line with our 10 Year Promise to eliminate cholera by 2028 has to be analysed to see if this can be a reality. Therefore, this study focused on the 2023 Cholera Outbreak and provided the relevant background on the sociodemographic factors associated with Cholera. The preparedness of the Cholera outbreaks, however, is also affected by the availability of drugs to cure and prevent the onset on the disease. In such a case, it is noted that just like any other bacteria, *Vibrio cholerae* can develop resistance to antibiotics. Knowing the prevalence of any disease provides insight on the nature of resources and preparedness that is needed to curb the outbreaks. This study therefore focused on the prevalence of cholera outbreaks in the seven districts of Manicaland. It will analyses the common biotypes; their drug resistance patterns as well as the sociodemographic and socioeconomic factors that were associated with this outbreak in Manicaland. This is in the hope to limit morbidity and mortality in any future outbreaks.

1.2 Statement of the problem.

Cholera outbreaks over the past decade have been managed well. However, the recent outbreak of cholera, which was identified on 15 March 2023, spread to the seven districts of Manicaland.

It caused devastating impacts in the socio-economic livelihoods of the people in the province. Efforts to control the disease are being made by the Ministry of Health and Child Care. Yet, there are challenges in accessing healthcare in some communities. This increases the risk of transmission among the districts of the province. Whilst data on the morbidity and mortality of Cholera is available on the governments SiteREP, there is some information that is not published. This includes the biotypes of the cholera and its resistance patterns. Such information is important to guide clinicians on the best clinical interventions. In addition, the socio-demographic information in affected areas is important to get. This is especially necessary since the disease was more common in Manicaland than any other province. This will help in establishing interventions to control the disease. These interventions will be specific to the community.

1.3 Aim of the study.

To investigate the prevalence of the different *Vibrio cholera* biotypes and antimicrobial resistance patterns from samples brought to VCPHL during the March 2023 to October 2023 period. The researcher also aimed to establish the socio-demographic factors associated with the Cholera outbreak in Manicaland in 2023.

1.4 Research Objectives.

- To report on the number of culture-confirmed *Vibrio cholerae* and its biotypes responsible for outbreak in the seven districts of Manicaland in 2023 using samples brought to the provincial laboratory.

- To determine the antimicrobial susceptibility patterns of *Vibrio Cholerae* during this outbreak
- To identify the socio-demographic and socio-economic factors associated with the cholera outbreak in Manicaland in 2023

1.5 Research questions.

- What is the number of culture-confirmed Vibrio cholerae and its biotypes responsible for outbreak in the seven districts of Manicaland in 2023 using samples brought to the provincial laboratory?
- How to determine the antimicrobial susceptibility tests (AST) pattern of *Vibrio Cholerae*?
- What are the socio-demographic and socio-economic factors associated with the cholera outbreak in Manicaland in 2023?

1.6 Significance of the Study.

The study is crucial in providing the required data, which can be used by the Ministry of Health and Childcare in the combating of the next Cholera outbreaks. Information from this study will unveil pertinent information required in the reduction and management of Cholera in the province.

1.7 Delimitations of the study.

- The study is to focus on the data that is collected by the Cholera Response Teams in the seven districts of Manicaland.

- The study is focusing on the samples collected since the start of the declared outbreak of Cholera in Manicaland province from the 15th of March 2023 till the 15th of October 2023

1.8 Limitations.

- The researcher was unable to visit the seven districts and carry out the socio-demographic survey by himself
- The findings of the study are applicable for use in the academics and the ministry of health and child care after application of recommendations.

1.9 Assumptions.

- The study assumes that all of the Cholera cases are reported to the nearest health facility
- All reported treated Cholera cases were obtained from infections in the Manicaland province not from other provinces.
- The health facilities and professionals are qualified to manage the disease.

1.10 Chapter Summary.

The chapter provided the background to the study. The problem statement of the study as well as the aims and objectives. The limitations and delimitations of the study as well as the significance of the study.

CHAPTER II

LITERATURE REVIEW

2.0 Introduction.

This chapter is for the related literature review. The chapter explores the number of cultured confirmed *Vibrio cholerae* and its biotypes responsible for cholera outbreaks. It also explores the Antimicrobial susceptibility tests (AST) patterns for *Vibrio cholerae* and the testing methods and antibiotics. The sociodemographic factors associated with the cholera outbreak will also be discussed.

2.1. Conceptual framework.

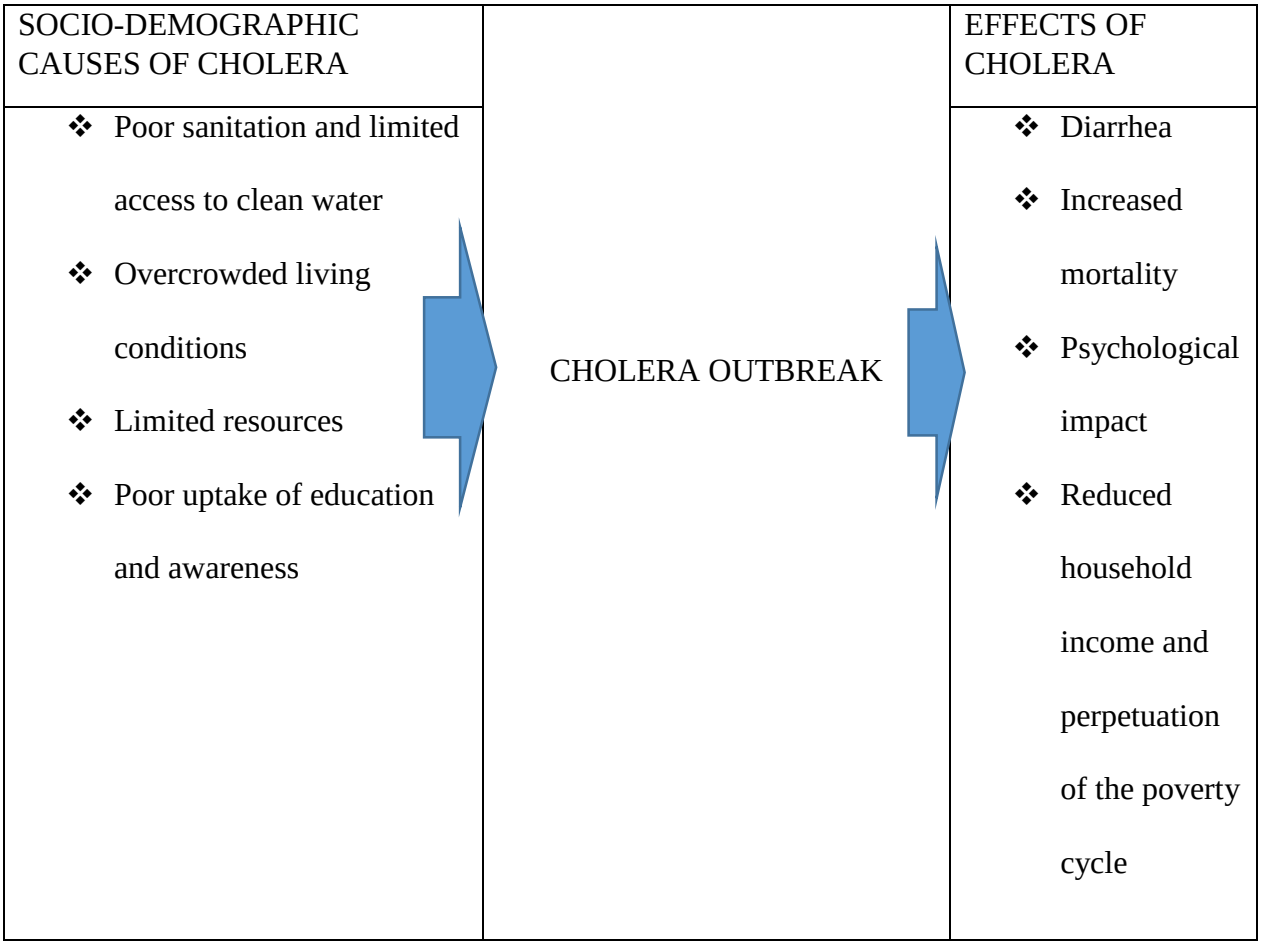


Figure 1: Conceptual framework (adapted from World Health Organisation, 2023)

Limited resources in the community and household can affect sanitary conditions, which promotes the transmission of Cholera. In addition, poor uptake or lack of awareness of the deleterious effects of Cholera promotes Cholera transmission. The disease itself is linked to increased morbidity and mortality. Diseased individuals also reduce the household income and if this spreads to the household and community, it perpetuates the poverty cycle. This can also affect national finances directly and indirectly.

