FACTORS ASSOCIATED WITH CHOLERA OUTBREAKS IN ISIOLO COUNTY, KENYA

BY

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DECLARATION

Student:

I declare that this thesis, submitted to the school of Public Health and Community Development, Maseno University, is my original work and has not been submitted to any institution of higher learning.

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DEDICATION

This work is dedicated to my family for their love and support and to the County and Sub County Health Management Teams in Isiolo County.

ABSTRACT

Isiolo County accommodates nomadic pastoralists with sedentary lifestyles. Since 2010, the county has had cholera incidences every year apart from 2014. In 2013 alone for instance, Isiolo confirmed 8 deaths from cholera (WHO, 2013); in 2016, 10 people were confirmed positive and 500 others treated from exposure (Relief web, 2016); in 2018, Isiolo was one of the six counties that contributed a cumulative of 2943 cholera cases with 55 fatalities (Reliefweb, 2018). There is a dearth of evidence on factors associated with the re-emergence and spread of cholera in Isiolo County. This cross sectional study applied simple random and purposive sampling of households and health care providers respectively, to assess how knowledge and attitude factors, environmental health factors and health system factors influence occurrence of cholera in Isiolo County. We employed Fischer's formula to obtain a sample of 401 respondents. Results indicate that participants interviewed were of modal age 20-39 (60.3%). There were more female respondents (62.6%) than male (37.4%). The majority (75.8%) were married and 76.8% had acquired some form of education ranging from primary to tertiary level. A bigger proportion of participants (69.3%) had no employment at all and majority of those who worked were self-employed (70%) earning a monthly household income of < 1000.00 shillings. 37.2% of the respondents reported having had at least a case of acute watery diarrhea in the past one week from a family member aged 5 years and above. Overall, evidence from this study shows that respondents who knew proper use of toilets ($_{a}$OR=1.38; 95% CI 0.80,2.37) and washing hands after using the toilet ($_{a}$OR=3.54; 95% CI 1.42, 8.81; *p=0.01*) as preventive ways, were less likely to experience occurrence of cholera compared to those who did not. Not washing hands after handling children's feaces ($_{a}$OR=1.98; 95% CI 1.13, 3.46; *p=0.02*); consuming unwashed fruits or vegetables ($_{a}$OR =0.41; 95% CI 0.25, 0.69) proper cooking of food as a practice ($_{a}$OR=0.52; 95% CI 0.28, 0.96; *p=0.04*) were found to be significant predictors to occurrence of cholera. Those who were willing to let a child receive cholera vaccine (OR=1.96; 95% CI, 1.14, 3.34); knew fever as a symptom ($_{a}$OR=0.57; 95% CI 0.33, 0.98; *p=0.04*) were also less likely to experience occurrence of cholera. We conclude that occurrence of cholera is predicted by knowing prevention measures such as proper use of toilet and washing hands after use of toilet. Hygiene factors including not washing hands after handling children's feces, consuming unwashed fruits or vegetables and proper cooking of food were also found to be significantly associated with cholera occurrence. Willingness to let a child receive cholera vaccine and knowledge of cholera symptoms predicted occurrence. The study recommends extensive health education in the county with specific focus on sensitization on the role of sanitation and general hygiene in prevention of cholera. This would require that (i) safety of drinking water is ensured (ii) the importance of toilet ownership is emphasized and (iii) the community is sensitized on the need to present themselves for vaccination against cholera. County health sector stakeholders should explore opportunities to adjust the current service delivery model to address predictor factors not proximal to the community like hospital distance to improve access to healthcare.

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AFRO	-	African Regional Office
CDC	-	Centre for Disease Control
CFR	-	Case Fatality Rate
CHV	-	Community Health Volunteer
CLTS	-	Community Led Total Sanitation
DDSR	-	Department for Disease Surveillance and Response
DHIS	-	District Health Information System
DSRU	-	Disease Surveillance and Response Unit
GIS	-	Geographic Information System
GTFCC	-	Global Task Force on Cholera Control
IDP	-	Internally Displaced Persons
IDSR	-	Integrated Disease Surveillance and Response
KDHS	-	Kenya Demographic and Health Survey
M&E	-	Monitoring and Evaluation
MOH	-	Ministry of Health
MOPHS	-	Ministry of Public Health and Sanitation
OCV	-	Oral Cholera Vaccine
ORS	-	Oral Rehydration Solution
SDGs	-	Sustainable Development Goals
SES	-	Socioeconomic Status
SPSS	-	Statistical Package for Social Sciences
UNICEF	-	United Nations M,Children's Emergency Fund
USD	-	US Dollar
WASH	-	Water, Sanitation, and Hygiene
WHO	-	World Health Organization

OPERATIONAL DEFINITION OF TERMS

Cholera: -An infectious disease which causes severe watery diarrhea which can lead to dehydration and even death if untreated. It is caused by eating food or drinking water contaminated with a bacterium called *Vibrio cholerae*.

Cholera Occurrence -The study defines a cholera occurrence as presence of a case of suspected person aged over 5 years with severe dehydration or death from acute watery diarrhoea with or without vomiting.

Case Fatality Rate: -The proportion of people who die from a specified disease among all individuals diagnosed with the disease over a certain period of time.

Environmental health factors: -Characteristics in a person's surroundings that increase their likelihood of becoming infected with cholera.

Health system factors: -Aspects of healthcare organization and the broader healthcare environment that affect healthcare service quality and delivery.

Knowledge and attitude factors: -Important background information that people know, feel or think about in the context of cholera disease. May be in terms of causes, symptoms, prevention, treatments, control etc

Household Head -The person in the house who is responsible for making decisions. Can either be male or female.

Hygiene -Conditions or practices conducive to maintaining health and preventing disease, especially through cleanliness.

Sanitation - The provision of facilities and services for the safe disposal of human urine and faeces (WHO)

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter introduces the study topic by giving a background of the subject while highlighting the trends of the issue globally, regionally and locally. In this chapter, we also present the staetemnt of the problem, study objectives, the research questions, significance of the study, scope and limitations of the study.

1.2 Background of the study

Cholera is a bacterial infection of humans caused by ingestion of bacterium *Vibrio cholerae* (of classical or El Tor biotypes) present in fecally contaminated water or food (Cowman, 2015). Vibrio cholerae causes an acute enteric infection, normally characterized by severe diarrhea, and death (in those severely affected) from water and electrolytes depletion (WHO, 2017). Cholera has been called “blue death” due to a patient’s skin turning to a bluish-grey color from extreme loss of fluids (WHO, 2017).

Occurrence of cholera is primarily linked to insufficient access to safe clean water and proper sanitation and hygiene. Its impact can be even more dramatic in areas where basic environmental infrastructures are disrupted or have been destroyed (Githuku *et al.*, 2017). A cholera case, refers to any patient, irrespective of age, presenting with acute watery diarrhea and severe dehydration usually with vomiting and an outbreak refers to an explosive event, characterized by a sudden and rapid increase in the number of cases of the disease in a population (Okullo et al., 2017).

In 2015, the World Health Organization estimated that nearly 1.4 to 4.3 million people got infected with cholera globally and more than 100,000 deaths were attributed to the disease (WHO, 2019). Low and middle income countries have carried the bigger burden of cholera disease due to weak surveillance systems which often result to slower detection leading to high attack rates and fatalities (Dalhat *et al.*, 2016). Key contributing factors that have been associated with cholera outbreaks in low and midle income countries include poor urban planning, poor sanitation, weak health systems and scarcity of safe drinking water (Opisa *et al* 2012; WHO, 2019). African countries have suffered the most from the burden of cholera since it re-emerged in 1970 (Mengel *et al.,* 2016). Each year, Africa records about 2.8 million cases of cholera and an estimated 91,000 deaths. In the period between 1980 and 2011, the continent accounted for 50 percent of cholera cases worldwide; and apart from the outbreak that occurred in Haiti in 2011, Africa contributed 86 percent of the global burden of cholera and 99 percent of global cholera deaths (Mengel *et al.,* 2017; Stoltzfus et al., 2019; Schaetti *et al.,* 2016; Huq et al., 2015).

In Kenya, the period between 1971 to 2015 was characterized by repeated cholera outbreaks occurring in different intensities across counties (Mohamed *et al.,* 2018; Mutonga *et al.,* 2018; Dunkle et al., 2017). For instance, in Western Kenya, 790 cholera cases and 53 deaths were reported in 2008 with a case fatality rate of 6.7% (Shikanga *et al.*, 2019). Between 2009 and 2010, 274 cholera deaths were reported from 11,769 cholera cases and a case fatality rate of 2.3% from 52 sub counties (Mohamed et al., 2012). Another outbreak occurred in 2014 and 2015, with 4218 cases of cholera and 79 deaths from 14 out of the 47 counties and an overall case fatality rate of 1.9 percent (Kigen *et al.,* 2020). In this particular period, outbreak of cholera was predicted by drinking contaminated water, lack of health education and consuming food outside home (Kigen *et al.,* 2020). Between 2017 and 2018 various counties have had instances of cholera outbreaks

amounting to 21,066 cases nationally, 325 deaths and a case fatality rate of 1.5% (MoH Kenyav (hisKenya.org). In 2017 alone, 43% (20 counties) reported 3967 cholera cases and 76 deaths from these cases; a case fatality rate of 1.9 percent (WHO, 2017).

Isiolo County which is located in the arid upper eastern Kenya, has reported several occurences of cholera cases since 2017 (Orimbo *et al.*, 2020). Assessment of the factors associated with cholera occurrence in the county is essential for planning, prioritization and implementation of prevention approaches. This study assessed the knowledge factors, environmental health factors and health system factors and their association with occurrence of cholera in Isiolo County.

1.3 Statement of the problem

Isiolo County accommodates nomadic pastoralists with sedentary lifestyles. Since 2010, the county has experienced yearly outbreaks of cholera apart from 2014 alone. At least 4 to 10 people die in an outbreak and children get affected more. In 2013 for example, Isiolo confirmed 8 deaths from cholera (WHO, 2013); in 2016, 10 people were confirmed positive and 500 others treated from exposure (Relief web, 2016); in 2018, Isiolo was one of the six counties that contributed a cumulative of 2943 cholera cases with 55 fatalities (Reliefweb, 2018). There is limited evidence to explain the persistent occurrence and the factors associated thereof with re-emergence of cholera in Isiolo County to adequately inform programming of interventions aimed at prevention of cholera.

1.4 Study objectives

1.4.1 Main objective

The main objective of this study was to assess factors associated with occurrence of cholera in Isiolo County, Kenya.

1.4.2 Specific objectives

1. To assess the extent to which knowledge and attitude influences occurrence of Cholera in Isiolo County
2. To assess the extent to which environmental health factors influence occurrence of cholera in Isiolo County
3. To assess the extent to which health system factors influence occurrence of cholera in Isiolo County

1.5 Research questions

1. To what extent does knowledge and attitude factors influence occurrence of cholera in Isiolo County?
2. To what extent do environmental health factors influence occurrence of cholera in Isiolo County?
3. To what extent do health system factors influence occurrence of cholera in Isiolo County?

1.6 Significance of the study

Understanding the factors that influence occurrence of cholera in a population is the first step to effective prevention and control. The results from this study provides evidence of association between knowledge, environmental health and health system factors and occurrence of cholera. This heightens the awareness level of Isiolo County Health Management Team and guides policy and intervention formulation and implementation so as to improve the management of cholera or prevent its occurrence. To researchers, the findings of this work adds to the body of knowledge and provide a baseline information for future reference.

1.7 Scope of the study

The study was conducted in all the three sub counties of Isiolo County. Household surveys were conducted with residents of Isiolo. Cholera occurrence in this study was defined as a case of acute watery diarrhea experienced in the past one week and the researcher relied on recall and self report strategy by the study participants to obtain this data. Data on cholera occurrence was then linked with the prevailing knowledge and attitude factors, environmental health factors and health system factors to establish any existing associations.

1.8 Limitations of the study

The present study acknowledges a few limitations as follows. First, data analyzed originated from self-reported measures, which have inherent limitations related to social desirability and recall bias. Secondly, the study was conducted in Isiolo County, therefore generalizability to other parts of the country is limited due to socioeconomic and geographical differences across the country. Cholera was defined as acute watery diarrhea and no confirmatory tests were considered due to limited resources. It is thus, likely that not all the reported acute watery diarrhea cases were due to cholera. Future research should factor in laboratory tests to confirm the presence of *V. Cholerae*.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to appraise what other researchers have reported with regards to occurrence of cholera and associated factors as well as to appreciate gaps in similar studies that that can be filled by the present study. The chapter thus gives an overview of the overall burden of cholera both globally and in the Kenyan and Isiolo context. It further sheds light on the findings from related studies that researched on underlying factors associated with the risk of cholera occurrence. Lastly, the chapter discusses the conceptual framework of the study.

2.2 Burden of cholera

2.2.1 Global burden of cholera

Cholera is an important public health problem worldwide and the number of cholera cases reported to WHO has continued to be high over the last few years. The disease still affects 47 countries across the globe resulting in an estimated 2.86 million cases and approximately 95,000 deaths per year worldwide (WHO, 2017). By the end of 2018, cholera cases were estimated at 1.3 million to 4.0 million and 21 000 to 143 000 deaths worldwide were due to cholera (WHO, 2019). In 2017, the World Health Organization reported that cholera continues to hit communities already made vulnerable by tragedies such as conflicts and famines. Yemen currently faces the world's largest cholera outbreak, with over 700,000 suspected cases and more than 2,000 deaths reported since April 2017. Over 800 people have died of cholera in Somalia since 2017, and over 500 in the DRC. Haiti has now reported nearly 1 million cases and 10,000 deaths since the beginning of the 2010 outbreak (WHO, 2017). On the other hand, developed countries such as Europe and North America

have remained free from cholera for decades now, attributable to improved sanitation and hygiene systems (Cowman, 2015).