2.2. The prevalence of *Vibrio cholerae* and its biotypes responsible for cholera outbreaks.

Since mid-2021, the world is facing an acute upsurge of the seventh cholera pandemic characterized by the number, size and concurrence of multiple outbreaks, the spread to areas free of cholera for decades and alarming high mortality rates (Rashid et.al,2022).

Acute and watery diarrhea are the symptoms of cholera, a gastrointestinal infection brought on by the toxic bacteria *Vibrio cholerae* serogroup *O1* or *O139* (Ali et.al, 2022). Cholera can present as a serious sickness, however other people may only show little or no symptoms (Khan, et.al, 2021). Remarkably, 1 in 10 cholera patients will experience severe symptoms such as cramping in the legs, vomiting, and watery diarrhea (Hasan and Siddique, 2021).

The gold standard for cholera laboratory diagnosis is still the isolation and identification of *Vibrio cholerae* serogroup *O1* or *O139* by culture of a stool specimen (WHO, 2023). Selective thiosulfate–citrate–bile salts agar (TCBS) is good for isolation and identification, whereas Cary Blair medium is best for transportation (Rashid et.al, 2022).

The World Health Organization suggests tetracycline, doxycycline, furazolidone, trimethoprim-sulfamethoxazole, erythromycin, or chloramphenicol as antimicrobial medicines for treating cholera patients. Both norfloxacin and ciprofloxacin work well (WHO, 2023). The sensitivity of *V. cholerae O1* strains to antimicrobial drugs should be identified at the start of an epidemic and should be routinely checked because antimicrobial resistance has been an increasing issue in many regions of the world (Hasan and Siddique, 2021)

2.3 The sociodemographic factors associated with the cholera outbreak.

Acute diarrheal illness known as cholera is brought on by direct human-to-human contact (Ali et.al, 2023). It puts 1.3 billion people at danger since it is prevalent in more than 50 countries

worldwide (Rashid et.al, 2022). According to reports, there are about 2.8 million cases and 95,000 fatalities worldwide each year (Hasan and Siddique, 2021). Although water and sewage treatment has essentially eradicated cholera from high-income countries more than a century ago, the disease is still a major source of sickness and mortality in many Asian and African nations (Ali et.al, 2023). Africa continues to have a greater rate of cholera infections and fatalities than any other region in the globe (He et.al, 2021). This is linked to deficient health systems, poor hygiene and sanitation, and limited access to clean drinking water, all of which promote the spread of cholera (Ali et.al, 2023). Improving access to WASH (potable water, sanitation, and hygiene) is essential to lowering the cholera epidemic in Africa.

Cholera may be contracted by eating or drinking food or water tainted with cholera bacterium. When there is an epidemic, the water or food is typically contaminated by an infected person's excrement. In places where sewage and drinking water are not properly treated, the illness can spread quickly (American CDC, 2023). Water sources that are contaminated are the primary cause of cholera infections. Surface and well water are potential habitats for the bacteria.

According to a research by Ali et.al (2023) on a cholera outbreak that began in the Eastern Ugandan district of Bwikhonge Sub-county and Bulambuli District on February 29, consuming tainted water from the Cheptui River was the source of the outbreak. Nonetheless, the research suggested purifying or boiling drinking water, enhancing sanitation, giving chlorine pills to the impacted areas, and installing more borehole pumps as a long-term fix.

This research will examine the effects of tainted drinking water, particularly in light of the presence of rivers in each of Manicaland's seven districts. These might be an upstream source of pollution that aids in the spread of *Vibrio cholerae* throughout all of Manicaland's districts.

To prevent feces from contaminating food and water, it is critical to separate feces. On the other hand, expanding access to sanitary facilities (such as pour-flush latrines, basic pit latrines, ventilated upgraded latrines, and latrines connected to a septic tank or public sewer). According to (He et.al,2021), latrines should be positioned at least 30 meters away from any water source and 2 meters above groundwater to prevent contamination of any drinking water sources.

In rural regions, open defecation is common, which contributes to the spread of cholera (WHO, 2023). However, the community needs to make sure that excreta is disposed of safely. In this situation, it is imperative to have functional restrooms in all residences as well as public areas like village meetings.

2.4 Chapter summary.

The frequency and biotypes of *Vibrio cholerae* in cholera epidemics were examined in this chapter. The report also included details on the AST patterns and the methodology of the examinations. The sociodemographic elements that contribute to cholera epidemics were also investigated.

CHAPTER III

RESEARCH METHODOLOGY

3.1 Introduction.

This chapter outlines the research design, study population, exclusion criteria, and inclusion criteria, sample size, sampling procedure, pilot study, data analysis and finally ethical consideration

3.2 Research design.

The research design used in the study was a retrospective cross-sectional study.

3.3 Study population.

The study populations in this study comprise the 7 districts of Manicaland which were affected by the cholera outbreak in 2023 which are Mutasa, Makoni, Nyanga, Mutare, Chimanimani, Chipinge, and Buhera. Suspected cholera samples were collected and brought to the laboratory from March 2023 to October 2023. This period was selected since it was the period when cholera cases were increasing when it started up.

The second population is for the sociodemographic factors that cause cholera these are to be obtained from the seven cholera response teams representing each district with reports in the provincial hospital.

3.4 Exclusion criteria.

Samples that were brought to the laboratory without full details of the patients (particularly address) were rejected and hence not processed.

3.5 Inclusion criteria.

All suspected cases of cholera as identified by the Cholera Rapid Response teams in the seven districts of Manicaland from March 2023 to October 2023 were brought to the laboratory for confirmations.

3.6 Sample size.

The following formula shall be used to calculate the sample size

$$\underline{N= (Z^2) (P) (1-P))}$$

$$D^2$$

Where:

N= the sample size.

Z= the statistic corresponding to level of confidence.

P= expected prevalence (obtained from pilot study or similar studies).

D= precision.

Z=1.96%.

P=Expected prevalence obtained from similar studies =50%.

D=precision hence there is no enough guidelines for choosing appropriate precision hence it is then recommended to select a precision below 5% if the prevalence is going to be between 10 and 90%.

$N= (1.96^2) (0.5) (1-0.5) / 0.05^2 = 369.$

Assuming there will be spoilt samples, a 10% contingency will be set. Therefore, the sample size will be 406.

3.7 Sampling procedure.

All samples brought to the laboratory during the specified time period were assessed for infection status, pathogen biotype, strain, and antimicrobial resistance patterns.

3.8 Pilot study.

A small-scale preliminary study was conducted at Victoria Chitepo Provincial Hospital Laboratory using data from March 2023 to evaluate the feasibility, duration and the cost of the study and the data which is required to do the project is readily available.

A questionnaire was used to get sociodemographic factors associated with the cholera outbreak from EHTs at VCPH. This has been attached as an appendix.

3.9 Study setting.

The study was conducted at Victoria Chitepo Provincial Hospital laboratory. The laboratory main catchment area is the Manicaland Province and it is one of the major government run institution laboratory in Zimbabwe with more than 50 diagnostic tests recommended by SADCAS in accordance with recognized international standard ISO15189:2012(Rashid et.al,2022). The laboratory also has an adequate staff complement of professional scientists with great capacity for quality testing and an information system to store and manage data. The microbiology department of the institution receives specimens for microscopy, culture and sensitivity from both private and public health institutions**.**

Study area.

According to ZIMSTAT, (2023), Manicaland province have approximately 2,098,110 people. It consists of seven districts namely Chipinge, Chimanimani, Makoni, Nyanga, Mutare, Buhera and Mutasa. The province have some prominent rivers, which are Save River, Pungwe, Gairezi, and Odzi. These rivers are important in the spreading of cholera in the district since for example Save, Odzi and Pungwe cuts through the provinces (Ministry of Tourism, 2023). The province have about 1286 water points are in the province with 113 piped water schemes according to the Rural Infrastructure Development Agency (2023). There are 277 health facilities serving the predominantly rural population, and most health facilities (89%) are government-owned rural health centers and clinics (MoHCC, 2024). These are critical in the referring and management of the cholera outbreaks.

3.10 Data analysis.

The researcher used excel spreadsheets to enter data and will later import to Statistical Package for Social Sciences (SPSS version 15) for statistical analysis of the data over the period of March 2023 -October 2023. Data collected was presented as frequencies. The evaluations of data will be carried out at 95% confidence level and $P<0.05$ will be considered statistically significant by the researcher in the study. The data to be collected for socio-demographics will be analysed using correlation and regression.

3.11 Ethical considerations.

The researcher obtained approvals from the office of the medical superintendent in charge of Victoria Chitepo Provincial Hospital as well as the medical laboratory manager at Victoria Chitepo Provincial Hospital Laboratory. An ethical approval was obtained from Africa University Research Ethics Committee (AUREC) before the researcher commences on data collection for the study. All the data that will be collected for the study will be handled with

utmost confidentially by the researcher. The researcher to identify patients/participants from whom the data will be obtained will use laboratory coding. Informed consent will be obtained from each participant in each questionnaire after the purpose of the study is explained to respondent. Confidentiality of the information will be assured and privacy of the respondent will be maintained. The participants will administer the questionnaires in an ethical consideration with provision of consent.

3.12 Chapter summary.

This chapter looked at how the study will be designed, the number of participants for the study as well as the criteria for accepting participants into the study. Ethical issues were also explored. The chapter also highlighted on how the data is going to be analysed and presented.

CHAPTER IV

DATA ANALYSIS AND PRESENTATION

4.0 Introduction.

This chapter is for the results presentation, discussion and analysis of the study on the investigation of cholera outbreak in Manicaland in 2023. However, in this chapter, the exploration on the report on the number of culture-confirmed *Vibrio cholerae* and its biotypes responsible for outbreak in the seven districts of Manicaland in 2023 using samples brought to the provincial laboratory was done. The results on the antimicrobial susceptibility patterns of *Vibrio Cholerae* during this outbreak were analysed and discussed. The socio-demographic and socio-economic factors associated with the cholera outbreak in Manicaland in 2023 was assessed in this chapter. Lastly, the chapter summary was provided.

4.1 Results of the study population.

The table 4.1 shows the study population of the total suspected cholera cases of 1538. The study population had 773 and 765 for males and females respectively. The age group 20-69 had the highest suspected cases with 942. The age group with lowest suspected cases is that for >69 with 71.

Table 4.1 Results of the baseline characteristics of the study population.

Age group (in years)	Males	Percentage of Total	Females	Percentage of Total	Total	Percentage of Total
<2	58	3.77%	33	2.15%	91	5.92%
2-5	72	4.68%	51	3.32%	123	8.00%
6-19	156	10.14%	155	10.08%	311	20.22%
20-69	458	29.78%	484	3.47%	942	61.25%
>69	29	1.89%	42	2.73%	71	4.62%
Total	**773**	**50.26%**	**765**	**49.74%**	**1538**	100.00%

Source (Primary data, 2024)

4.2 Results on the number of culture-confirmed *Vibrio cholerae* and its biotypes responsible for outbreak in the seven districts of Manicaland.

This section will provide the results of the culture-confirmed *Vibrio cholerae* and its biotypes responsible for the outbreak in the seven districts of Manicaland from March 2023 to October 2023. The results will be based on all the cholera suspected samples brought to the Victoria Chitepo Hospital Laboratory for culture confirmation.

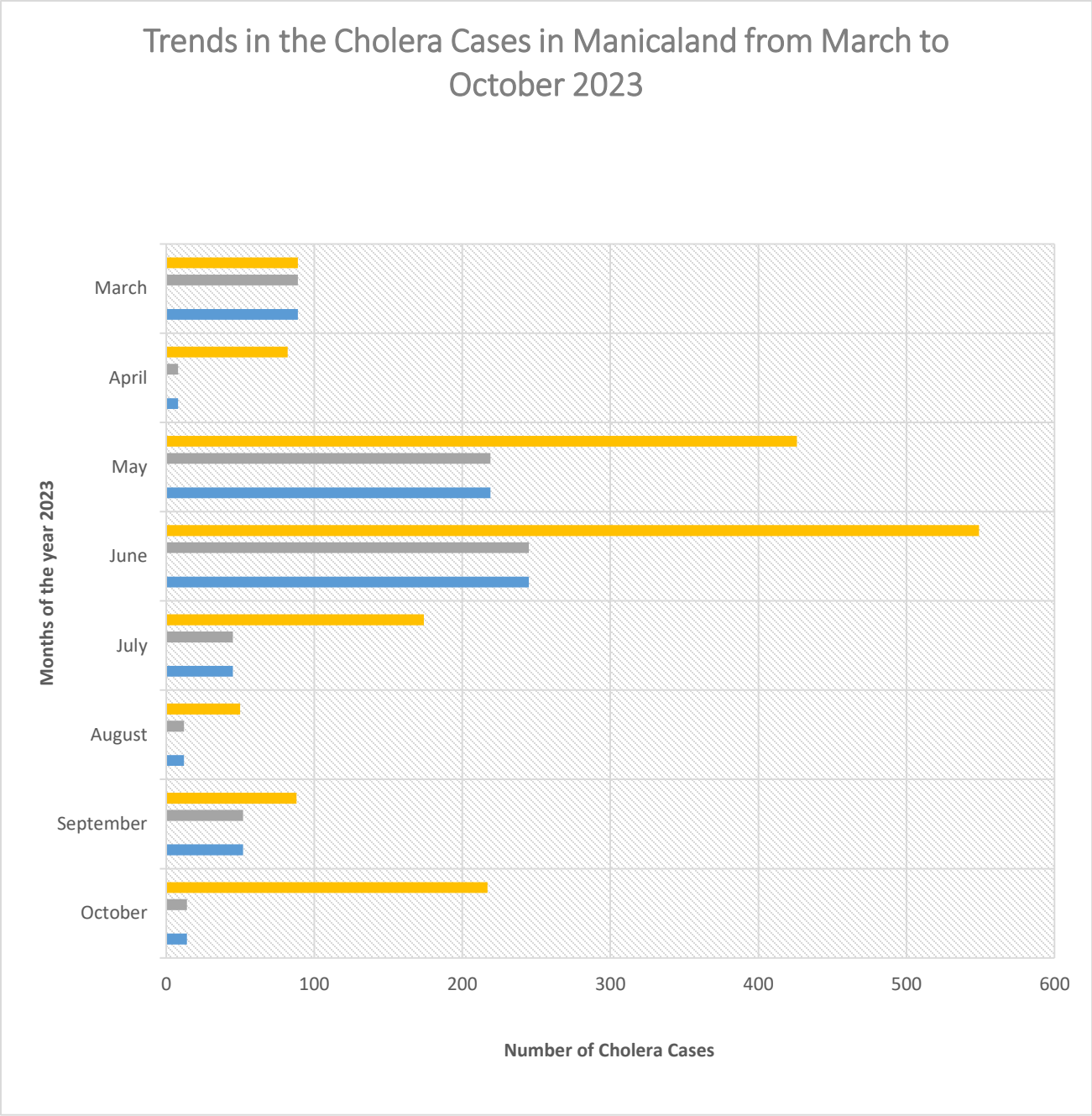


Figure 4.2: The results for the suspected cholera samples tested at Victoria Chitepo Hospital Laboratory.

The Figure 4.2 above shows that there was the greatest number of suspected cholera tests carried out by the laboratory in June. The tests were 549 and of these 245 were tested positive which

constituted 44% of the total samples. In March, 48 suspected cholera cases samples were brought to the laboratory for testing and 14 samples tested positive for *Vibrio cholerae*. However, the number of samples brought to the laboratory increased from March 2023 to June 2023, after which the suspected cholera samples brought to the laboratory decreased to 174 in July and further reduced until September. In October, the suspected cases rose from 88 in September to 217.

The results also show that there was no other cholera biotype that was confirmed except the *El Tor* one. The other biotype that was also considered was the Classical biotype which showed negative for all the tests for the period March to October 2023.

4.3 The Results on the number of culture-confirmed *Vibrio cholerae* and the biotypes in each district.

Below is the graph that analyses the data collected per each district for the biotypes and the *Vibrio cholerae* culture-confirmed cases.