Between 2000 and 2015, 52812 (83%) of 63 658 cholera deaths reported globally, occurred in sub-Saharan Africa and currently, more than 40 million people in Africa live in cholera "hotspots" where outbreaks are a regular occurrence (Lessler *et al.*, 2018). Over the last year, cholera (or suspected cholera) outbreaks have struck in Kenya, Algeria, Angola, Bangladesh, Burundi, Chad, the Democratic Republic of the Congo, Djibouti, Ethiopia, The Kingdom of Saudi Arabia, India, Malawi, Mozambique, Nigeria, Niger, Somalia, Sudan, South Sudan, United Republic of Tanzania, Uganda, Yemen, Zambia, and Zimbabwe, while the long-running outbreak in Haiti continues (WHO 2018). Spurred by the large outbreaks in different parts of the world, the Global Task Force on Cholera Control (GTFCC) launched an initiative in October 2017, titled Ending Cholera: A Global Roadmap to 2030, with the objective to reduce cholera deaths by 90% worldwide, and eliminate cholera in at least 20 countries by 2030 (WHO, 2017).

2.2.2 Cholera in Kenya

Since 1971, Kenya has suffered several waves of cholera occurrence. From 1974 to 1989, Kenya reported cases every year with an average case fatality rate of 3.57%. Its largest epidemic started in 1997 and lasted until 1999, with more than 33,400 notified cases, representing 10% of all cholera cases reported from the African continent in the same 3 years (WHO, 2009).From 2000 – 2006 outbreak was controlled and a slight decrease in cases was reported each year ranging from 1 157 to 816 except for 2002, with 291 cases affecting 9 districts: West Pokot, Isiolo, Turkana, Kwale, Garissa, Wajir, Kisumu, Bondo and Siaya. As of 15 May, a cumulative total of 625 cases had been reported with 35 deaths (WHO, 2010).

Since 2006 cholera incidence has been on the increase and outbreaks have been increasing in numbers since 2007. In 2009/2010, cholera was reported in 52 districts in all the provinces of Kenya with more than 11,679 cases and with an overall case fatality rate of 2.3%. More profound effects of the outbreaks were felt in the arid and semi-arid areas of the country, Nyanza and Coast provinces and the urban slums of Nairobi (Ministry of Public Health and Sanitation, 2011). Between 2011 and 2013 there were few cases of cholera reported in Kenya, and these cases were limited to a relatively small geographic area in northern and eastern regions of Kenya (Cowman, 2015). This reflected some success in cholera prevention and control.

In 2015, the country experienced another outbreak which lasted up to December 2016, characterized by multiple peaks of varying sizes as cholera spread from county to county, with the largest peak occurring in February 2015 and more than half of all the cases being reported from three counties; Wajir (2,426; 22.0%), Nairobi (1,824; 16.5%) and Migori (1,521 cases; 13.8%). Overall, 178 cholera-related deaths were reported (case fatality rate = 1.6%) (Githuka et al., 2016). In 2017 alone, a total of 3967 laboratory-confirmed and probable cases including 76 deaths (case fatality rate = 1.9%) were reported by the Ministry of Health to WHO. Of the cases reported, 596 were laboratory confirmed. 20 out of the 47 counties (43%) in Kenya had reported cases (WHO, 2017).

In 2018, Kenya had reported a total of 1,704 cases and 41 deaths by the month of March (Reliefweb, 2018). According to the WHO weekly bulletin, in 2019, Kenya has so far reported the highest number of new cholera cases (115 cases including 2 deaths) (WHO & UNICEF 2019). From the above statistics, it is conclusive that while the country experiences cholera outbreaks every year, the ability of the Ministry of Health to contain the cases, is difficult to conclude evident from the fluctuating number of cases and deaths.

2.2.3 Cholera in Isiolo County

In Isiolo County, a semi-arid region lying in the Eastern part of Kenya, poor sanitation and water shortage remain a major problem facing the rural communities. The main water sources present in the County predominantly include surface and shallow water sources such as boreholes, water pans, sand dams, and shallow wells distributed across the region with the majority of the residents still practicing open defecation (Okullo *et al.*, 2017).

Isiolo County has routinely reported cases of cholera. Between 2009 and 2013 for instance, Isiolo was one of the 32 counties that reported cholera in the country. During this period, the highest incidence counties were located in northern Kenya (Marsabit and Turkana), eastern Kenya (Isiolo, Kitui, and Tharaka), the coast (Lamu and Kwale), western Kenya (West Pokot), and northeastern Kenya (Garissa) (Cowman, 2015). From 2014 – 2016, Isiolo County reported 8 cholera cases and 1 death (CFR of 12.5%) among the 22 counties that were affected (George *et al.*, 2016). In 2017 through 2018 Kenya experienced 5,470 Cholera cases (78 deaths and Case Fatality Rate of 1.4%) reported across 19 counties and by end of June 2018, Cholera outbreak was active in eight counties (Isiolo, Garissa, Tana River, Turkana, West Pokot, Meru, Mombasa, and Kilifi) (UNICEF, 2018).

Interventions, policies, and strategies that are perceived to be effective in cholera prevention and control include: (i) Community Led Total Sanitation, which aims to eliminate open defecation, (ii) provision of clean water, and (iii) the Integrated Disease Surveillance and Response strategy, which is Kenya's platform for implementation of the International Health Regulations (WHO, 2017).

2.3 Factors associated with occurrence of cholera

A mixture of factors have been reported to have the potential to increase the vulnerability and the susceptibility of different populations to cholera occurence. In Kenya, some of these factors include regional drought, conflict, and insecurity in the Horn of Africa which contributes to increased movements within and to the country by people fleeing conflicts in countries such as Somalia and South Sudan. WHO recommends proper and timely case management in cholera treatment centres. The affected communities should have improved access to water, effective sanitation, proper waste management, enhanced hygiene and food safety practices. Key public health communication messages should as well be provided travelers to affected areas are encouraged to take proper hygiene precautions to prevent potential exposure (WHO, 2017).

2.3.1 Influence of knowledge and attitude on occurrence of cholera

The level of knowledge about cholera and the effect it has on the risk of occurrence of the disease has been reported in a range of studies. Ali *et al.*, (2021) reports from a study in Saudi Arabia that poor knowledge and awareness of the public about the modes of transmission and early measures of diagnosis and treatment of cholera symptoms is a key contributing factor to the spread of cholera. On the other hand, Burnett et al., (2016) conducted a post-vaccination campaign, household-level survey about knowledge and attitudes regarding diarrhea and cholera in areas targeted and not targeted for cholera vaccination. Respondents in vaccinated areas were more likely to have received cholera education in the previous 6 months (33% v. 9%; $p = 0.04$), to know signs and symptoms (64% vs. 22%; $p = 0.02$) and treatment (96% vs. 50%; $p = 0.02$) of cholera, and to be aware of cholera vaccine (48% vs. 14%; $p = 0.02$). However, there were no differences in water, sanitation, and hygiene practices, meaning that the increased level of knowledge had minimal impact when it comes to practice. In a randomized controlled trial of a 1-week hospital-

and home-based intervention aimed at promoting cholera awareness, there was evidence that awareness increased cholera knowledge score in the intervention arm compared with the control arm at both the 1-week follow-up {score coefficient = 2.34 (95% confidence interval [CI] = 1.96, 2.71)} and 6 to 12-month follow-up period (score coefficient = 1.59 [95% CI = 1.05, 2.13]). The study however did not prove whether this reduced the risk of cholera occurrence (Saif-Ur-Rahman et al., 2016).

2.3.2 Influence of environmental health factors on cholera occurrence

Studies have investigated the potential link between cholera and environmental factors in different regions and noted that Cholera is spread when people consume contaminated food or water. To put it bluntly, cholera spreads when people have no choice but to eat food or drink water that contain feces. WHO clarifies that Cholera being a waterborne disease, is closely linked to poor environmental conditions and that the absence or shortage of safe water and of proper sanitation, as well as poor waste management, are the main causes of spread of the disease (WHO, 2017).

Oyugi and colleagues analyzed an outbreak of cholera in western Kenya in 2015 through a case control study using 52 cases and 104 controls with an aim of determining the magnitude of the outbreak in two counties, characterize the cholera cases in terms of time, place and person as well as identify the risk factors. The study identified poor latrine coverage and personal hygiene practices as the main drivers of the outbreak (Oyugi *et al.*, 2017). In 2013, Julta *et al* investigated and confirmed the hypothesis that elevated air temperatures create environmental conditions favorable for bacterial growth and, when followed by above normal rainfall in combination with appropriate transmission mechanisms such as poor availability of safe water and destruction of sanitation infrastructures aiding in mixing of overflowing sewers with flood waters, result in an epidemic of cholera (Jutla *et al.*, 2013). A similar hypothesis was validated in Zimbabwe

confirming that that poor conditions of sanitation, coupled with elevated temperatures, and followed by heavy rainfall can initiate outbreaks of cholera (Jutla *et al.,* 2015).

Cowman studied cholera prevention and control in Kenya with a goal of answering whether progress with respect to existing development indicators translate into reduced incidence of cholera, a disease that is typically associated with poverty. The researcher identified key challenges towards cholera prevention and control to include lack of access to improved water and sanitation for a large proportion of the population as a key challenge to implementers (Cowman, 2015). In 2013, a study in India established a strong association between open field defecation and cholera outbreaks (Deepthi et al., 2013). Cholera cases were commonly reported in houses that did not own a latrine ($p < 0.001$) and those that did not practice any method of water purification ($p < 0.002$). One would conclude therefore from the above investigations that occurrence of cholera is linked with access to clean drinking water and proper sanitation.

A systematic review and meta-analysis of individual and household risk factors for symptomatic cholera infection reported a stronger association between cholera infection and informal urban residence populations. This association attributed to breakages in water distribution pipes in addition to the fact that in most of such areas, piped water supply system, water pipes and sewage channels are laid beside each other, possibly for engineering convenience. When any pathogen with the potential for causing an outbreak enters a water delivery system, there is a marked increase in the likelihood of an outbreak (Richterman *et al.,* 2018).

2.3.3 Influence of health system factors on cholera occurrence

Effective cholera prevention and control measures are early detection and rapid control of outbreaks. Thus, quick access to treatment (intravenous fluid or Oral Rehydration Solution-ORS),

and access to an efficacious oral cholera vaccine (OCV) are key health measures towards management and containment of cholera. The goal of cholera Prevention and Management thus would be to decrease the spread to the larger population.

Universal access to health care requires service availability and accessibility for those most in need. However, in rural settings, increased distance can reduce facility use (Escamilla et al., 2018). According to a study on factors influencing health seeking behaviour, a study reports poor health seeking behaviour where health services are not available in a community (Musinguzi *et al.*, 2018). However, when the illness is perceived severe, distance would only affect the outcome and not the decision to seek care (Webair & Bin-Gouth, 2013).

Care is insufficient when the number of facilities available are overburdened, thus fewer facilities to a population that is constantly growing compromises quality of care delivery (Leslie et al., 2017). A different study emphasizes that healthcare quality can be improved by supportive visionary leadership, proper planning, education and training, availability of resources, effective management of resources, employees and processes, and collaboration and cooperation among providers (Mosadeghrad, 2014). Health care staffing is a crucial health policy issue. A balance of nurse or doctor to patient ratio ensures lower risk of in hospital mortality (Jarrar et al., 2015).

2.3.5 Gap from the literature

Cholera has resulted in several early deaths which probably could have been avoided. Assessment of potential underlying factors that increase the risk of cholera is essential for the planning and implementation of preventive measures. Knowledge and attitude about cholera, environmental health factors and health system factors have been reported to have an important role in the exposure to and spread of cholera. Studies assessing the effect of these factors have been carried

out in different settings and with a wide range of populations. Available evidence from existing literature demonstrate mixed results from these factors which means generizability is limited thus, necessitating context specific evidence. This study was counducted to understand the effect of these factors in the context of Isiolo County.

2.4 Conceptual framework

The concept of this study was built on the ecological model for disease occurrence. This particular perspective is concerned with the ways human behavior, in its cultural and socioeconomic context, interacts with environmental conditions to produce or prevent disease. Unlike the concepts of specific etiology and germ theory, the disease ecology perspective sees health outcomes as far more than direct pathogen-host interactions. Rather, it encourages careful examination of the social, economic, behavioral, cultural, environmental and biological context in which disease occurs. This must be considered, in addition to the characteristics of the illness itself, in order to fully understand health events and outcomes in a population. Thus, this study structured the concept above to answer the research questions. Specifically, rather than simply assuming that cholera outbreak occurs as a result of direct contact with the cholera pathogen, this work first questioned the environmental factors, knowledge and attitude levels and health system factors that are involved in the process of the disease pathway. Various components such as food and water contamination, open defecation, high population density, limited access to proper healthcare, low literacy level are potential risk factors. The scope of this research thus went beyond simply pathogen-host relationships, integrating vital components of human and disease ecology to further understand cholera risk factors. A diagrammatic representation of the study variables and their potential relationship is shown in Figure 2.1.