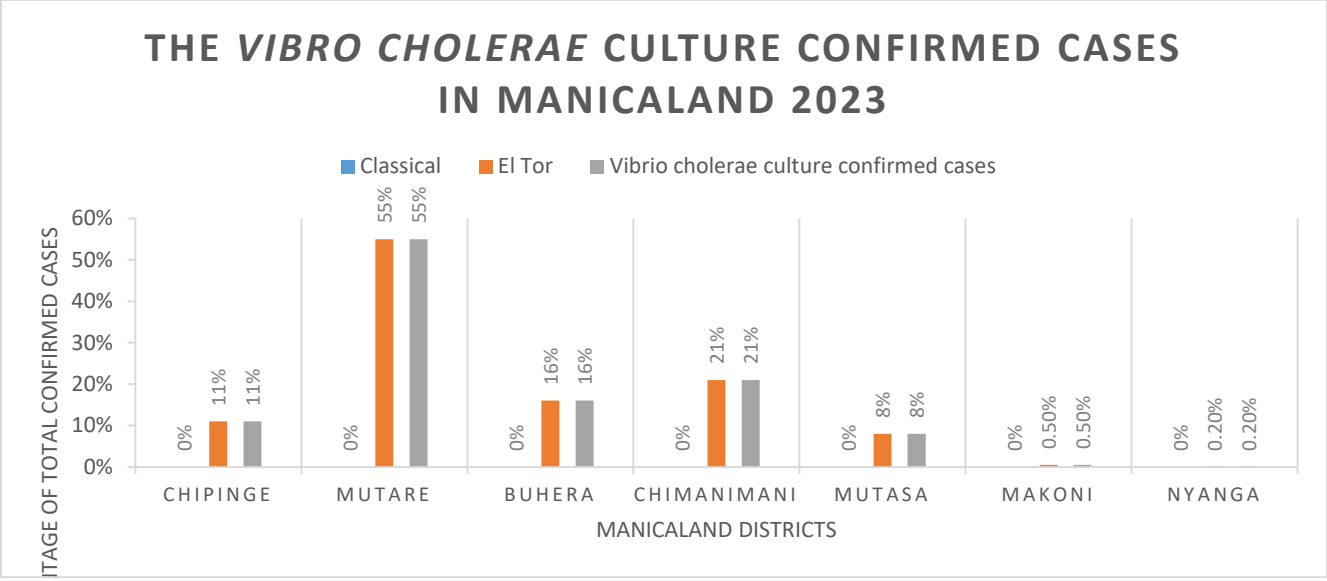


Figure 4.3: Culture-confirmed *Vibrio cholerae* and the biotypes in each district for the period March 2023 to October 2023.

The results showed that Mutare district had the highest percentage of the *Vibrio cholerae* culture confirmed cases *El Tor* biotype constituting 55%. Chimanimani district had the second highest rate of 21%. The district with the least rate of *Vibrio cholerae* culture confirmed cases was Nyanga with 0.2%. Also, Makoni and Mutasa districts had lower *Vibrio cholerae* culture confirmed cases compared to the other districts with rates of 0.5% and 8% respectively. Chipinge and Buhera districts had significant *Vibrio cholerae* culture confirmed cases although these were lower than Mutare and Chimanimani districts with rates of 11% and 16% respectively.

4.3 The antimicrobial susceptibility patterns of *Vibrio Cholerae* during this outbreak.

This section will provide the results of the antimicrobial susceptibility patterns of *Vibrio cholerae* during the outbreak for the period March 2023 to October 2023.The patterns for the susceptibility and resistance of the *Vibrio cholerae* biotype *El Tor* will be assessed in this section. This will provide the various antibiotics that were best for use in the treatment of the cholera in the March 2023 to October 2023 outbreak.

Table 4.4: The antimicrobial susceptibility patterns of *Vibrio cholerae* from March 2023 to October 2023.

	Tetracycline			**Chloramphenicol**			**Azithromycin**			**Cotrimoxazole**			**Ampicillin**			**Ciprofloxacin**		
	S	**I**	**R**	**S**	**I**	**R**	**S**	**I**	**R**	**S**	**I**	**R**	**S**	**I**	**R**	**S**	**I**	**R**
Mar	14	0	0	14	0	0	14	0	0	0	0	14	0	0	14	Out of stock		
Apr	8	0	0	8	0	0	8	0	0	0	0	8	0	0	8	Out of stock		
May	219	0	0	219	0	0	219	0	0	0	0	219	0	0	219	Out of Stock		
Jun	245	0	0	0	245	0	245	0	0	0	0	245	0	0	245	Out of stock		
Jul	Out of stock			0	45	0	45	0	0	0	0	45	0	0	45	Out of stock		
Aug	Out of stock			Out of stock			12	0	0	0	0	12	Out of stock			Out of stock		
Sep	Out of stock			Out of stock			52	0	0	0	0	52	Out of stock			Out of stock		
Oct	89	0	0	89	0	0	89	0	0	0	0	89	0	0	89	89	0	0

Source: Researcher's compilation (2024)

Key

S	Susceptible	**I**	Intermediate	**R**	Resistant

The table above showed that there are six antibiotics that are recommended for use in the treatment of cholera. These are tetracycline, chloramphenicol, Azithromycin, Ampicillin, Cotrimoxazole and ciprofloxacin. However, it was seen that for the start of the outbreak in March 2023 until October 2023, *Vibrio cholerae* was resistant to Cotrimoxazole and Ampicillin. However, during the start of the cholera outbreak, Ciprofloxacin was out of stock until September. The impact of antibiotics out of stock has impact on delayed response to outbreak. In October, *Vibrio cholerae* was susceptible to this same drug with 89 cultured samples susceptible. Azithromycin was the only drug that was used for the whole period March 2023 to October 2023 with *Vibrio cholerae* being susceptible in all of the samples tested. Tetracycline antibiotic was available from March until June when it went out of stock until it was available in October. In the months when it was available *Vibrio cholerae* was susceptible in all of the tests that were conducted. Chloramphenicol was available from March to July and went out of stock in August and September until it was available in October. However, *Vibrio cholerae* was susceptible to this drug from March until May. In June and July, *Vibrio cholerae* became intermediately sensitive to the drug before it went out of stock. When it was available after 2 months, the *Vibrio cholerae* became susceptible to chloramphenicol drug for all of the 89 samples tested.

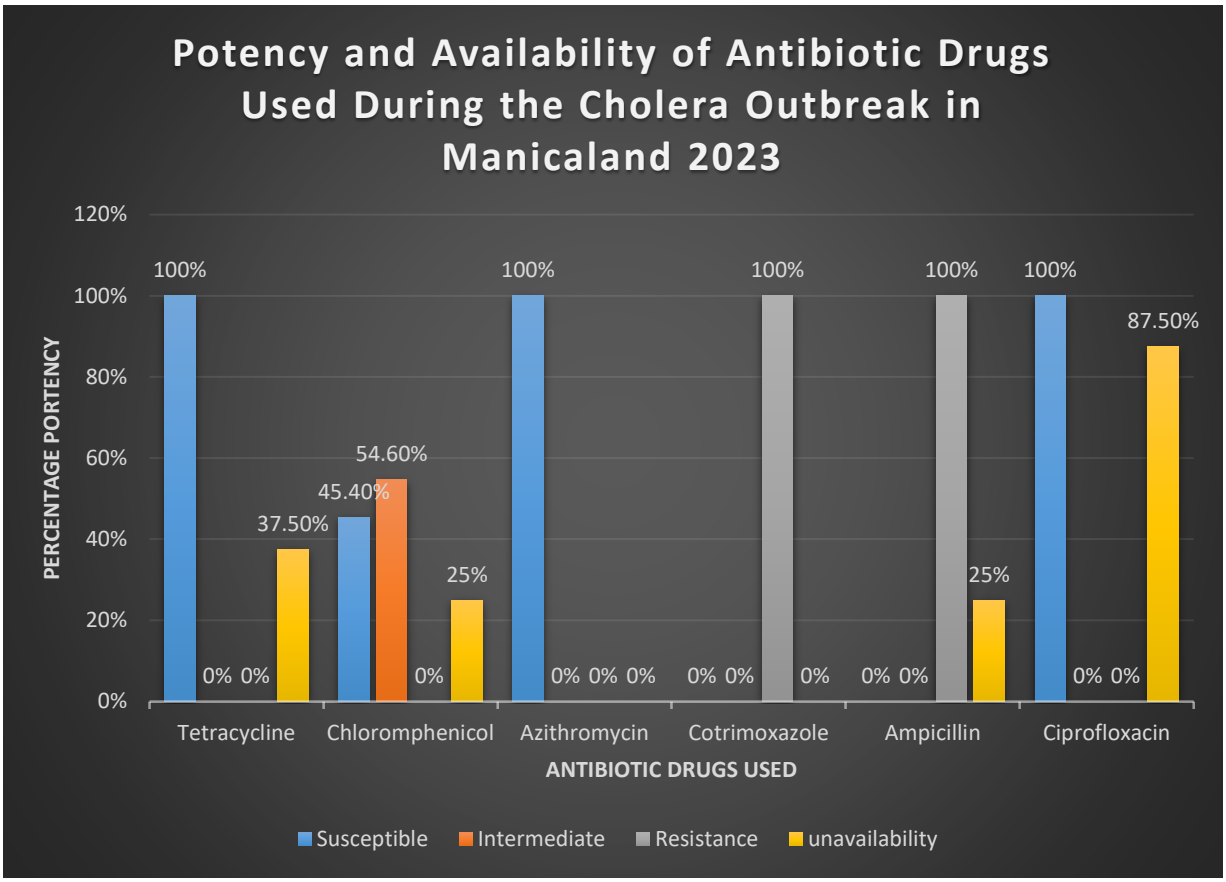


Figure 4.4: The antimicrobial susceptibility patterns of *Vibrio cholerae* from March 2023 to October 2023.

The results showed that for every time that tetracycline, Azithromycin and Ciprofloxacin was used as the antibiotic for antimicrobial susceptibility, *Vibrio cholerae* showed 100% susceptibility. There was 100% resistance showed by *Vibrio. cholerae* against Cotrimoxazole and ampicillin. It was seen also that chloramphenicol had intermediate potency of 54.6% and 45.5% to the *Vibrio cholerae* strains isolated in this time period. Ciprofloxacin was unavailable for 87.5% of the time but able to be effective on its availability. Cotrimoxazole and Azithromycin were always available yet the former was resisted by the *Vibrio cholerae* and the later was 100% effective.

4.4 The socio-demographic and socio-economic factors associated with the cholera outbreak in Manicaland in 2023.

This section will provide the results found on the socio-demographic and socio-economic factors associated with the cholera outbreak in Manicaland. Below is the table of the results.

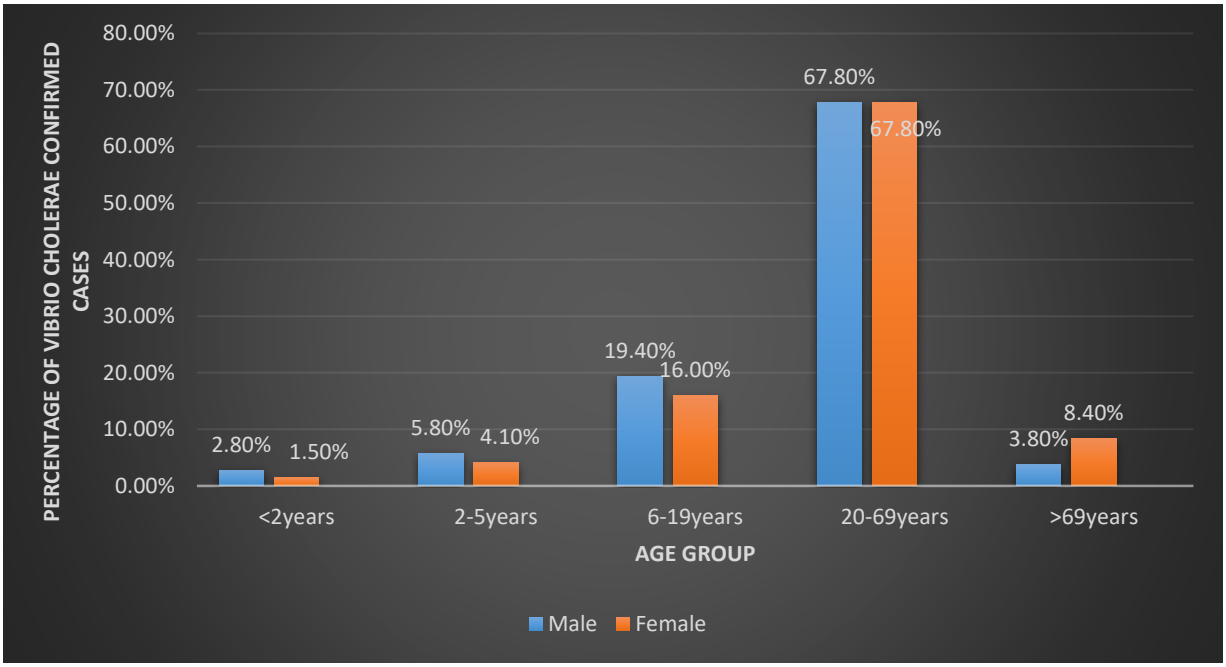
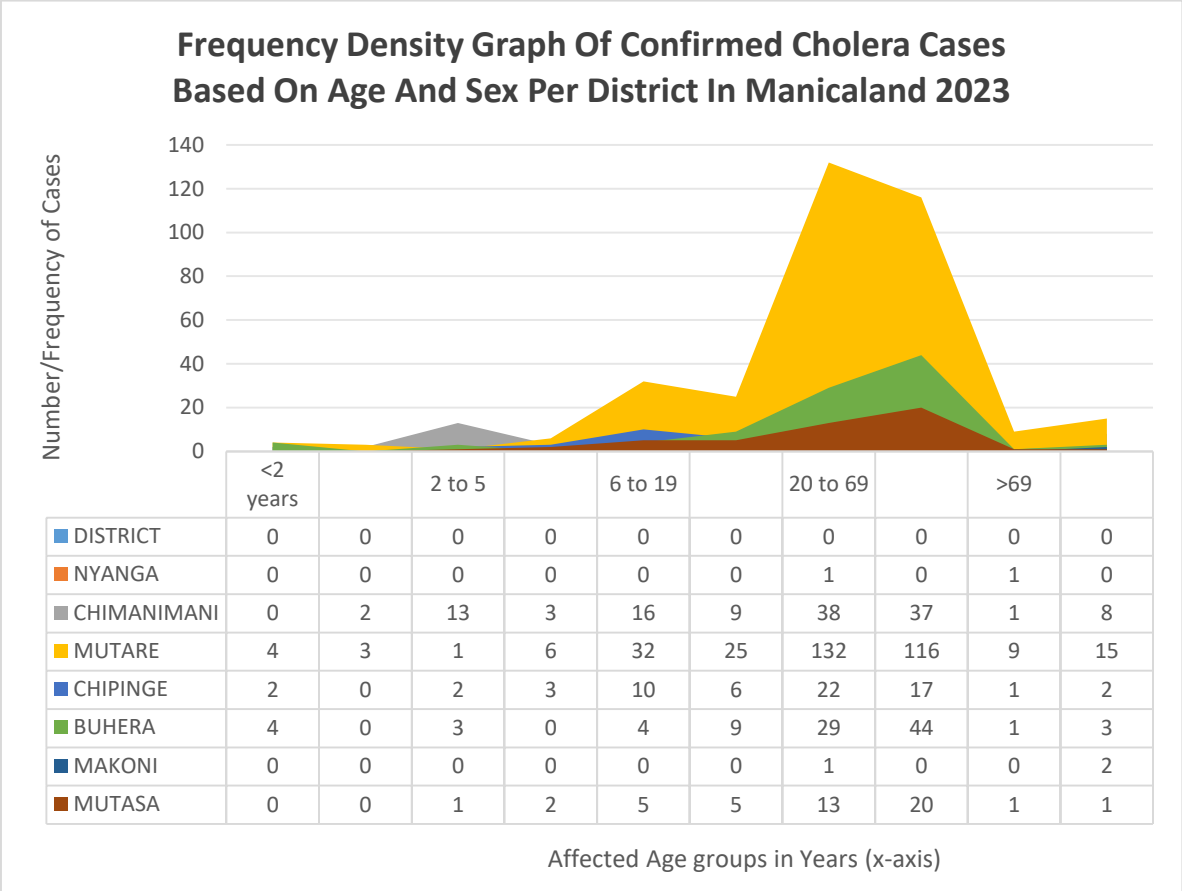


Figure 4.5 Age-sex demographic factors of culture confirmed cholera cases for the seven districts of Manicaland province for the 2023 cholera outbreak.

Below are the results for the different seven districts of Manicaland that shows how each district was affected by the Vibrio cholerae cases of the 2023 cholera outbreak on the age-sex demographics. The seven districts are Mutasa, Nyanga, Makoni, Mutare, Chipinge, Chimanimani and Buhera.

Figure 4.6: The results of the age demographics that shows the statistics for each district of Manicaland province.



	<2 years		2 to 5		6 to 19		20 to 69		>69	
DISTRICT	0	0	0	0	0	0	0	0	0	0
NYANGA	0	0	0	0	0	0	1	0	1	0
CHIMANIMANI	0	2	13	3	16	9	38	37	1	8
MUTARE	4	3	1	6	32	25	132	116	9	15
CHIPINGE	2	0	2	3	10	6	22	17	1	2
BUHERA	4	0	3	0	4	9	29	44	1	3
MAKONI	0	0	0	0	0	0	1	0	0	2
MUTASA	0	0	1	2	5	5	13	20	1	1

The results above showed that the highest number of confirmed *Vibrio cholerae* culture confirmed cases were in Mutare district. The highest age group being 20 to 69 years the rates being 132(38.2%) and 116(34.3%) for male and females respectively. This age group had the highest culture confirmed cases across all the 7 districts. Nyanga had the least rates of confirmed *Vibrio cholerae* culture cases with only 1 (0.3%) for 20 to 69 years and (1) 0.3% for >69% age group. However, the age group of below 2 years had the least confirmed cases for both males and females in all districts with the highest in this age group being Mutare district with 4(1.2%) males and 3(0.9%) for males and females respectively.