Independent variables

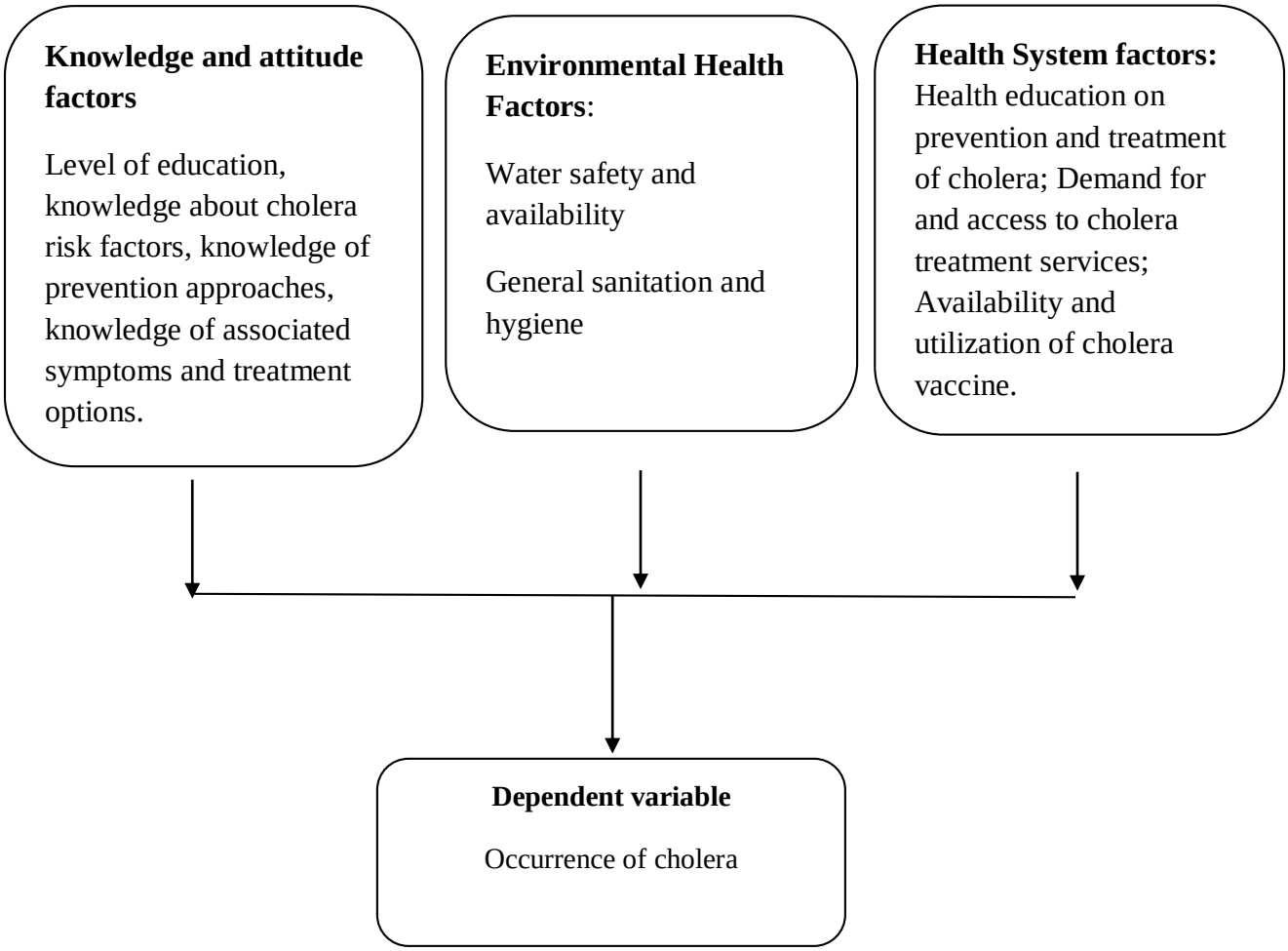

Figure 1.0: Conceptual framework diagram borrowed from the ecological model for factors influencing disease occurrence (Smith, 2005)

CHAPTER THREE

METHODOLOGY

3.1 Introduction

In this chapter, we describe the approach that was taken to respond to the research questions in this study. The chapter describes the study area, the research design, target population, study variables, the sampling design, inclusion and exclusion criteria, data collection tools, data collection procedures, data analysis and ethical considerations.

3.2 Study area

This study was conducted in Isiolo County. The county borders Samburu and Garissa to the east, Tana River to the south east, Kitui and Meru to the south west, Marsabit to the North West and Wajir to the north east. Isiolo County comprises of three sub counties – Isiolo, Garbatulla and Merti, ten wards (appendix vi), 40,000 households and an estimated population of 158,716 people. About 51% of the population is male while 49% is female. Most parts of Isiolo County are arid and receives less than 150 mm annually. Generally, the county receives low rainfall of between 300-500 mm per year, and experiences temperatures ranging from 12°C to 28°C. Main economic activities in the ounty include pastoralism, subsistence agriculture, small-scale trade, and tourism. Generally, the county is afflcted by poverty, underdevelopment and poor infrastructure. Diarheal diseases rank 4th in the county. Isiolo County Referral hospital is the biggest health facility in the county besides which there are other 37 government sponsored health facilities, 11 faith based and 5 private facilities that cater for the health needs of the people of Isiolo.

3.3 Research design

A cross sectional study design was adopted. This design was considered because this study sought to collect and analyze data from a population at a specific-point in time. Qualitative and quantitative methods were used to explore and understand the influence of knowledge and attitude, environmental health factors and health system factors on occurrence of cholera in Isiolo County.

3.4 Target population

The study targeted residents of Isiolo County. Household heads. Isiolo county has approximately 40,000 households and an estimated population of 158,716 comprising of 51% males and 49% females. Isiolo Sub County is the most populated with a population estimate of 67,823 persons. It comprises of 4 wards including Wabera (19,307 persons), Bulla Pesa (25,167 persons), Burat (17,235 persons) and Ngaremara (6,114 persons). Garbatulla Sub County is the second in terms of population size, with an estimated population of 47,758 people. It has three wards namely Kinna (16191 people), Garbatulla (18,166 people) and Sericho (13,401 persons). Merti is the least populated Sub County with 43,135 persons and it has 3 wards including Oldonyiro (17,044 persons), Chari (5,296 persons) and Cherab (20,795 persons). The study was conducted in all the three sub counties.

3.5 Study variables

The dependent variable for this study was occurrence of cholera. On the other hand, independent variables included; respondent's knowledge, environmental health factors and health system factors. Knowledge was assessed in terms of level of education, knowledge about cholera risk factors, knowledge of prevention measures, knowledge of associated symptoms and treatment options for cholera. Two key environmental factors were considered including water safety and

availability and sanitation and general hygiene. Under these two components, variables considered included source of drinking water, access to the source in terms of distance, water treatment, and availability of water at the source throughout the year. Sanitation and general hygiene were assessed in terms of toilet ownership, open defecation, disposal of daily refuse, type of house, sharing house with domestic animals, and hand washing. Lastly, health system factors included health education and promotion on cholera prevention and control, access to and demand for cholera treatment services and availability and utilization of cholera vaccine.

3.6 Sampling design

3.6.1 Sample size determination

The Fischer's formula (Fischer *et al*, 1998) below was used to calculate the sample size of households to be included in the study.

$$n = \frac{Z^2(P)(1-P)}{I^2}$$

Where:

n = Sample size (where population > 10,000)

z = Standard normal deviation at the desired confidence interval. In this case, it was taken at 95% confidence level. Z value at 95% =1.96

p = Proportion of the population with the desired characteristic, set at 50%. i.e. (0.5)

q = (1-P), Proportion of the population without the desired characteristic

I = Degree of precision, taken to be 5%

Therefore:

$$n = \frac{1.96^2(0.5)(1-0.5)}{0.05^2}$$

$$n = \frac{0.9604}{0.0025}$$

$$n = 384$$

Adjusting for non-response, additional 10% of the calculated sample was considered.

Thus,

$$n = 384 + 10\ \%\ (384) = 384 + 38 = 422 \text{ household heads}$$

For qualitative data, 3 key informants were interviewed from each of the selected wards. These included, a community health volunteer (CHV), public health officer in charge of the ward and a healthcare provider from the selected hospitals, selected from a high volume facility in the unit. Thus, a total of 9 key informants were interviewed. Sample population from each of the three wards was determined using the formula: $s = \frac{n*x}{N}$: where s = ward sample size, n = total sample size = 422, N = Total population of the 3 wards = 64128 and x = ward population (Table 3.1).

Table 3.1: Sample size distribution by study wards

Sub County	**Ward (highest population)**	**Population size (x)**	**Sample: s = $\frac{n*x}{N}$**
Isiolo	Bulla Pesa	25,167	166
Merti	Burat	20,795	137
Garbatulla	Garbatulla	18,166	119
	Total	**N = 64,128**	**n = 422**

3.6.2 Sampling procedure

Three out of the ten wards were purposively sampled for data collection on the basis of population size to represent each of the three sub counties. For each sub County one ward with the highest population was selected for study. Through simple random sampling, households were randomly selected from each ward proportionately based on the population size of each watrd. Only household heads were engaged in the exercise and incase the household head was absent another household was recruited for study.

3.7 Inclusion and exclusion criteria

3.7.1 Inclusion criteria

1. Residents of Isiolo County, household heads aged 18 and above.
2. Those households who consented to the study

3.7.2 Exclusion criteria

1. Households heads who were sick by the time of the study or unable to independently give consent for participation.

3.8 Data collection tools

In this study, two instruments were used for data collection: a questionnaire for quantitative data and an interview guide for qualitative data. The instruments are described as follows.

3.8.1 Questionnaire for quantitative data

A questionnaire was designed according to the three objectives of this study. The questionnaire comprised of three main sections. Section one contained questions addressing knowledge of Isiolo County residents in association with cholera occurence. Variables of interest included; level of education, knowledge of risk factors associated with cholera occurence and knowledge of cholera

prevention methods, knowledge of associated symptoms of cholera and knowledge of treatment options for cholera. Section two contained questions addressing environmental health factors associated with cholera occurence. Variables of interest included; water safety and availability and general sanitation and hygiene. The last section looked at health system factors and their association with cholera occurence. Variables of interest included; access to health education services on prevention and treatment of cholera, demand for and access to cholera treatment services and user perception on oral cholera vaccine. The questionnaire contained both closed and open ended questions (appendix iii).

3.8.2 Key informant interview guide

An interview guide was developed to facilitate qualitative data collection form the sampled key informants and supplement primary data collected from the respondents. The guide comprised of questions on knowledge, environmental health factors and health system factors and their perceived influence on cholera occurence in Isiolo County (appendix iv).

3.9 Data collection procedure

3.9.1 Quantitative data collection

With the administrative permission to access the target wards to interact with the residents, eligible participants were identified and visited at household level. Each study participant was taken through a comprehensive informed consent process to explain the purpose, study objectives, benefits, risks and any other aspect of the study that was relevant for them to understand. Only household heads were considered for this exercise and only those who provided consent were engaged further. The questionnaire was administered in Kiswahili or borana language.

3.9.2 Qualitative data collection

For qualitative data, key informant interviews were conducted both at facility level and community. CHVs were interviewed at the community while the public health officers and the facility heads were interviewed at the health facility. Every key informant was taken through informed consent process as a first step for the interview process. Attention was paid to the principle of voluntary participation and the requirement of informed consent was observed. Study objectives were explained to the participants during consenting process. Confidentiality measures were strictly observed and anonymous numbering used to secure their identities. All filled up data was reviewed on a daily basis to ensure accuracy and completeness before analysis was commenced. Interviews were scheduled without interrupting their duties.

3.9.3 Pre-testing data collection tools

A pilot study was conducted prior to the main data collection exercise. Wabera ward, in Isiolo sub-county which comes second in population size after Bulla Pesa was selected for this exercise. The ward was not included in the final study. Simple random sampling was used to select 42 participants constituting 10% of the study sample (Connelly, 2008) for quantitative data. Adjustments were reviewed before the actual data collection. For qualitative data, interviews were conducted with the ward public health officer, CHV and the facility head from a high volume facility in Wabera ward. Data from the piloting exercise was not included in the actual study database. Averagely, 45 minutes were enough for each respondent.

3.10 Validity and reliability of data collection tools

3.10.1 Validity of data collection tools

Validity of the data collection tools was achieved in two ways. First, research assistants were trained on the approach of the study and the use of the data collection tools to obtain responses

from the respective respondents. Secondly, the tools were pre-stested in a pilot study conducted in Wabera ward. The results of the pilot study were not included in the main study but were useful in making necessary adjustments to improve the quality of the main data for the study.

3.10.2 Reliability of data collection instruments

Reliability of data collection tools was achieved through randomness of selecting each respondent. Every participant had an equal chance of being selected to participate in the study. Also, data was managed using SPSS software, version 23. This made it easy to code, clean and carry out analysis.

3.11 Data analysis

Quantitative data collected using the questionnaires was checked for completeness, coded and entered into SPSS. We conducted descriptive and inferential analysis. We used Chi-squared or Fisher exact when appropriate for descriptive analysis. For inferential analysis, we used multiple regression to understand predictors of cholera occurrence. Qualitative data collected from the interviews with key informants were subjected to manual content thematic analysis and themes developed were presented with verbatim.

3.12 Ethical consideration

Approval to carry out this study was obtained from School of graduate studies, Maseno University (appendix vii) and clearance from Maseno University Ethics and Research Committee (Reference Number – MSU/DRPI/MUERC/00806/19) (appendix viii). Administrative clearance was also sought both from the hospitals involved and the respective community gate keepers. Informed consent was obtained from participants before the administration of the research questionnaire and before the interviews with key informants. The consent form included details of ethical considerations, procedure of the study, confidentiality, benefits, risks and the right not to

participate or withdraw at any time. Respondents were requested to sign and keep a copy of the consent form.

All anticipated risks and discomforts were explained to the participants during the consent process. There was no direct benefits to the participants and this was clarified by the researcher. They were not be paid for participating neither did they pay to participate in the study. All the information shared by study participants was kept confidential. Respondents' information was protected and all identifiable information encrypted and stored on password-protected computers. No individual identities were used in any reports that came out of this study. The decision to participate in this study was personal. Participants were free to join the study or not. If they decided to join, they were also free to change their mind and stop their participation in the study at any time for any reason. There was no penalty for such and this was clarified in the consent process.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the findings based on the objectives of the study. First is a summary of characteristics of the study participants. This is followed by the trend of occurrence of diarrheal infections at household level after which the results for the bivariate analysis are presented in two by two tables, followed by final results from the multivariate analysis. The coding for qualitative data from the key informant interviews is presented in table 4.12.