Table 4.7: Results for the socio-economic factors for the seven districts.

SOCIO-ECONOMIC FACTORS		Frequency of the culture-confirmed cholera cases
Source of water	Tap water	273
	Borehole	135
	Shallow well	138
	Borehole bush pump	138
How far is the source of water	Less than 10meters	200
	Less than 50meters	120
	less than 500 meters	133
	More than 1km	231
Toilet systems	Blair	213
	Pit latrine	240
	Flush system	231
Number of people staying at the homestead	2	40
	3	78
	4	79

	5	120
	More than 5	367
Is the water treated	Yes	120
	No	564
Did the cases attended funerals of victims of cholera?	Yes	364
	No	320

From the table above, it can be observed that most of the confirmed cases used tap water (n=273; 40%). However, a good number also used a shallow well (n=180; 20%) or a borehole bush pump (n=138; 20%). The rest used a borehole. Most of these water sources were more than a kilometer away (n=231; 33.7%) although this value is almost the same as those water sources that were less than 10 meters (n=200; 29.2%) away from the household. In 82% of the cases, there was no evidence of water treatment of these water sources. The distribution of the use of safe water systems (Blair system - 31%; Pit Latrine - 35%; Flush System - 34%) was more or less similar.

In terms of density per household, more than half of the confirmed cases (n=367; 54%) were found to be residing with more than 5 people per household. At least 17% of the cases lived with 5 people in the household.

Table 4.8 Factors Observed in the Case Fatalities of Victims of Cholera.

Factors	Frequency Of Factors In The 90 Case Fatalities Observed	
How many funerals made use of a body bag for their deceased relative?	80	
How many practice good hygiene at home? (90 Case Fatalities)	Wash hands with soap	14
	Wash hands without soap	30
	Use ashes to wash hands	17
	Does not use water	32

Source: Primary data, (2024)

At least one third of these cases did not wash their hand regularly and another third did not use soap when washing hands with water. Almost half (53%) of the cholera case victims attended a funeral of another cholera case victim. With regard to disaster response, of the 90 fatalities that occurred, 80 were able to accept to use a body bag for the funeral.

4.4 Chapter summary.

This chapter provided the results and analysis of those results as found from the research. However, results of those that were infected by the *Vibrio cholerae* and the biotypes that were responsible was articulated. In addition, the antimicrobial sensitivity tests patterns were also

provided and the socio-economic and socio-demographic factors that were responsible for the *Vibrio cholerae* outbreak were discussed.

CHAPTER V

DISCUSSION

5.0 Introduction.

This chapter covers the discussion of the major findings of the study. In this study, the conclusions are also focused on. The recommendations are given in this chapter also.

5.1 The number of culture-confirmed *Vibrio cholerae* and its biotypes responsible for outbreak in the seven districts of Manicaland.

In the month of March 2023 and April there were low figures for the suspected cholera samples brought to the laboratory are based on the fact that it was the month that cholera outbreak was first reported and the health department was organizing the Response Teams to combat the outbreak (Figure 4.1). According to WHO, (2023) it articulated that low figures in the outbreaks of most diseases, many institutions such as those in Africa lacks the resources for tackling emergency diseases. However, though the Ministry of Health and Child Care had a task force in place it is important to strengthen surveillance and monitoring systems since early detection and rapid response are key in cholera outbreaks (WHO,2023).The increase in cholera cases samples brought to the laboratory after the confirmed March 2023 cholera outbreak testifies to this notion that the outbreak was contained to a lesser extent and there is need to always become fast in mobilization of response teams (Centers for disease Control,2020).

The increase in cholera cases from March to June and a drop until September could be attributed to the fact that in those months will be the rain season. According to Wang et.al, (2023), it was found out that the eastern highlands including Manicaland receive higher rainfall than any other region in the country, which is often longer starting from November to March. However, the climate change has caused the irregular distribution of the rainfall, which often starts early and distributes itself irregularly until the winter. This however explains its contribution in the cholera outbreak. It should be noted that in the rain season cholera transmission is often easy as rainfall can lead to contamination of water sources (CDC, 2022). In addition, the increased flooding during the raining season can cause sewage to overflow and mix with drinking water sources leading to cholera ingestion of cholera bacteria. According to Rebaudet et.al, (2023), heavy rainfall can promote the growth and spread of *Vibrio cholerae* in aquatic environments. However, according to Manicaland Province Statistical Data, (2023), Manicaland has many rivers that are a source of water for the residents such as Mutare, Pungwe, Save, Odzi, Umvumvumvu and so on. It can be also noted that rain season can contribute to poor sanitation and hygiene practices since flooding can disrupt infrastructure and cause overcrowding. These are contributing factors in areas such as Sakubva residential areas and other high-density areas of Manicaland Province. These results are coordinated with those found by Ali et.al (2023), who found out that Bangladesh, India, and Mozambique had more cholera cases reported during rainy season.

The results showed that the biotype responsible for the 2023 cholera outbreak is the *El Tor* type. However, it should be noted that its availability in Zimbabwe is due to its ability to cause more severe and widespread epidemics compared to the classical biotype (WHO,

2023). According to Mutreja et.al. (2021), the *El Tor* type has displaced the previous dominant biotype, the classical biotype in many parts of the world. The *El Tor* type has the higher fitness advantage and is better adapted to survive in the environment allowing it to outcompete other biotypes (WHO, 2024).

5.2 The antimicrobial susceptibility patterns of *Vibrio Cholerae* during this outbreak.

The results showed that cholera outbreak, which had extended from March 2023 until October 2023, a period of about 8 months may have been caused by the dynamics of the lack of antibiotics from stock. However, according to WHO (2023), the unavailability of antibiotics in cholera outbreaks makes *Vibrio cholerae* have great chances to antibiotic resistance.

The reason why chloramphenicol was potent in killing the *Vibrio cholerae El Tor* biotype but later the bacteria becomes intermediately sensitive was that during the first months of the outbreak, the drug may be effective treatment option due to its broad-spectrum antibiotic activity against many pathogens. However, overtime the bacteria may develop resistance to chloramphenicol through various mechanisms such as genetic mutation or acquisition of resistance genes (CDC, 2023). As a result, the effectiveness of chloramphenicol in treating cholera may decrease, and the strain of *Vibrio cholerae* may become resistant to this antibiotic. However, if chloramphenicol goes out of stock or is not readily available for use in the outbreak, alternative antibiotics may be used for treatment. Over time, if the sensitivity of chloramphenicol is removed and the use of other antibiotics becomes more common in this case, the other drugs the resistance to chloramphenicol will decrease a phenomenon called antibiotic cycling or antibiotic resistance cycle. This trend

is also explained in ciprofloxacin where the drug was not available from March until it was used in October when it was successfully useful in trying to eliminate *Vibrio cholerae*.

Azithromycin and tetracycline functions through their inhibition of protein synthesis in the bacterial cell while the later works by inhibiting protein synthesis and disrupting bacterial cell wall formation. However, these two antibiotics can work over a long period in the treatment of cholera due to several aspects. The mode of action of these two antibiotics works by targeting essential processes in the bacterial cell that are crucial for survival. This therefore makes it difficult for *Vibrio cholerae* to develop resistance mechanisms against these two antibiotics. In addition, it has been noticed that the effectiveness of these antibiotics may be based of the conservative use of these antibiotics, which makes them effective over a long period (WHO, 2024).

The resistance of *Vibrio cholerae El Tor* biotype to Cotrimoxazole and ampicillin has been attributed to the pathogen developed specific resistance mechanisms. According to Dutta et.al, (2023), found that the resistance to Cotrimoxazole in *Vibrio cholerae El Tor* biotype is mediated by the acquisition of a plasmid that harbors the genes for dihydropteroate reductase and dihydropteroate synthase, which are the target enzymes of Cotrimoxazole. This plasmid also carries genes for other antibiotic resistance determinants, allowing the bacteria to resist multiple antibiotics. In addition, resistance to ampicillin in *Vibrio cholerae El Tor* biotype has been attributed to the production of Beta-lactamases, enzymes that hydrolyze the Beta-lactam ring of ampicillin and render it ineffective (Shah et.al, 2022). He also elucidated that other researchers found that they found Beta-lactamases (ESBLs) in a strain of *Vibrio cholerae El Tor* biotype that conferred resistance to multiple Beta-lactam antibiotics including ampicillin

5.3 The socio-demographic and socio-economic factors associated with the cholera outbreak in Manicaland in 2023.

The age and sex results on those that got contracted *Vibrio cholerae* infections as they were confirmed by culture in the Victoria Chitepo Hospital Laboratory showed that these demographic features had impact on the disease. However, it was shown that for the children under the age of 2years and those above the age of 69 years had been the least infected. This observation is contrary to most findings of infectious diseases. Infants and children under 2 years of age and geriatrics may be at risk of being infected due to their immature immune systems and lack of protective antibodies against the bacteria. According to a study conducted in Zimbabwe, children under the age of two are more vulnerable to cholera infection because their immune systems are not fully developed, making them infections that are more susceptible to severe and complications (Mukaratirwa et al., 2019). Additionally, young children in Zimbabwe may be at increased risk of cholera infection due to poor hygiene practices, limited access to clean water, and inadequate sanitation facilities in their communities. (World Health Organization, 2023; Bain et al., 2019). Additionally, elderly individuals may also have limited access to clean water and sanitation facilities, which are crucial in preventing the spread of cholera (Rukuni et al., 2022). These factors contribute to the increased vulnerability of elderly people to *Vibrio cholerae El Tor* biotype infections in Zimbabwe.

The majority of those that was infected by *Vibrio cholerae* were of the age group of 20 to 69 with similar proportions of both males and females. This was based on the number of factors. The results show that there were 346 men who were confirmed to be cholera

infected as compared to females who were 338.The results were coordinated with the results found in literature. However, Men in Zimbabwe are vulnerable to being infected by *Vibrio cholerae El Tor* biotype due to a combination of socio-economic factors and cultural practices that put them at higher risk of exposure to the bacterium. One reason is that men in Zimbabwe often work in sectors such as agriculture, mining, and construction where they may meet contaminated water sources. *Vibrio cholerae* is typically transmitted through the consumption of contaminated water or food, and individuals working in these sectors are more likely to be exposed to such sources of contamination (World Health Organization, 2020). Furthermore, cultural practices in Zimbabwe, such as communal eating and sharing of utensils, can also increase the risk of *Vibrio cholerae* transmission among men. Men in Zimbabwe are more likely to participate in communal gatherings, where they may consume food or water that has been contaminated with the bacterium. This can result in a higher likelihood of infection among men compared to women who may not participate as frequently in these communal practices (World Health Organization, 2020). Additionally, limited access to clean water and sanitation facilities in some parts of Zimbabwe can contribute to the vulnerability of men to *Vibrio cholerae* infection. Men are often responsible for providing for their families and may be more likely to seek out alternative sources of water, such as rivers or streams that are not adequately treated or purified. This increases the risk of exposure to the bacterium and subsequent infection (World Health Organization, 2020).

There are several mining areas in Manicaland province, including Penhalonga, Odzi, and Mutare. These mining areas contribute to the risk of *Vibrio cholerae El Tor* biotype infections through the contamination of water sources with mining wastes containing

heavy metals and other pollutants. Mining activities can increase the risk of cholera outbreaks by affecting the quality of water sources used for drinking, cooking, and hygiene practices in local communities. For example, a study by Makoni et al. (2020) found that mining activities in Mutare can contribute to the growth and spread of *Vibrio cholerae* bacteria. Additionally, the excavation and processing of minerals in Penhalonga and Odzi have been linked to increased levels of sedimentation and pollution in rivers and streams, which can serve as breeding grounds for cholera-causing bacteria (Rukuni et al., 2023). The mining activities in Manicaland province can significantly contribute to the risk of *Vibrio cholerae El Tor* biotype infections by contaminating water sources with pollutants and creating favorable conditions for the growth and spread of the bacteria. Efforts to improve water quality and sanitation practices in these mining areas are crucial to mitigating the risk of cholera outbreaks. The mining activities may be why there was an observed heighted number of cases in Mutare district but limited cases in Nyanga district which is more upstream and has limited mining activities.

The results on source of water showed that it contributed to the infections of *Vibrio cholerae*. However, the results showed that borehole water has the least cholera confirmed cases (100), Tap water had the highest cholera-confirmed cases infection rates with 224. Borehole bush pump had the same rates of 180 apiece. However, the high rates in those that used tap water was because there were challenges with water supply and proper hygiene and sanitation could not be done. In most places in the towns in Manicaland, some they go for may days without water just as other towns in Zimbabwe which makes all the hygiene techniques to be very narrowly practiced such as washing hands with running water, proper use of the toilet flash toilet systems. Uncovered water sources can contribute

to *Vibrio cholerae El Tor* biotype infections by providing a breeding ground for the bacteria and allowing for contamination, increasing the risk of cholera transmission. Contaminants such as fecal matter, debris, and other pathogens can easily enter uncovered water sources, leading to the proliferation of *Vibrio cholerae* and the spread of the disease (Mwale et al., 2019). Additionally, uncovered water sources are more susceptible to external contamination from animals, insects, and environmental factors, further increasing the likelihood of *Vibrio cholerae El Tor* biotype infections in Zimbabwe.

Personal hygiene practices have a significant impact on *Vibrio cholerae El Tor* biotype infections and their spread. Good personal hygiene, such as proper hand washing with soap and water, can help prevent the ingestion of contaminated food and water, reducing the risk of contracting cholera (Sur et al., 2023). The results from this study show that two thirds of the cases did not practice good hand hygiene. Additionally, practicing safe food handling and preparation, as well as ensuring safe disposal of human waste, can further limit the transmission of *Vibrio cholerae* and prevent the spread of the disease within communities.

The results showed that there were 564 who had no water treated who were infected by the *Vibrio cholerae* against the 120 who had water treated. However, these results showed that water treated is very critical in cholera prevention. However according to the World Health Organisation, (2024), it showed that clean water contributes to the prevention of cholera. In addition, by this same token it is very essential for the provision of safe drinking water to all. This is the reason for the provision of WASH projects by UNICEF and Oxfam in the schools and communities of Zimbabwe (UNICEF, 2023). The results showed also that the way water is collected played a critical role in the spread of cholera infections. In

this case, those that got their water from far away were more infected as the distance increases.

The type of toilets that are used by the communities played a critical role in *Vibrio cholerae* infections. In this case, it was found that all the recommended toilet systems were used. Blair toilets, also known as VIP (Ventilated Improved Pit) latrines, are designed to improve ventilation and reduce odors in pit latrines. While the design of Blair toilets can help reduce the risk of fecal contamination and odors, improper maintenance and lack of proper cleaning can still lead to the growth and spread of *Vibrio cholerae* bacteria, particularly if the pit latrine becomes flooded or leaks into the surrounding environment (Strande et al., 2023). Pit latrines, commonly used in rural areas, consist of a simple hole dug in the ground for waste disposal. Inadequately constructed or managed pit latrines can contaminate groundwater and surface water sources with *Vibrio cholerae* bacteria, leading to an increased risk of cholera transmission in communities relying on these sanitation facilities (Mekonnen et al., 2023). These have been seen to be used by many of the rural communities in the Manicaland province rural areas. Flush system toilets are connected to a sewer system that transports waste to a treatment facility. Properly managed flush toilets can effectively remove and treat human waste, reducing the risk of *Vibrio cholerae* contamination and the spread of cholera. The towns and growth points of Manicaland such as Mutare, Chimanimani, Rusape, and Nyanga use these in their waste management. However, in areas with inadequate sanitation infrastructure or where wastewater treatment is insufficient, flush toilets can contribute to environmental contamination and the transmission of cholera (Lanata et al., 2023).

The results showed that about 364 of the confirmed cases they visited funerals of those that died of cholera disease. However, 320 did not attend the funerals yet were infected. The statistics showed that they were other factors they caused the infections other than funeral attendance. Due to the high population density per household and poor hygienic practices, those that attended funerals could have acquired the infection and spread it to their housemates. In this case, it should be noted that funeral attending is the source of infection to a greater extend the interactions of people provides the great platform for the infection spreading and transmission according to WHO, (2024). Also, the use of body bags which was highly recommended for those 90 people that died of the disease showed that funerals were properly handled and less risk for cholera spreading was promoted. The results showed that 80 of the 90 funerals held of those deceased with cholera accepted the use of the body bags, which made the infection spreading less. The people that died it was found out that they were not practicing proper sanitation hygiene as recommended by the World Health Organization and the Ministry of Health and Child Care in Zimbabwe. However, results were found that the least number of those that died, 14 wash hands with soap, 30 wash hands without soap, 17 use ashes to wash hands and 32 did not use water.