4.2 Socio-Demographic Characteristics of respondents

A total of 401 respondents of modal age 20-39 (60.3%) were successfully interviewed between October to December, 2019. The study response rate was 95% with a non-response bias of 5%. There were more female, 251 (62.6%) than male, 150 (37.4%) respondents **(table 4.1).** The majority, 304 (75.8%) were married and 76.8% had acquired some form of education ranging from primary to tertiary level. Respondents with primary level of education were the majority, 137 (34.2%) followed by those with secondary level of education 124 (30.9%) (See tabe 4.1) A bigger proportion of participants 278 (69.3%) had no employment at all and majority of those who had some form of work were self-employed 86 (70%) (See table 4.1). Only 6 respondents (1.5%) earned a monthly income of more than 30,000 shillings. The remaining earned less than this. More than half of the respondents, 236 (58.9%) were muslims (**table 4.1).**

Table 4.1: Summary characteristics of study participants

Characteristic	Frequency (N = 401)	Percent
Gender		
Males	150	37.4
Females	251	62.6
Age in years		
0 – 19	15	3.7
20 – 39	242	60.3
40 – 59	121	30.2
60 – 79	23	5.7
Marital status		
Not married	97	24.2
Married	304	75.8
Level of education		
Never attended school	93	23.2
Primary	137	34.2
Secondary	124	30.9
Tertiary	47	11.7
Employment status		
Employed	123	30.7
Not employed	278	69.3
Type of employment (N = 77)		
formal employment	32	26
Self-employment	86	70
Casual employment	5	4
Monthly income		
<1000	284	70.8
1001-10,000	44	11
10,001- 20,000	36	9
20,001- 30,000	31	7.7
>30,000	6	1.5

4.3 Occurrence of cholera

The primary outcome of the study was occurrence of cholera outbreak. The study defines a cholera case as suspected person aged over 5 years with severe dehydration or death from acute watery diarrhoea with or without vomiting. According to the study findings, about 149 (37.2%)

respondents reported at least a case in the household within the past one week. The rest 252 (62.8%) had no case **(Figure 4.1).**

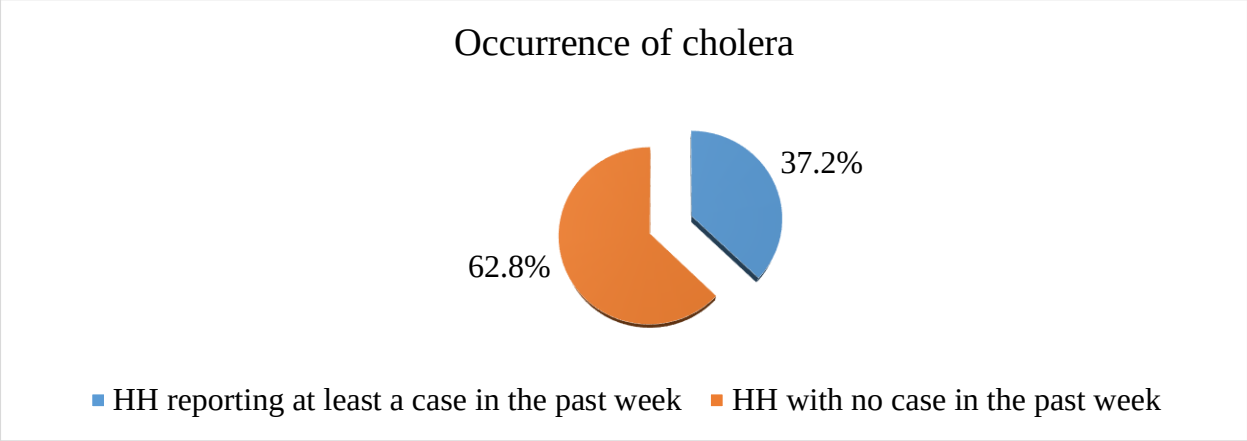

Figure 4.1: Occurrence of cholera

4.4 Knowledge factors and cholera occurrence

Four variables were used to score respondents' knowledge on cholera. These included, level of education, awareness of cholera risk factors, awareness of prevention approaches of cholera, knowledge of symptoms associated with cholera and awareness of treatment options of cholera. The findings are as follows.

4.4.1 Level of education

Participants were examined in four categories; those who had never attended school, those who attained primary education, secondary education and tertiary education. A total of 137(34.16%) respondents, constituting the majority, had attained primary education. Out of these, 44 (32.12%) reported having had a family member with acute watery diarrhea in the past week while the remaining 93(67.88%) respondents did not. This category was followed by 124 (30.92%) respondents who had attained secondary education and out of whom 57 (45.97%) reported presence of a family member with acute watery diarrhea in the past week. The remaining 67 (54.03%) did not report having any member of the family with acute watery diarrhea in the past

week. 93 (23.19%) participants had no education at all and out of these, only 19 (20.43%) reported having had a family member with acute watery diarrhea in the past week. The resmaining 74 (79.57%) did not. About 47 (11.72) participants had attained tertiary education from whom 29 (61.70%) reported having had a family member with acute watery diarrhea in the past week while 18 (38.30) did not. Further statistical analysis found a significant association ($\chi^2 = 28.883$, df = 3, $p = 0.000$) between level of education and occurrence of cholera.

Table 4.2: Association between level of education and occurrence of cholera

Level of Education	Acute watery diarrhea in the past week		
	Yes (N=149) n/%	No (N=252) n/%	*P* value
Never attended school	19/12.75	74/29.37	≤0.0010
Primary	44/29.53	93/36.90	
Secondary	57/38.26	67/26.59	
Tertiary	29/19.46	18/7.14	
Totals	149	252	

4.4.2 Knowledge of causes, prevention, sysmptoms and treatment

We also assessed knowledge factors on the basis of causes, prevention, treatment and symptoms of cholera. This study used proportions to assess the knowledge levels of occurrence of cholera. Results indicate that majority of the respondents, 368 (91.77%) believed that drinking of contaminated water is the main cause of cholera. Most of them 330 (82.29%) opined that eating contaminated food and 262 (65.34%) that not washing hands after visiting toilet were the main causes of cholera. More than half of the respondents 219 (54.61%) mentioned that cholera could be caused by not washing hands before and after handling food. Among the respondents, 189 (47.13%), 162 (40.40%) and 104 (25.94%) agreed that cholera is transmitted through unwashed fruits or vegetables, not washing hands after handling children's faeces and open defecation in bush or roadside respectively. Regarding the practices relating to cholera prevention, different

measures were mentioned including boiling drinking water 341 (85.04%, storing drinking water in a clean container 258 (64.04%), proper use of toilets 263 (63.09%), washing hands after visiting toilets 253 (63.09%). The least mentioned practice was consulting a traditional healer 24 (5.99%) followed by drinking river water 27 (6.73%). When interviewed on the ways of treating cholera, the largest proportion of the respondents 395 (98.50%) stated that cholera could be treated by visiting the hospital. Amongst them, 51 (12.72%), 121 (30.17%) and 33 (8.23%) believed that herbal remedies, homemade oral rehydration and prayer respectively could treat cholera. However, 3 (0.75%) of the respondents, did not know any method of treating cholera (Table 4.3). With respect to symptoms of cholera, vomiting 366 (91.27%) accounted for the highest proportion. More than three quarter of the respondents342 (85.29%) mentioned watery diarrhea. Other mentioned symptoms included fever 221 (55.11%), dehydration 204 (50.07%), abdominal cramps 160 (39.90%) and bloody diarrhea 68 (16.97%). Overall, only 11(2.74%) of the respondents did not know any symptom of cholera. Table 4.3 lists the knowledge and attitude levels on occurrence of cholera in Isiolo County.

Table 4.3: Knowledge and Attitude levels on occurrence of Cholera in Isiolo county

Knowledge and attitudes variables	All N=372 n (%)	Cholera		p-Value
		Infected N=149 n(%)	Not Infected N=252 n (%)	
Causes of cholera				
Drinking contaminated water	368 (91.77)	141 (94.63)	227 (90.08)	0.11
Eating contaminated food	330 (82.29)	128 (85.91)	202 (80.16)	0.15
Unwashed fruits/vegetables	189 (47.13)	99 (66.44)	90 (35.71)	<0.001
Not washing hands before and after handling food	219 (54.61)	97 (65.10)	122 (48.41)	<0.001
Not washing hands after visiting toilet	262 (65.34)	103 (69.13)	159 (63.10)	0.22
Open defecation in bush or roadside	104 (25.94)	48 (32.21)	56 (22.22)	0.03
Not washing hands after handling children's faeces	162 (40.40)	67 (44.97)	95 (37.70)	0.15
Prevention of cholera				
Boiling drinking water	341 (85.04)	132 (88.59)	209 (82.94)	0.13
Storing drinking water in a clean container	258 (64.34)	116 (77.85)	142 (56.35)	<0.001
Proper use of toilets	263 (65.59)	108 ()72.48	155 (61.51)	0.03
Washing hands after visiting toilets	253 (63.09)	107 (71.81)	146 (57.94)	0.01
Washing hands before and after handling food	207 (51.62)	89 (59.73)	118 (46.83)	0.01
Drinking treated water	209 (52.12)	93 (62.42)	116 (46.03)	<0.001
Drinking river water	27 (6.73)	13 (8.72)	14 (5.56)	0.22
General personal and household hygiene	202 (50.37)	90 (60.40)	112 (44.44)	<0.001
Washing household surfaces and utensils with clean water	173 (43.14)	78 (52.35)	95 (37.70)	<0.001
Praying	38 (9.48)	21 (14.09)	17 (6.75)	0.02
Consulting a traditional healer	24 (5.99)	13 (8.72)	11 (4.37)	0.08
Proper cooking of food	119 (29.68)	65 (43.62)	54 (21.43)	<0.001

Treating Cholera				
Visiting a hospital	395 (98.50)	147 (98.66)	248 (98.41)	0.85
Herbal remedies	51 (12.72)	19 (12.75)	32 (12.70)	0.99
Homemade oral rehydration	121 (30.17)	65 (43.62)	56 (22.22)	<0.001
Prayer	33 (8.23)	15 (10.07)	18 (7.14)	0.3
Don't know	3 (0.75)	0	3 (1.19)	0.18
Symptoms of Cholera				
Fever	221 (55.11)	106 (71.14)	115 (45.63)	<0.001
Vomiting	366 (91.27)	140 (93.96)	226 (89.68)	0.14
Watery diarrhea	342 (85.29)	132 (88.59)	210 (83.33)	0.15
Abdominal cramps	160 (39.90)	82 (55.03)	78 (30.95)	<0.001
Bloody diarrhea	68 (16.96)	30 (20.13)	38 (15.08)	0.19
Dehydration	204 (50.07)	94 (63.09)	110 (43.65)	<0.001
Other	37 (9.23)	18 (12.08)	19 (7.54)	0.13
Don't know	11 (2.74)	5 (3.36)	6 (2.38)	0.56

We used Chi-squared or Fisher exact when appropriate

Cholera outbreak is associated with various characteristics. This study further compared characteristics of respondents who had cholera and those who did not have. Causative factors such as unwashed fruits or vegetables (*p<0.001*), not washing hands after handling children's faeces (*p<0.001*) and open defecation in bush or roadside (*p=0.03*) were significantly associated with occurrence of cholera. A health officer emphasized the role of food safety as follows.

"Every day we make sure that hotels are inspected and that food is sold in clean places to people." – a PHO

With regard to preventive measures , factors such as storing drinking water in a clean container (*p<0.001*), proper use of toilets (*p=0.03*), washing hands after visiting toilets (*p=0.01*) , washing hands before and after handling food (*p=0.01*), drinking treated water (*p<0.001*), general personal and household hygiene (*p<0.001*), washing household surfaces and utensils with clean water

(*p<0.001*), praying (*p=0.02*) and proper cooking of food (*p<0.001*) were significantly associated with occurrence of cholera. For treatment factors, only homemade oral rehydration (*p<0.001*) was found to be significantly associated with occurrence of cholera. Symptoms of cholera such as fever, abdominal cramps and dehydration were found to be significantly associated with occurrence of cholera (*p<0.001*). However, factors such as drinking of contaminated water, boiling drinking water, visiting the hospital, vomiting among others did not report significant association with occurrence of cholera (*p>0.05*) (Table 4.3). According to a CHV, part of their duty has been educating people on latrine use to prevent water contamination.

"We have taught every village to have latrines because when it rains our water gets contaminated if we do not use toilets." – a CHV

To better understand the predictors of occurrence of cholera, this study analyzed the independent factors using two models, bivariate and multivariate logistic models. Table 4.4 presents the results from the bivariate and multivariate logistic regressions. From the bivariate analyses, causative factors such as drinking of contaminated water (OR=0.52; 95% CI 0.23, 1.17), eating contaminated food (OR=0.66; 95% CI 0.38, 1.16), not washing hands after visiting toilets (OR=0.76; 95% CI 0.50 1.18) and not washing hands after handling children's faeces (OR=0.74; 95% CI 0.49, 1.12) were not significantly associated with occurrence of cholera. Unwashed fruits or vegetables, not washing hands before and after handling food and open defecation in bush or roadside were significantly associated with occurrence of cholera though with reduced odds (OR=0.28; 95% CI 0.18, 0.43), (OR=0.50; 95% CI 0.33, 0.76) and (OR=0.60; 95% CI 0.38, 0.95) respectively. In relation to preventive practices, storing drinking water in a clean container (OR=0.37; 95% CI 0.23, 0.58), proper use of toilets (OR=0.61; 95% CI 0.39, 0.94), washing hands after visiting toilets, (OR=0.54; 95% CI 0.35, 0.84), washing hands before and after handling food, (OR=0.59;

95% CI 0.39, 0.89), drinking treated water, (OR=0.51; 95% CI 0.34, 0.78), general personal and household hygiene (OR=0.52; 95% CI 0.35, 0.79), washing household surfaces and utensils with clean water (OR=0.55; 95% CI 0.37, 0.83), praying (OR=0.44; 95% CI 0.22, 0.87) and proper cooking of food (OR=0.35; 95% CI 0.23, 0.55) were significantly associated with occurrence of cholera though with reduced odds. However, this study did not find significant association between boiling drinking water (OR=0.62; 95% CI 0.34, 1.14), drinking river water (OR=0.62; 95% CI 0.28, 1.35) and consulting traditional healer (OR=0.48; 95% CI 0.21, 1.10) at the bivariate level. Treatment factors such prayer (OR=0.69; 95% CI 0.34, 1.40) and visiting a hospital (OR=0.84; 95% CI 0.15, 4.66) were not significantly associated with occurrence with cholera. Homemade oral rehydration (OR=0.37; 95% CI 0.24, 0.57) was significantly associated with cholera though with reduced odds. Herbal remedies (OR=1.00; 95% CI 0.54, 1.83) was associated with increased odds on cholera though with insignificant effect ($p>0.05$), such that respondents who used herbal remedies were more likely to treat cholera than those who did not use home remedies. Finally, bivariate analyses on symptoms of cholera reports that fever (OR=0.34; 95% CI 0.22, 0.52), abdominal cramps (OR=0.37; 95% CI 0.24, 0.56) and dehydration (OR=0.45; 95% CI 0.30, 1.17) were significantly associated with cholera though with lower odds. Vomiting (OR=0.56; 95% CI 0.25, 1.23), watery diarrhea (OR=0.64; 95% CI 0.35, 1.18), bloody diarrhea (OR=0.70; 95% CI 0.42, 1.19) and other symptoms (OR=0.59; 95% CI 0.30, 1.17) were not significantly associated with occurrence of cholera (Table 4.4).

A CHV confirmed;

> *"When we introduced CLTS to the community, you can see that the villages which liked it have changed and when they are crowned open defecation free you can see people become happy and they want to do more." - CHV*

When this study controlled for potential confounders such as unwashed fruits or vegetables, not washing hands after handling children's faeces, storing drinking water in a clean container, proper use of toilets, praying, consulting traditional healer, proper cooking of food, herbal remedies, homemade oral rehydration, fever and bloody diarrhea in the multivariable model, not washing hands after handling children's faeces was found to be a significant predictor to cause occurrence of cholera such that respondents who did not wash hands after handling children's faeces ($_{a}$OR=1.98; 95% CI 1.13, 3.46; *p=0.02*) were more likely to get cholera as compared to those who washed their hands after handling children's faeces. Unwashed fruits or vegetables ($_{a}$OR =0.41; 95% CI 0.25, 0.69) remained associated with reduced odds but statistically significant effect (*p<0.05*). Proper cooking of food as practice of preventing cholera remained statistically significant though with reduced odds ($_{a}$OR=0.52; 95% CI 0.28, 0.96; *p=0.04*). Storing drinking water in clean container ($_{a}$OR=0.61; 95% CI 0.35, 1.09; *p=0.10*), praying ($_{a}$OR=0.56; 95% CI 0.26, 1.21; *p=0.14*) and consulting a traditional healer ($_{a}$OR=0.54; 95% CI 0.21, 1.40; *p=0.21*) were not significantly associated with occurrence of cholera after adjusting with other covariates. However, respondents who properly used toilets ($_{a}$OR=1.38; 95% CI 0.80,2.37) were more likely to prevent occurrence of cholera compared to those who did not use toilets properly but the effect was not statistically significant (*p=0.24*). Herbal remedies (OR=1.54; 95% CI 0.75, 3.15) remained significant factor of preventing cholera though with insignificant effect (*p>0.05*), however, homemade oral rehydration was not associated significantly with occurrence of cholera at the multivariable level ($_{a}$OR=0.67; 95% CI 0.38, 1.20; *p=0.18*). Finally, fever remained significant symptom of cholera though with reduced odds ($_{a}$OR=0.57; 95% CI 0.33, 0.98; *p=0.04*) and bloody diarrhea remained insignificantly associated with occurrence of cholera ($_{a}$OR=0.70; 95% CI 0.39, 1.26; *p=0.24*) (Table 4.4).

Table 4.4: Knowledge and Attitude levels on occurrence of Cholera in Isiolo county

Knowledge and Attitudes Predictors	Cholera		Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	p-Value
	Infected N=149 n(%)	Not Infected N=252 n (%)			
Causes of cholera					
Drinking contaminated water	141 (94.63)	227 (90.08)	0.52 (0.23,1.117)		
Eating contaminated food	128 (85.91)	202 (80.16)	0.66 (0.38,1.16)		
Unwashed fruits/vegetables	99 (66.44)	90 (35.71)	0.28 (0.18,0.43)	0.41 (0.25,0.69)	
Not washing hands before and after handling food	97 (65.10)	122 (48.41)	0.50 (0.33,0.76)		
Not washing hands after visiting toilet	103 (69.13)	159 (63.10)	0.76 (0.50,1.18)		
Open defecation in bush or roadside	48 (32.21)	56 (22.22)	0.60 (0.38,0.95)		
Not washing hands after handling children's faeces	67 (44.97)	95 (37.70)	0.74 (0.49,1.12)	1.98 (1.13,3.46)	**0.02**
Prevention of cholera					
Boiling drinking water	132 (88.59)	209 (82.94)	0.62 (0.34,1.14)		
Storing drinking water in a clean container	116 (77.85)	142 (56.35)	0.37 (0.23,0.58)	0.61 (0.35,1.09)	0.1
Proper use of toilets	108 ()72.48	155 (61.51)	0.61 (0.39,0.94)	1.38 (0.80,2.37)	0.24
Washing hands after visiting toilets	107 (71.81)	146 (57.94)	0.54 (0.35,0.84)		
Washing hands before and after handling food	89 (59.73)	118 (46.83)	0.59 (0.39,0.89)		
Drinking treated water	93 (62.42)	116 (46.03)	0.51 (0.34,0.78)		
Drinking river water	13 (8.72)	14 (5.56)	0.62 (0.28,1.35)		

General personal and household hygiene	90 (60.40)	112 (44.44)	0.52 (0.35,0.79)		
*Washing household **	78 (52.35)	95 (37.70)	0.55 (0.37,0.83)		
Praying	21 (14.09)	17 (6.75)	0.44 (0.22,0.87)	0.56 (0.26,1.21)	0.14
Consulting a traditional healer	13 (8.72)	11 (4.37)	0.48 (0.21,1.10)	0.54 (0.21,1.40)	0.21
Proper cooking of food	65 (43.62)	54 (21.43)	0.35 (0.23,0.55)	0.52 (0.28,0.96)	0.04
Treating Cholera					
Visiting a hospital	147 (98.66)	248 (98.41)	0.84 (0.15,4.66)		
Herbal remedies	19 (12.75)	32 (12.70)	1.00 (0.54,1.83)	1.54 (0.75,3.15)	0.24
Homemade oral rehydration	65 (43.62)	56 (22.22)	0.37 (0.24,0.57)	0.67 (0.38,1.20)	0.18
Prayer	15 (10.07)	18 (7.14)	0.69 (0.34,1.40)		
Don't know	0	3 (1.19)	0		
Symptoms of Cholera					
Fever	106 (71.14)	115 (45.63)	0.34 (0.22,0.52)	0.57 (0.33,0.98)	0.04
Vomiting	140 (93.96)	226 (89.68)	0.56 (0.25,1.23)		
Watery diarrhea	132 (88.59)	210 (83.33)	0.64 (0.35,1.18)		
Abdominal cramps	82 (55.03)	78 (30.95)	0.37 (0.24,0.56)		
Bloody diarrhea	30 (20.13)	38 (15.08)	0.70 (0.42,1.19)	0.70 (0.39,1.26)	0.24
Dehydration	94 (63.09)	110 (43.65)	0.45 (0.30,0.69)		
Other	18 (12.08)	19 (7.54)	0.59 (0.30,1.17)		
Don't know	5 (3.36)	6 (2.38)	0.70 (0.21,2.34)		

**Washing household surfaces and utensils with clean water,* CI- Confidence Interval

4.5 Environmental and health factors on occurrence of Cholera in Isiolo county.

Univariate analysis of the environmental and health factors indicates that majority of the respondents used piped water 334 (83.29%) as their main source of drinking water. Protected spring water 5 (1.25%) and river water 6 (1.50%) were the least sources of water used by the respondents. Majority of the respondents 372 (92.77%) were less than two kilometers away from the water sources. Of the 401 respondents, 206 (51.37%) treat water at their household level, 116 (59.49%) of the 195 (48.63%) who don't treat water believe that the raw water is okay for drinking. For those who treat water, 73 (35.44%) are consistent in treating water, however, 133 (64.56%) irregularly treat their water for drinking. More than half 225 (56.11%) have water available throughout the year. Two hundred and seven (51.11%) of the respondents owned a toilet, of the 207 respondents with toilets, only 105 (50.72%) have toilets with hand washing facility. Of the 194 (48.38%) without a toilet, 193 (99.48%) stated that owning a toilet is costly, one respondent (0.52%) had other reasons for not having a toilet. Twenty-eight (14.43%) of those without a toilet, use bushes as toilets and 166 (85.57%) share with their neighbors. Regarding how they dispose household waste, most 182 (45.39%) use compost pit, quite a number 142 (35.41%) burn their household waste and a small proportion dump their waste along the road side. The highest number of the respondents 264 (65.84%) lived in semi-permanent type of houses and only 3 (0.75%) had grass thatched houses. Thirty-one (7.73%) of these respondents share a house with domestic animal, of which 18 (58.06%) of them share a house to provide security to their animals. Overall, 347 (86.53%) wash their hands after using the toilet, 336 (83.79%) wash their hands before and after eating (Table 4.5).

Analysis from chi-square test detected significant association between main source of drinking water and occurrence of cholera ($p=0.01$). This study reports similar results for treating water at

household level (p<*0.001*), water availability throughout the year (p=*0.001*), household ways of disposing waste (*p=0.03*), type of house (*p=0.01*), washing hands before and after handling food (*p<0.001*) (Table 4.5). Distance from the water sources and other factors such as sharing a house with animal, washing hands after using the toilet, reasons for not treating water did not detect significant association with occurrence of cholera (*p>0.05*).

Table 4.5: Knowledge and Attitude levels on occurrence of Cholera in Isiolo county

Environmental Health variables	All N=401 n (%)	Cholera		p-Value
		Infected N=149 n(%)	Not Infected N=252 n (%)	
Main sources of drinking water				
Piped water	334 (83.29)	131 (87.92)	203 (80.56)	
Protected spring	5 (1.25)	1 (0.67)	4 (1.59)	
Borehole	35 (8.73)	15 (10.07)	20 (7.94)	0.01
River	6 (1.50)	1 (0.67)	5 (1.98)	
Others	21 (5.24)	1 (0.67)	20 (7.94)	
Distance to water sources				
< 2 km	372 (92.77)	144 (96.64)	228 (90.48)	
2-3 km	26 (6.48)	5 (3.36)	21 (8.33)	0.05
3-4 km	3 (0.75)	0	3 (1.19)	
Treat water at household level (Yes)	206 (51.37)	109 (73.15)	97 (38.49)	<0.001
Reasons not treating water (N=195)				
It takes a lot of time	13 (6.67)	2 (5.00)	11 (7.10)	
It is costly	36 (18.46)	9 (22.50)	27 (17.42)	0.41
Water is okay	116 (59.49)	26 (65.00)	90 (58.06)	
Don't know	30 (15.38)	3 (7.50)	27 (17.42)	
Consistency in treating drinking water (N=206)				
Always	73 (35.44)	42 (38.53)	31 (31.96)	0.33
Sometimes	133 (64.56)	67 (61.47)	66 (68.04)	
Water availability throughout the year (Yes)	225 (56.11)	113 (75.84)	112 (44.44)	<0.001
Household own a toilet	207 (51.62)	107 (71.81)	100 (39.68)	<0.001
Toilet have hand washing facility (N=207)	105 (50.72)	67 (62.62)	38 (38.00)	<0.001
Reasons not owning a toilet (N=194)				
Costly	193 (99.48)	42 (100.00)	151 (99.34)	0.6
Others	1 (0.52)	0	1 (0.66)	
Places used as toilets (N=194)				

Bush	28 (14.43)	5 (11.90)	23 (15.13)	0.6
Sharing with neighbors	166 (85.57)	37 (88.10)	129 (84.87)	
Household dispose of daily refuse				
Compost pit	182 (45.39)	77 (51.68)	105 (41.67)	0.03
Special place in the compound	34 (8.48)	10 (6.71)	24 (9.52)	
Burning	142 (35.41)	53 (35.57)	89 (35.32)	
Bush	18 (4.49)	3 (2.01)	15 (5.95)	
Road side	14 (3.49)	1 (0.67)	13 (5.16)	
Others	11 (2.74)	5 (3.36)	6 (2.38)	
Type of house				
Permanent	127 (31.67)	61 (40.94)	66 (26.19)	0.01
Semi-permanent	264 (65.84)	85 (57.05)	179 (71.03)	
Grass thatched	3 (0.75)	1 (0.67)	2 (0.79)	
Others	7 (1.75)	2 (1.34)	5 (1.98)	
Share a house with domestic animal (Yes)	31 (7.73)	12 (8.05)	19 (7.54)	0.85
Reasons for sharing a house with domestic animal (N=31)				
Insecurity	18 (58.06)	5 (41.67)	13 (68.42)	0.33
Limited space	6 (19.35)	3 (25.00)	3 (15.79)	
Others	7 (22.58)	4 (33.33)	3 (15.79)	
When to wash hands				
After using the toilet	347 (86.53)	126 (84.56)	221 (87.70)	0.37
Before and after eating	336 (83.79)	128 (85.91)	208 (82.54)	0.38
Before and after handling food	234 (58.35)	102 (68.46)	132 (52.38)	<0.001
After handling children faeces/diapers	167 (41.65)	77 (51.68)	90 (35.71)	<0.001
Others	91 (22.69)	53 (35.57)	38 (15.08)	<0.001

Univariate analysis of environmental health predictors of occurrence of cholera showed that borehole water (OR=1.16; 95% CI, 0.57, 2.35), not treating water because it's costly (OR= 1.16; 95% CI, 0.34, 9.89) or raw water is okay (OR, 1.59; 95% CI, 0.33, 7.63), sharing toilets with neighbors (OR,=1.32; 95% CI, 0.47, 3.71), sharing a house with domestic animal because of limited space (OR= 2.60; 95% CI, 0.39-17.45) and washing the hands after using the toilets (OR= 1.30; 95% CI, 0.73-2.33) had increased odds with occurrence of cholera though the effects were not statistically significant (Table 4.6). However, at multivariable level, only washing hands after using toilet ($_{a}$OR=3.54; 95% CI 1.42, 8.81; *p=0.01*) remained significantly associated with occurrence of cholera after adjusting for other covariates.

Table 4.6: Environmental and health factors associated with on occurrence of cholera in Isiolo County

Environmental Predictors	Cholera				
	Infected N=149 n(%)	Not Infected N=252 n (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	p-Value
Main sources of drinking water					
Ground Piped water	131 (87.92)	203 (80.56)	Ref	Ref	
Protected spring	1 (0.67)	4 (1.59)	0.39 (0.04,3.50)	0.69 (0.07,7.22)	0.76
Borehole	15 (10.07)	20 (7.94)	1.16 (0.57,2.35)	0.94 (0.42,2.07)	0.88
River	1 (0.67)	5 (1.98)	0.31 (0.04,2.68)	0.73 (0.05,11.70)	0.83
Others	1 (0.67)	20 (7.94)	0.08 (0.01,0.58)	0.11 (0.01,0.93)	0.04
Distance to water sources					
< 2 km	144 (96.64)	228 (90.48)	Ref		
2-3 km	5 (3.36)	21 (8.33)	0.38 (0.13,1.02)		
3-4 km	0	3 (1.19)	0		
Treat water at household level (Yes)	109 (73.15)	97 (38.49)	0.23 (0.15,0.36)	0.30 (0.17,0.53)	<0.001
Reasons not treating water (N=195)					
It takes a lot of time	2 (5.00)	11 (7.10)	Ref		
It is costly	9 (22.50)	27 (17.42)	1.83 (0.34,9.89)		
Water is okay	26 (65.00)	90 (58.06)	1.59 (0.33,7.63)		

Don't know	3 (7.50)	27 (17.42)	0.61 (0.09,4.18)		
Consistency in treating drinking water (N=206)					
Always	42 (38.53)	31 (31.96)	Ref		
Sometimes	67 (61.47)	66 (68.04)	0.75 (0.42,1.33)		
Water availability throughout the year (Yes)	113 (75.84)	112 (44.44)	0.25 (0.16,0.40)		
Household own a toilet	107 (71.81)	100 (39.68)	0.26 (0.17,0.40)	0.41 (0.24,0.70)	<0.001
Toilet have hand washing facility (N=207)	67 (62.62)	38 (38.00)	0.37 (0.21,0.64)		
Reasons not owning a toilet (N=194)					
Costly	42 (100.00)	151 (99.34)	Ref		
Others	0	1 (0.66)	0		
Places used as toilets (N=194)					
Bush	5 (11.90)	23 (15.13)	Ref		
Sharing with neighbors	37 (88.10)	129 (84.87)	1.32 (0.47,3.71)		
Household dispose of daily refuse					
Compost pit	77 (51.68)	105 (41.67)	Ref	Ref	
Special place in the compound	10 (6.71)	24 (9.52)	0.57 (0.26,1.26)	0.98 (0.39,2.47)	0.97
Burning	53 (35.57)	89 (35.32)	0.81 (0.52,1.27)	0.62 (0.36,1.05)	0.08
Bush	3 (2.01)	15 (5.95)	0.27 (0.08,0.98)	0.23 (0.06,0.86)	0.03
Road side	1 (0.67)	13 (5.16)	0.10 (0.01,0.82)	0.12 (0.01,1.25)	0.08

Others	5 (3.36)	6 (2.38)	1.14 (0.33,3.86)	0.87 (0.21,3.58)	0.85
Type of house					
Permanent	61 (40.94)	66 (26.19)	Ref		
Semi-permanent	85 (57.05)	179 (71.03)	0.51 (0.33,0.79)		
Grass thatched	1 (0.67)	2 (0.79)	0.54 (0.05,6.12)		
Others	2 (1.34)	5 (1.98)	0.43 (0.08,2.31)		
Share a house with domestic animal (Yes)	12 (8.05)	19 (7.54)	0.93 (0.44,1.98)		
Reasons for sharing a house with domestic animal (N=31)					
Insecurity	5 (41.67)	13 (68.42)	Ref		
Limited space	3 (25.00)	3 (15.79)	2.60 (0.39,17.45)		
Others	4 (33.33)	3 (15.79)	3.47 (21.35)		
When to wash hands					
After using the toilet	126 (84.56)	221 (87.70)	1.30 (0.73,2.33)	3.54 (1.42,8.81)	**0.01**
Before and after eating	128 (85.91)	208 (82.54)	0.76 (0.44,1.36)	0.66 (0.28,1.58)	0.35
Before and after handling food	102 (68.46)	132 (52.38)	0.51 (0.33,0.78)		
After handling children faeces/diapers	77 (51.68)	90 (35.71)	0.52 (0.34,0.78)	1.47 (0.81,2.68)	0.21
Others	53 (35.57)	38 (15.08)	0.32 (0.20,0.52)	0.46 (0.26,0.80)	0.01

Ref-Reference groups

4.6 Health system factors on occurrence of Cholera in Isiolo county.

Of the 401 respondents enrolled in this study, 122 (30.42%) received health education on prevention and treatment of cholera. The most common lesson learnt by majority was water treatment and storage 105 (86.07%). Other lessons taught during this health education were personal hygiene 100 (81.97%), general cleanliness 96 (78.69%) and only 46 (37.70%) of those who received the health education were taught on solid waste management. Overall, less than a quarter 55 (13.72%) went to hospital for cholera or diarrhea treatment and all were given medication. Surprisingly, none of the respondents received any support from the MoH. In relation to time to the nearest hospital, about half of the respondents 192 (47.88%) take a maximum of one hour to reach the nearest hospital, however, 5 (1.25%) could not approximate the time it takes them to reach the nearest hospital. Eighty-three of these respondents had heard of cholera vaccine and very insignificant number 9 (2.24%) received the vaccine in the last six months. Lastly, this study reports largest proportion of respondents 336 (83.79%) who were willing to let their children to receive cholera vaccine.

The spread of cholera is associated with various health system factors in a population. This study investigated health factors that influence occurrence of cholera. Table 4.7 lists the distribution of occurrence of cholera against health characteristics of the respondents. Receiving health education on prevention and treatment of cholera, personal hygiene, hand washing with soap during critical times and willing to let a child to receive cholera vaccine were the important health factors that significantly determined the occurrence of cholera ($p<0.001$). Factors such water treatment and storage, general cleanliness and latrine usage did not report significant association with occurrence of cholera in this study (Table 4.7).

Table 4.7: Health system factors on occurrence of Cholera in Isiolo county

Health System variables	Cholera			p-Value
	All N=401 n (%)	Infected N=149 n(%)	Not Infected N=252 n (%)	
Received health education on prevention and treatment of Cholera	122 (30.42)	63 (42.28)	59 (23.41)	<0.001
Lessons taught (N=122)				
Water treatment and storage	105 (86.07)	57 (90.48)	48 (81.36)	0.15
Personal Hygiene	100 (81.97)	57 (90.48)	43 (72.88)	0.012
General cleanliness	96 (78.69)	50 (79.37)	46 (77.97)	0.85
Hand washing with soap during critical times	97 (79.51)	55 (87.30)	42 (71.19)	0.03
Solid waste management	46 (37.70)	27 (42.86)	19 (32.20)	0.23
Latrine usage	82 (67.21)	47 (74.60)	35 (59.32)	0.07
Gone to hospital for cholera or diarrhea treatment	55 (13.72)	26 (17.45)	29 (11.51)	0.1
Medication given (N=550	55 (100.00)	26 (100.00)	29 (100.00)	0
Support received from department of health				
Oral rehydration solution	0	0	0	0
Chlorine solution	0	0	0	0
Soap	0	0	0	0
Chlorine tablets/water	0	0	0	0
Print materials	0	0	0	0
Jericans	0	0	0	0
Others	0	0	0	0
Time it takes to reach nearest hospital				
0.5 hours	191 (47.63)	86 (57.72)	105 (41.67)	
0.5-1 hour	192 (47.88)	58 (38.93)	134 (53.17)	
2 hours	12 (2.99)	5 (3.36)	7 (2.78)	0.01
2.5 hours	1 (0.25)	0	1 (0.40)	
Don't know	5 (1.25)	0	5 (1.98)	
Heard of cholera vaccine	83 (20.70)	39 (26.17)	44 (17.46)	0.04
Received cholera vaccine in the last six months	9 (2.24)	5 (3.36)	4 (1.59)	0.3
Willing to let a child to receive cholera vaccine	336 (83.79)	116 (77.85)	220 (87.30)	0.01

This study confirms that willing to let a child to receive cholera vaccine (OR=1.96; 95% CI, 1.14, 3.34) was a significant predictor of occurrence of cholera. Other significant health factors were receiving health education on prevention and treatment of cholera (OR= 0.42; 95% CI, 0.27-0.65),

personal hygiene (OR= 0.28; 95% CI, 0.10-0.78), hand washing with soap during critical times (OR= 0.36; 95% CI, 0.14-0.91), however, they were associated with reduced odds with occurrence of cholera (Table 4.7). However, at multivariable level, only willing to let a child to receive cholera vaccine ($_{a}$OR=3.42; 95% CI 1.25, 9.36; *p=0.02*) remained significantly associated with occurrence of cholera after adjusting for other covariates.

Table 4.8: Health system factors associated with on occurrence of cholera in Isiolo County

Health System Predictors	Cholera				
	Infected N=149 n(%)	Not Infected N=252 n (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	p-Value
*Received health education **	63 (42.28)	59 (23.41)	0.42 (0.27,0.65)		
Lessons taught (N=122)					
Water treatment and storage	57 (90.48)	48 (81.36)	0.46 (0.16,1.33)		
Personal Hygiene	57 (90.48)	43 (72.88)	0.28 (0.10,0.78)	0.35 (0.11,1.09)	0.07
General cleanliness	50 (79.37)	46 (77.97)	0.92 (0.39,2.19)		
Hand washing with soap during critical times	55 (87.30)	42 (71.19)	0.36 (0.14,0.91)	0.52 (0.19,1.40)	0.19
Solid waste management	27 (42.86)	19 (32.20)	0.63 (0.30,1.33)		
Latrine usage	47 (74.60)	35 (59.32)	0.50 (0.23,1.07)		
*Gone to hospital **	26 (17.45)	29 (11.51)	0.62 (0.35,1.09)		
Medication given (N=55)	26 (100.00)	29 (100.00)	0		
Support received from department of health					
Oral rehydration solution	0	0	0		
Chlorine solution	0	0	0		
Soap	0	0	0		

Chlorine tablets/water	0	0	0		
Print materials	0	0	0		
Jericans	0	0	0		
Others	0	0	0		
Time it takes to reach nearest hospital					
0.5 hours	86 (57.72)	105 (41.67)	Ref	Ref	
0.5-1 hour	58 (38.93)	134 (53.17)	0.53 (0.35,0.80)	1.31 (0.55,3.08)	0.54
2 hours	5 (3.36)	7 (2.78)	0.87 (0.27,2.85)	0	0
2.5 hours	0	1 (0.40)	0	0	0
Don't know	0	5 (1.98)	0	0	0
Heard of cholera vaccine	39 (26.17)	44 (17.46)	0.60 (0.37,0.97)		
*Received cholera vaccine**	5 (3.36)	4 (1.59)	0.46 (0.12,1.76)		
Willing to let a child to receive cholera vaccine	116 (77.85)	220 (87.30)	1.96 (1.14,3.34)	3.42 (1.25,9.34)	**0.02**

**Received health education on prevention and treatment of Cholera, *Gone to hospital for cholera or diarrhea treatment, *Received cholera vaccine in the last six months*

4.7 Multivariate Analysis to predict occurance of cholera

This study presents results for multivariate analysis for each of the specific objectives to predict occurrence of cholera.

4.7.1 Influence of knowledge factors on occurrence of cholera

A multiple regression was run to predict occurrence of cholera from level of education, knowledge of cholera risk factors including consumption of unwashed fruits and vegetables, handling food with dirty hands and open defacation; knowledge of cholera prevention measures including proper use of toilet, storing water in clean containers, washing hands with soap after visiting the toilet, washing hands before handling food, drinking treated water, general personal and household hygiene, washing household surfaces and utensils with clean water, proper cooking food, praying; knowledge of home made oral rehydration solution as a treatment option for cholera; and knowledge of symptoms assocted with cholera including fever, abdominal cramps, and dehydration.

Four out of these variables statistically significantly predicted occurrence of cholera, $F(16, 384) = 6.098$, $p < .000$, $R^2 = .203$. The four variables that added statistically significantly to the prediction at $p < .05$ included, level of education, knowing that unwashed fruits and vegetables is a risk factor, praying as a means of prevention and knowing fever as a symptom. The results are shown in Table 4.9.

Table 4.9: Multiple regression to predict occurrence of cholera from knowledge factors

Model	Unstandardized coefficients		Standardized Coef.	t	Sig.	95% CI for B	
	B	Std Error	Beta			Lower Bound	Upper Bound
Constant	1.088	.202		5.382	.000	.691	1.485
Level of education	-.128	.024	-.252	-5.292	.000	-.175	-.080
Unwashed fruits and vegetables	.142	.057	.146	2.490	.013	.030	.254
Handling food with dirty hands	-.107	.059	-.097	-1.823	.069	-.222	.008
Open defeacation	-.003	.054	-.003	-.047	.963	-.109	.104
Proper use of toilet	-.073	.055	-.072	-1.336	.182	-.181	.035
Storing water in clean containers	.087	.061	.086	1.429	.154	-.033	.206
Washing hands with soap after toilet	.017	.055	.017	.317	.752	-.091	.125
Washing hands before hadling food	-.034	.057	-.035	-.585	.559	-.147	.079
Personal and household hygiene	.027	.058	.028	.470	.639	-.087	.142
Cleaning surfaces/utensils with clean water	-.101	.061	-.103	-1.662	.097	-.220	.018
Proper cooking of food	.143	.078	.087	1.840	.067	-.010	.296
Praying	.144	.064	.136	2.249	.025	.018	.269

Home made ORS for treatment	.093	.064	.089	1.453	.147	-.033	.220
Knowing fever as a symptom	.116	.056	.120	2.094	.037	.007	.226
Abdoinal cramps	.060	.061	.061	.994	.321	-.059	.180
Dehydration	.006	.059	-.006	-.102	.919	-.122	.110

4.7.2 Influence of environmental and health factors on occurrence of cholera

On environmental health factors, predictor variables that were considered in the model included; source of drinking water, treating drinking water, consistency of treating water, availability of water throughout the year, toilet ownership, type of house, handwashing before and after handling food and handwashing after handling a child's feaces.

From the model, occurrence of cholera was statistically significantly predicted by two variables - source of drinking water and toilet ownerhip; $F(8, 391) = 9.200$, $p < .000$, $R^2 = .158$. Table 4.11 shows the results above.

Table 4.10: Multiple regression to predict occurrence of cholera from knowledge factors

Model	Unstandardized coefficients		Standardized Coef.	t	Sig.	95% CI for B	
	B	Std Error	Beta			Lower Bound	Upper Bound
Constant	.954	.105		9.117	.000	.748	1.160
Source of drinking water	.632	.021	.071	1.497	.035	-.010	.074
Treating drinking water	.170	.101	.176	1.675	.095	-.029	.369
Consisitency of treating water	.057	.067	.090	.848	.397	-.075	.190
Water adequately available	.048	.116	.049	.415	.678	-.179	.275
Toilet ownership	.457	.112	.163	1.404	.021	-.063	.378
Type of house	.010	.043	.012	.243	.808	-.074	.094
Washing hands before and after handling food	.031	.051	.032	.608	.543	-.069	.131
Washing hands after hadling child's feaces	-.075	.055	-.076	-1.357	.176	-.183	.034

4.7.3 Influence of health system factors on occurrence of cholera

Hospital distance and willingness to let a child or family member receive cholera vaccine both statistically significantly predicted occurrence of cholera, $F(2, 398) = 5.419$, $p < .0005$, $R^2 = .027$.

See table 4.11.

Table 4.11: Multivariate analysis predicting occurrence of cholera using health system factors

Model	Unstandardized coefficients		Standardized Coef.	T	Sig.	95% CI for B	
	B	Std Error	Beta			Lower Bound	Upper Bound
Constant	1.638	.115		14.201	.000	1.411	1.865
Hospital distance	.103	.048	.107	2.136	.033	.008	.198
Willingnes to let child get vaccinated	-.141	.066	-.108	-2.151	.032	-.270	-.012

Table 4.12: Key informant interview results

Question	**Response and code**	**Theme**
I would like to ask you about interventions that have been implemented in Isiolo County to prevent or control cholera.	-"They are very many, depending on who is responsible. For example, our community health workers educate community members at household level for proper hygiene like use of a toilet. There is also a requirement for food venders to be medically certified before selling food to the public." – a clinician - "Every day we make sure that hotels are inspected and that food is sold in clean places to people." – a PHO - "We have taught every village to have latrines because when it rains our water gets contaminated if we do not use toilets." – a CHV	Cholera prevention and control interventions implemented in Isiolo County and their effectiveness

What interventions do you think have been particularly effective in preventing or controlling cholera in the County?	-"Like here in Bullapesa you can see that people are having toilets apart from others who cannot afford."- a CHV -"Since the launch of community led total sanitation, it has triggered interest of the members to be keen on sanitation and hygiene issues."- a PHO - "When we have a diarrhea case in the facility, we attend to them promptly because if it is cholera, it will spread to others" – a nurse -"Community based interventions including educating the community has worked in some areas, again you know here in the rural, hygiene is not so good and people don't know what is right unless you teach them." – a clinician
What contributed to their effectiveness?	-"Sometimes when you get support from NGOs like UNICEF and they drive the implementation process of these interventions like CLTS, the results can be seen. But the ministry of health when implementing alone receives a lot of challenges." – a PHO -"It is the community to decide, for example when they see that what you are telling them is good and is helping them, they will accept and do it." – a CHV
What information is available for evaluating the effectiveness of interventions?	-"If a hospital is reporting high numbers of diarrhea then you can know that sanitation and hygiene in the community is poor." – a Clinician
What new interventions, if any, do you think should be implemented in Isiolo County and why?	-"The ministry of health to focus on delivery of cholera vaccine because this will help many people. Also, community interventions should still continue because it will help them at community level."- Clinician -"Water is our main problem here since we are not in a town set up. Some months are too dry that

	people are forced to get water from unsafe sources. In the rainy months, all sources get contaminated by floods and this increases chances of the ingestion of cholera bacteria. If the government of Isiolo supplies clean water for everyone then people will not drink contaminated water."- Clinician -"People who sell Anolei - Borana word for camel milk - to also be given medical certificate. This will protect community from taking contaminated milk."- CHV	
Are you familiar with oral cholera vaccines and WHO's stockpile?	-"I know of cholera vaccine, and yes I am familiar with WHO's stockpile." – Nurse -"Vaccines are very many especially when you go to the referral hospital, maybe even cholera vaccine can be found there."- CHV	
Has there been consideration of using this vaccine in Isiolo County, and do you see any barriers to implementation?	-We have never received any supplies of cholera vaccine because of limited supply at the county."– Nurse. -Here at this hospital, what we receive is not enough for everyone." – Nurse	
What policies or strategies have contributed to successful prevention and control of cholera in Isiolo County?	-"We have projects that are brought to us by NGOs like the safe water project by UNICEF which has seen a number of households accessing clean water for drinking." – PHO -"When we introduced CLTS to the community, you can see that the villages which liked it have changed and when they are crowned open defecation free you can see people become happy and they want to do more." - CHV	Policies and strategies addressing cholera at county level
How does the policy or strategy contribute to success?	-"When community have toilets, people don't contaminate water sources with open defecation." – CHV	

What weaknesses do you see in existing policies and strategies or their implementation?	- "Lack of consistency in implementation is our major problem. Again Isiolo has other more serious health problems like maternal and child health that gains more attention as compared to the problem of cholera. We sometimes also lack transparency in regards to resource allocation and utilization and this is a key drawback when it comes to policy implementation. It has also made us over rely on donor support." - Doctor	
What suggestions do you have for improving cholera prevention and control through policy and strategy formulation?	-"If we continuously sensitize the community on the dangers of open defecation then we can reduce fecal contamination of water." – CHV -"Bridging the gap between policy and practice is the only solution. The country is not short of policies that can curb cholera outbreaks but all these are shelved due to resources constraint."-PHO	
What data is available to decision makers to enable informed decisions on cholera prevention and control strategies?	-"All kinds of data related to water, sanitation and hygiene, for example reports of villages that still practice open defecation, high prevalence rates of diarrhea, U5 mortality due to diarrheal complications related to poor fecal disposal, deaths from confirmed cholera cases." – Nurse	Availability of data for decision making
What data is lacking for informed decision-making?	-"Sometimes even the data from the health facilities do not reach the DHIS2 because we don't have good supply of MOH registers. This means that even the community data does not accurately get reported when registers are not there. Now if we have incomplete data, then we cannot rely on it for decision making. If today you log in to DHIS2 of Isiolo County you will just meet incomplete data so we do not know if the data we generate serves the purpose." – Doctor	
How does your organization communicate with other organizations	-"As a ministry, I know that every implementer must first of all engage the County leadership through meetings before anything is done, but as for the	Communication mechanisms of coordination among organizations

that are involved in cholera prevention and control activities? What structures exist for communication and coordination? What challenges have you seen with respect to communication and coordination among organizations? What suggestions do you have for improving communication and coordination among organizations?	NGOs, they don't work together, I think it is because every donor has different requirements." PHO -"The only common way of communicating is the DHIS2 which has all the health data from the ministry of health. Anyone from the private or public sector can access this if they require any health information for Isiolo County."-Nurse -"Every organization comes with their goals which are very important but these can make great impacts when synergized amongst themselves and together with what the MOH is already doing."- Nurse -"Let us shift focus on strengthening the already existing MOH structures for reporting and communication because they are here for a longer period compared to the individual organizations that have a shorter life on the ground."- Doctor -"Engage the community more and enhance community strategy, since cholera prevention is more linked to behavioral change than just a one - time intervention." – PHO	engaged in cholera prevention
Are you familiar with the Multi-sectoral Cholera Prevention and Control Plan developed by the Ministry of Health with stakeholders? What has been achieved by this plan?	"Yes, it is actually the mother document for anyone who is involved in the fight against cholera." – PHO "It is not easy to quantify the success of this policy document because of several challenges which have led to scanty implementation. Sometimes there are resources for implementation, sometimes there is no allocation. We often rely on partners like UNICEF to promote components of the policy such as water sanitation and hygiene." – Doctor	Multi-sectoral Cholera Prevention and Control Plan

What challenges exist in implementing this plan?	"It might not be easy to quantify the success of this policy document because of several challenges which have led to scanty implementation. Sometimes there are resources for implementation, sometimes there is no resource allocation. We often rely on partners like UNICEF to promote components of the policy such as water sanitation and hygiene." – Doctor	
What suggestions do you have for improving implementation of this plan?	"The county division of health promotion should have a continuous plan of action for its activities in addressing cholera prevention. In so doing, there shall be a shift from the conventional responsive to preventive way of controlling the disease." – PHO "If the county can spare budget allocation to sustain continuous health promotion campaigns throughout the year, then cholera prevention will get adequate attention from both the community around and the health care workers. Also, there is need for regular updates and training for all health staff involved in disease outbreaks response." – Nurse	
What opportunities does devolution present for improving cholera prevention and control?	-"We have all the authority to make decisions in terms of resource allocation and service delivery as a county." – PHO	Implications of devolution with respect to cholera prevention and control
What challenges does devolution present to cholera prevention and control? Closing	-"When county leaders are faced with the challenge of corruption, resources are misused and quality of healthcare is compromised." – Nurse -"Other diseases and health problems have been given priority such as HIV and Malaria compared to cholera which is also dangerous." - CHV	

CHAPTER FIVE

DISCUSSION, SUMMARY AND CONCLUSION

5.1 Introduction

In this chapter, we appraise and critique the findings of this study while comparing with the results from previous studies in the same subject area. The sub sections in this chapter are presented in line with the specific objectives of the study.

5.1.1 Influence of Knowledge and attitude on occurrence of cholera outbreaks

Similar to the evidence from this study, educational disparities in health status are well documented. The relationship exists across the range of educational degrees; more education is associated with healthier behaviors (Teye *et al.*, 2015). For example, more educated individuals are less likely to smoke, more likely to engage in physical activity, and more likely to have a good diet (Centers for Disease Control 2013; Cutler and Lleras-Muney 2010; Margerison-Zilko and Cubbin 2013). As Stevens, Armstrong, and Arum (2018) note, education sorts and stratifies individuals, develops social competencies, legitimizes official knowledge, and connects multiple institutions, such as healthcare, the labor market, the family, and the nation-state. In India, a study related level of education to increased toilet use (Conradin *et al.*, 2010). A household in which the head had attained higher education was 3.1 times more likely to use a toilet when compared to a household where heads were non-educated. The underlying presumption is that the poor in India cannot afford to construct a toilet. This association could be as a result of socioeconomic empowerment and more knowledge of disease prevention that can be attributed to higher literacy levels.

The significant association between consumption of unwashed fruits and vegetables and occurrence of cholera can possibly be explained by the fact that contaminated food is a common vehicle for cholera transmission. This is because cholera is water and food borne disease spread through fecal oral transmission. Vegetables are likely to be facally contaminated during preparation, particularly by infected food handlers in an unhygienic environment or through unduly farming practices. This finding is consistent with the result of a study that assessed risk factors of cholera epidemic in Buea, Cameroon and reported poor food preservation method (OR = 9.20, CI: 3.67–23.08, $p < 0.0001$) as an independent risk factor for cholera (Nsagha *et al.*, 2015). Considering food security as a multi-dimensional factor, including availability, access, affordability, utilization, quality and safety, Ritcherman *et al* (2019) sought to establish the relationship between food security and cholera outbreaks and identified a strong relationship between food security and incidence rate of cholera. It is thus commendable that foods (fruits and vegetables included) should be prepared, sold, served and eaten in a hygienic environment, free from fecal contamination in order to reduce the risk of food-borne transmission of cholera. In addition, proper cooking, storing, and re-heating of foods before eating, could be important safety measures for preventing food-borne transmission of cholera.

This study also found a statistical significance between prayer and occurrence of cholera. This association can be explained from an anthropological point of view by the fact that such kind of a belief may directly hinder health seeking behaviour. When the sick entrust God with prayers or acts of devotion, with the conviction that only God would be able to provide recovery from cholera, the decision to seek medical intervention is compromised. Similar to this, are findings of a study by Romeo *et al* (2015) which reported that people entrusted the Holy Spirit, God, Jesus, Mary and the Saints with prayers or acts of devotion in order to heal their diseases. In a meta-analysis by

Sundaram *et al* (2016), prayer as a form of self-treatment was associated with acceptance of oral cholera vaccine in the Democratic Republic of Congo and Western Kenya but not in Zanzibar.

Studies have also demonstrated a consensus on the association between not knowing cholera symptoms and occurrence of cholera (Wahed et al., 2013; Gwenzi & Sanganyado, 2019). This study obtained similar findings, between knowing fever as a symptom for cholera and occurrence of cholera. Not being able to identify a symptom associated with cholera may lead to delay in response thus giving room for transmission since cholera is a highly contagious disease and disease progression. To affirm this, World Health Organization, (2015) posits that understanding the environmental drivers, reservoirs of cholera, and the associated symptoms is key for effective and timely prevention and control and is critical for the eradication of cholera.

5.1.2 Environmental health factor and occurrence of cholera outbreaks

This study reported a positive association between toilet ownership and occurrence of cholera. Cholera is spread through faecal-oral route, and studies demonstrate that ingestion of *Vibrio cholerae* occurs from consuming contaminated food and water, contact with cholera cases and transmission from contaminated environmental point sources. Open defecation perpetuates a vicious cycle of this disease. Practice of proper use of toilet on the other hand ensures proper disposal of human feces thereby limiting possible fecal contamination of water and food sources. According to Pickering *et al.,* (2015) latrine ownership, use, and quality indicators such as type of latrine, presence of handwashing facility among others were proven impactful in cholera prone areas in South Sudan. The study reported a statistically significant increase in private or shared latrine construction in intervention groups compared to comparison groups. In Ghana, an increase in private latrine ownership was reported from training natural leaders (Crocker *et al.,* 2016) indicating there is an aspect of behaviour change intervention. Contrary to this finding, Garn *et al.,*

(2016) urgue that one of the primary aims of sanitation is improved health, but measuring these changes is difficult if the sanitation intervention did not result in a sufficient reduction in open defecation or exposure to fecal contamination. His study invalidates the obvious assumption that an increase in latrine coverage reduces diarrheal infections.

The significant association between source of drinking water and occurrence of cholera is attributable to the transmission role that water plays. Therefore, in order to control transmission of cholera pathogen, it is important to provide safe drinking water. WHO (2018) confirms that a person can become infected by drinking water or eating food contaminated by the bacterium and thus recommends drinking only water that has been boiled or disinfected with chlorine, iodine or other suitable products. This is similar to the findings of a study in Uganda that did an investigation to identify the source and mode of transmission, and recommend evidence-led interventions to control and prevent cholera outbreaks in Kaiso village, Western Uganda. The study found that the cholera outbreak in Kaiso Village was caused by drinking untreated lake water contaminated by human faeces washed down a gully channel during heavy rainfalls. It recommended treatment and boiling of drinking water to stop the outbreak as well as fixing the vandalized piped water system and constructing latrines in the community, to prevent future cholera outbreaks (Oguttu et al., 2017).

5.1.3 Influence of health system factors on occurrence of cholera outbreak

This study examined associations between health education on prevention and treatment, demand for and access to cholera treatment services and availability and uptake of cholera vaccine. There was a significant association between hospital distance as well as willingness to let a household member receive cholera vaccine and occurrence of cholera outbreak. The distance one has to cover to get to the nearest hospital speaks to geographical access to the services and this may be more

affected by remoteness of an area. Studies have tried to establish the impact of distance on the use of hospitals and other health care services. According to Jordan et al., (2004), travel to hospital is already known to be a problem for some groups in rural areas of the world. Although informal systems of 'lift-giving' and more formal 'voluntary taxi' schemes often exist, these are not available everywhere, and it could be argued that a measure of travel by public transport is vital in determining accessibility for the most disadvantaged populations. The study suggested that better measures of access, which integrate private and public transport, are required to reflect the experience of those on low incomes, and without their own transport.

A systematic review investigating whether there is an association between differences in travel distance to healthcare services and patients' health outcomes reported that 77% of the included studies identified evidence of a distance decay association, whereby patients living further away from healthcare facilities who needed attention had worse health outcomes such as survival rates, length of stay in hospital and non-attendance at follow-up than those who lived closer. 6 of the studies identified the reverse (a distance bias effect) whereby patients living at a greater distance had better health outcomes. The remaining 19 studies found no relationship. The review observed thus, that a relationship between travelling further and having worse health outcomes cannot be ruled out and should be considered within the healthcare services location debate (Kelly et al., 2016).

The world health Organization recommends use of mass oral cholera vaccine in cholera endemic zones alongside other WASH interventions (WHO, 2018). However, vaccine acceptance and behavior determine its uptake. For example, unlike communities opposed to cholera control or settings where public confidence in vaccines is lacking, uptake is likely low (Schaetti et al., 2012). In a different study, a high willingness to receive the cholera vaccines was countered by a coverage

that was less than satisfying (Sarker, 2020). Heyerdahi (2019), observes that high community awareness of cholera and a positive attitude towards receiving oral cholera vaccines, especially if they are provided without charge, suggest little opposition to vaccination as a supplementary means to cholera control.

5.2 Summary of Findings

Overall, available evidence from this study shows that Respondents who knew proper use of toilets ($_{a}$OR=1.38; 95% CI 0.80,2.37) and washing hands after using the toilet ($_{a}$OR=3.54; 95% CI 1.42, 8.81; *p=0.01*) as preventive ways, were less likely to experience occurrence of cholera compared to those who did not. Not washing hands after handling children's feaces ($_{a}$OR=1.98; 95% CI 1.13, 3.46; *p=0.02*); consuming unwashed fruits or vegetables ($_{a}$OR =0.41; 95% CI 0.25, 0.69) proper cooking of food as a practice ($_{a}$OR=0.52; 95% CI 0.28, 0.96; *p=0.04*) were found to be significant predictors to cause occurrence of cholera. Those who were willing to let a child receive cholera vaccine (OR=1.96; 95% CI, 1.14, 3.34); knew fever as a symptom ($_{a}$OR=0.57; 95% CI 0.33, 0.98; *p=0.04*) were also less likely to experience occurrence of cholera.

5.3 Conclusions and recommendations

We conclude that knowledge of prevention measures of cholera transmission such as proper use of toilet, proper hand hygiene particularly washing hand after visiting the toilet is associated with a low risk of cholera occurrence. The study recommends that the community and community health workers should embrace prevention strategies such as community led total sanitation strategy to strengthen best practices in water, sanitation and hygiene.

Practices such as not washing hands after handling children's feaces, consuming unwashed fruits or vegetables, proper cooking of food as a practice were found to be significant predictors to

occurrence of cholera. As such, we recommend the promotion of extensive health education focusing on the role of sanitation and general hygiene with key emphasis on safe waste disposal and proper food handling.

Lastly, willingness to let a child receive cholera vaccine and knowledge of symptoms of cholera were also associated with less occurrence of cholera. We recommend to healthcare providers, community health education focusing control and prevention of cholera. In addition, community sensitization on the role of oral cholera vaccine would be appropriate. Lastly, County health sector stakeholders should explore opportunities to adjust the current service delivery model to address predictor factors not proximal to the community like hospital distance to improve access to healthcare services.

5.4. Recommendation for further research

Effectiveness of cholera prevention solely depend on a near perfect level of water, sanitation and hygiene practices. However, several factors determine a community's ability to stay within this requirement. While this study focused on three of factors that seem key, there is need for a study focusing on the role of multi-sectoral approach towards cholera prevention as was evident in the key informant interviews towards the attainment of the Multi-sectoral Cholera Prevention and Control Plan developed by the Ministry of Health. Secondly, in the interest of resources, the study relied on self reported acute watery diarrhea in the household as a definition for cholera. A laboratory confirmatory test would be more appropriate.

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APPENDICES

APPENDIX I: INFORMED CONSENT FORM FOR HOUSEHOLD SURVEYS

Introduction and Purpose of the Study

Hello, my name is Patrick Musyoka Martin. I am a student at Maseno University and I am currently conducting a research study as a requirement for the award of a Degree of Master of Public Health. The research project is entitled, "Assessment of Factors Associated with Cholera Outbreaks in Isiolo County, Kenya." This study targets 422 household heads randomly sampled from three wards representing all the three sub counties of Isiolo. I am inviting you to participate in this study because you meet the eligibility criteria for the study. Before you decide to be part of the study, it is important for you to understand what this study involves. Please ask me if there is anything that is not clear, or if you would like more information. When all of your questions have been answered and you feel that you understand the study purpose, you will be asked if you wish to participate in the study, and if yes, to sign this informed consent form. You will be given a signed copy to keep.

Procedures

If you choose to participate in this study, here is what will happen: you will be asked to take part in a personal survey that will cover questions about knowledge factors, environmental health factors and health care system factors and how in your view they influence occurrence of cholera outbreaks in Isiolo County. The survey will take at most 45 minutes of your time.

Risks or Discomforts

Your participation in this study may have few risks. While answering questions, you may experience discomfort interacting with a stranger, asking questions that you may consider personal but the researcher will minimize this risk through procedures to protect your privacy and confidentiality. I understand that the time you take to be a participant in this survey may cause some inconvenience to your schedule of the day, and you may also find one or more of the questions asked to be upsetting or emotionally sensitive. You do not have to respond to any question that makes you feel uncomfortable.

Benefits

There shall be no direct benefits to you for participating in the study. You will not be paid nor will you have to pay for your participation in this study. However, study findings will be useful in promoting cholera prevention and control measures in Isiolo County

Confidentiality

All the information you share shall be kept confidential. Only the researcher and school supervisors will have access to the information gathered during our conversation and no personal identifiers will be connected to the data for analysis. You will be assigned a number that is linked to your name and your actual name will not be required, in this manner your personal information will be safe and not accessible by anyone. Interviews will be conducted in a private room where only you and the researcher will be available.

Data safety

Information that relates to and identifies you will be protected accordingly. You will be provided with a unique number in place of your name and household. Data collected from you will be kept securely. Filled questionnaires will be stored under key and lock. All information will thereafter be encrypted and stored on password-protected computers accessible to only the researcher and the school supervisors. The researcher will not use your identities in any reports or publications that may result from this study.

Voluntary Participation

You are free to join this study or not. If you decide to join, you are also free to change your mind and stop your participation in the study at any time for any reason. You will not have any penalty if you do not want to participate or stop participating.

Measures to safeguard your rights as a participant

In order to safeguard your rights, the researcher will ensure that you are taken through a comprehensive informed consent process with emphasis on privacy and confidentiality concerns and that the principle of autonomy and voluntariness is observed. Benefits and risks from the research study will be clearly explained to you before the interview session and you will be treated with patience and respect devoid of prejudice, allowing free will and ruling out any form of insensitivity. Researcher will assess your language and literacy capability and shall use an acceptable language that can be comfortably understood by you at any time.

Contact (Further Questions)

If at any time during the survey period you have questions or concern about the study, you may contact the researcher directly who will do his best to answer your questions. You may please call Patrick at 0724982855. If you have any concerns regarding your rights or welfare as a participant in this study, you may please contact the Secretary, Maseno University Ethics Review Committee, Private Bag, Maseno; Telephone numbers: 057-51622, 0722203411, 0721543976, 0733230878; Email address: muerc-secretariate@maseno.ac.ke; muerc-secretariate@gmail.com.

Do you have any questions up to that point?

Consent Signing (by the participant)

I have clearly understood the purpose of this study. I have received an explanation of the planned research, procedures, risks and benefits and privacy of my personal information. I agree to take part in this study. I understand that my participation in this study is voluntary.

Participant: Unique No. & Signature: ---------- Date: ----------

Researcher: Name & Signature: ---------- Date: ----------

APPENDIX II: RECRUITMENT LETTER FOR KEY INFORMANTS

Dear [insert participant's name],

My name is Patrick Musyoka Martin, and I am a Master of Public health student at Maseno University School of Public Health and Community Development. I am requesting your participation in a study I am conducting on assessment of factors associated with cholera outbreaks in Isiolo County, Kenya. I will be interviewing 9 professionals with expertise in this field. Your participation in the study would involve discussing your opinions on the key factors which in your perspective influence occurrence of cholera outbreaks in Isiolo County including the successes and challenges of cholera prevention and control in the county and any recommendations that you may have for improvement. The interview would take place at a time and location convenient for you and will last about 45 minutes.

Background

In Eastern region of Kenya, Isiolo County has the highest prevalence rate of diarrheal infections linked with scarcity and safety of water sources. About 68% of the county population practice open defecation while 65% rely on unprotected water sources. Only 49% have some formal education and 69% live below poverty line. There is little evidence of effort towards establishing any potential association between the prevailing risk factors in Isiolo County and the persistent cyclical cholera outbreaks that have occurred every year since the re-emergence of cholera in 2015.

The aim of this study is to assess the factors associated with cholera outbreaks in Isiolo County. Topics of particular interest in this study include: cholera interventions, policies and strategies, data for decision-making, communication and coordination, Kenya's 5-year Multi-sectoral Cholera Prevention and Control Plan, and implications of devolution. The goal is to produce information that will be useful to the County Government of Isiolo and its partners in establishing or strengthening policies and programs that effectively prevent and control cholera.

Confidentiality and privacy of information

The interview will be completely confidential, and your name will not be connected to your responses in any way. Any information that you provide will be released only as group summaries. Information from the interview will be securely stored and destroyed upon completion of this study. Thank you for considering participation in this study. Please confirm if you are willing to participate. Feel free to contact me at pmusyoka86@gmail.com or +254 724 982 855 if you have any questions.

Sincerely,

Patrick Musyoka Martin

APPENDIX III: QUESTIONNAIRE FOR HOUSEHOLD RESPONDENTS

Assessment of Factors Associated with Cholera Outbreaks in Isiolo County, Kenya.

Date:	Questionnaire No.:	HH ID:

A.RESPONDENT'S DEMOGRAPHIC CHARACTERISTICS

1. Sex: 1. Male 2. Female

   Age: ----------

2. What is your current marital status?

   1=Not married 2=Married

3. What is your highest level of education?

   1=Never attended school 2=Primary 3=Secondary 4=Tertiary

4. What is your religion/Denomination?

   1=Muslim 2=Christian 3= other, specify……..

5. Are you currently employed? (If No, skip to question 1.9)

   1=Yes 2=No

   If yes above, what type of employment?

   1=formal employment 2= Self-employment 3=Casual employment

6. On average, what is your monthly income from all the sources that you have? 1=<1000 2=1001-10,000 3= 10,001 – 20, 000 4=20,001 – 30,000 5= >30,000

7. In the past week, has anyone in the household been ill with diarrhea, that is, stools that are more frequent and more liquid than usual? 1=Yes 2= No
8. How many household members including yourself were sick with diarrhea in the past week? Number sick: 1=None 2= 1-3 3=4-5 4= More than 5

B. RESPONDENTS' KNOWLEDGE AND ATTITUDE ON CHOLERA

10 What causes cholera? (Do not read out, circle yes for all that have been mentioned and No for all that are not mentioned)

Drinking contaminated water	1=Yes [ ]	2 = No [ ]
Eating contaminated food	1=Yes [ ]	2 = No [ ]
Unwashed fruits/vegetables	1=Yes [ ]	2 = No [ ]
Not washing hands a before and after handling food	1=Yes [ ]	2 = No [ ]
Not washing hands after visiting the toilet	1=Yes [ ]	2 = No [ ]
Open defecation in bush/road side	1=Yes [ ]	2 = No [ ]
Not washing hands after handling children feaces	1=Yes [ ]	5 = No [ ]

11 How can you prevent you or your family from easily contracting cholera? (Choose the correct statement (Tick Yes OR No)

i) Boiling drinking water 1=Yes, 2=No
ii) Storing drinking water in a clean container 1=Yes, 2=No
iii) Proper use of toilets 1=Yes, 2=No
iv) Washing hands often with soap after visiting latrine 1=Yes, 2=No
v) Washing hands before and after handling food 1=Yes, 2=No
vi) Drinking treated water 1=Yes, 2=No
vii) Drinking river water 1=Yes 2= No
viii) General personal and household hygiene 1= Yes 2= No
ix) Washing household surfaces and utensils with clean water 1=Yes, 2=No
x) Praying 1=Yes, 2=No
xi) Consulting a traditional healer 1= Yes 2=No
xii) Proper cooking of food 1= Yes 2= No

12 How would you treat cholera for you or your family member? Choose yes or No for each statement

i) Visit a hospital 1=Yes, 2=No
ii) Herbal remedies 1=Yes, 2=No
iii) Home-made oral rehydration 1=Yes, 2=No
iv) Prayer 1=Yes, 2=No
v) Don't know 1=Yes, 2=No

13 What symptoms are associated with cholera? (Do not read. Circle yes for all that are mentioned and circle no for those that are not mentioned)

Fever	1=Yes	2 = No
Vomiting	1=