5.4 Conclusions.

The results showed that the 44% of the samples that were brought to the laboratory at Victoria Chitepo were cultured-confirmed *Vibrio cholerae* cases. Of these 44% cases, the Biotype *El Tor* caused all. The results for the Antimicrobial Sensitivity Tests patterns of the *Vibrio cholerae* showed that of the six antibiotics, the most effective drugs that were sensitive to *El Tor* were Azithromycin and Tetracycline and can be recommended empiric drugs for current treatment of cholera in Manicaland. Cotrimoxazole and Ampicillin

should not be recommended for use in the cholera outbreak due to the resistance of the *Vibrio cholerae El Tor* biotype to these drugs. In addition, it was found that availability of drugs in the treatment of cholera is very vital as it provides a broad spectrum of drugs, which makes effectiveness of the other drugs high. The socio-demographic and socio-economic factors that are responsible for the outbreak of cholera in Manicaland were attributed to the poor personal hygiene, over crowdedness, untreated water supply and mobility of people in places where cholera cases have been reported and confirmed.

5.5 Recommendations.

- Since ensuring access to clean water and adequate sanitation facilities is crucial in preventing the transmission of cholera, improving sanitation in urban areas of the province such as Mutare where cholera cases are the highest. This includes implementing water treatment systems, promoting hygiene practices.
- Since vaccination, campaigns are very critical in reducing the impact of cholera as elaborated in some cholera prone areas such as Mozambique, Malawi, Zambia and Bangladesh according to WHO, (2023). However, deploying cholera vaccines in high-risk areas can help reduce the burden of cholera and prevent outbreaks. Vaccination strategies should be tailored to the specific epidemiological context and target vulnerable populations (World Health Organisation,2024)
- Health Education and community engagement: Educating communities about cholera prevention, symptoms, and treatment can help increase awareness and promote early detection and response. Community engagement initiatives can empower individuals to prevent cholera transmission (Harris et.al, 2023).

- Recommend the use of Tetracycline and Azithromycin in the empiric treatment of *Vibrio cholerae, El Tor* current outbreaks in Manicaland.

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APPENDIX I: GANTT CHART

Gantt chart

	February	March	April	May
Research Initiation/ letters of permission				
Data collection phase				
Data presentation and analysis				
Final report				

APPENDIX II: BUDGET

Budget

Description	**Total (In USD)**
Stationery	$10
Transport	$20
Internet services	$15
Consultations	$60
Total	**$105**

APPENDIX III: DATA REVIEW FORM (QUESTIONNARE)

TO THE HEALTH PROFESSIONALS IN CHOLERA RESPONSE TEAM IN THE SEVEN DISTRICTS

My name is Amos Chinheya (200416). I am conducting a study in the health sector. My study is entitled **"*Investigation of a cholera outbreak in Manicaland in 2023*"** This form is meant to collect information with regard to Cholera Outbreak from March 2023 to October 2023. This information is being sought solely for academic purposes and will be treated with strict confidence.

The questionnaire is based on the data to be collected for the 25 confirmed cases in each district and to be completed by the Rapid Response Cholera Team.

Please randomly select 25 confirmed cases from your district and report on the following

SECTION A: BACKGROUND INFORMATION

1. **Name of District…….**
2. **Number Confirmed Cases…….**
3. **Number of Cholera Deaths recorded in the March to October 2023 period……..**

4. Age and Sex

Age	Frequency	
	Males	Females
<2 years		
2 - 5		
6 - 19		
20-65		
>65		

SECTION B: SOCIO-DEMOGRAPHIC CHARACTERISTICS

1. Please kindly fill in the sociodemographic following.

		Frequency		
Source of water	Tap water			
	Borehole			
	Shallow well			
	Borehole bush pump			
How far is the source of water	Less than 10 meters			
	Less than 50 meters			
	less than 500 meters			
	More than 1km			
Is the source of water covered	Yes			
	No			
Toilet systems	Blair			
	Pit latrine			
	Flash system			
Number of people who share the same toilet	2			
	3			
	4			
	5			
	More than 5			
Is the water treated	Yes			
	No			
Number of people staying at the homestead	2			
	3			
	4			
	5			
	More than 5			

2. Concerning the number of cases that occurred in the district. Did the cases attended funerals of victims of cholera?

	Frequency
Yes	
No	

For the cholera deaths that occurred,

3. Were there sufficient body bags in stock? *(Tick appropriate)*

Sufficient	Available but not sufficient	Not available

4. How many funerals were able to accept the use of a body bag for their deceased relative?

Frequency

5. How many practice good hygiene at home? (*Tick where appropriate*).

	Frequency
Wash hands with soap	
Wash hands without soap	
Use ashes to wash hands	
Does not use water	

6. Do they wash water collection containers?

	Frequency
Yes	
No	

APPENDIX IV: LABAORATORY DATA COLLECTION TOOL FOR AST

The prevalence of *vibrio cholera* and its biotypes responsible for outbreak in the seven districts of Manicaland in 2023 and determining the antimicrobial susceptibility patterns of *Vibrio Cholerae* during this outbreak.

Specimen ID	Date Received	Age	Sex	Biotype	Strain	AST																	
						Azithromycin			Cotrimoxazole			Tetracyline			Cloramphenicol			Ciprofloxacin			Ampicillin		
						S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R

APPENDIX V

Data of the confirmed cholera samples tested at Victoria Chitepo Hospital Laboratory

	confirmed cases	Classical biotype	El Tor biotype	Total samples tested
March	14	0	14	48
April	8	0	8	82
May	219	0	219	426
June	245	0	245	549
July	45	0	45	174
August	12	0	12	50
September	52	0	52	88
October	89	0	89	217

APPENDIX VI: ETHICAL APPROVAL LETTER FROM VICTORIA CHITEPO PROVINCIAL HOSPITAL

4

Telephone: 263-020-64321
Fax: +263-020-67048
E-mail: mphosp@syscoin.co.zw

ZIMBABWE

Reference:

Victoria Chitepo Provincial Hospital
P.O. Box 30
Mutare
MANICALAND
ZIMBABWE

16 February 2024

Att: Mr Amos Chinheya
Victoria Chitepo Provincial Hospital
Po Box 30
Mutare

Re: PERMISSION TO CARRY OUT A RESEARCH ON INVESTIGATION OF CHOLERA OUTBREAK IN MANICALAND IN 2023 AT VICTORIA CHITEPO PROVINCIAL HOSPITAL

In reference to the above subject matter:

I have no objection to your request.

You can go ahead with your research.

Hope you will find this institution helpful in your research.

MUTARE PROVINCIAL HOSPITAL
MEDICAL SUPERINTENDENT
19 FEB 2024
P.O. BOX 30 MUTARE
ZIMBABWE

DR H. Makiwa
ACTING MEDICAL SUPERINTENDENT

APPENDIX VII: CONFIRMATION LETTER FROM SUPERVISOR

AFRICA UNIVERSITY
(A United Methodist-Related Institution)

"Investing in Africa's Future"

DEPARTMENT OF BIOMEDICAL AND LABORATORY SCIENCES
COLLEGE OF HEALTH, AGRICULTURE AND NATURAL RESOURCES

22 February 2024

Aurec Director

Dear Sir/ Madam

RE: APPLICATION FOR DISSERTATION STUDIES FOR Amos Chinheya

This letter serves to confirm that I am supervising the above-mentioned student in his final year dissertation. He has satisfied the requirements of the college in developing his research proposal and it is ready for ethical review.

Your facilitation for the review of the proposal is greatly appreciated.

Thank you

Mr Z Chiwodza

Research Supervisor

zchiwodza@africau.edu

APPENDIX VIII: APPROVAL LETTER FROM AUREC

Inventing in Africa's future

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61 785 Website: www.africau.edu

Ref: AU3173/24

11 March, 2024

AMOS CHINHEYA
C/O Africa University
Box 1320
MUTARE

RE: INVESTIGATION OF A CHOLERA OUTBREAK IN MANICALAND IN 2023

Thank you for the above-titled proposal that you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

a) Research proposal

- **APPROVAL NUMBER** AUREC3173/24
  This number should be used on all correspondences, consent forms, and appropriate documents.
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** March 11, 2024
- **EXPIRATION DATE** March 11, 2025
- **TYPE OF MEETING**: Expedited
  After the expiration date, this research may only continue upon renewal. A progress report on a standard AUREC form should be submitted a month before the expiration date for renewal purposes.
- **SERIOUS ADVERSE EVENTS** All serious problems concerning subject safety must be reported to AUREC within 3 working days on the standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)
APPROVED
P.O. BOX 1320, MUTARE, ZIMBABWE

Yours Faithfully

MARY CHINZOU
ASSISTANT RESEARCH OFFICER: FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE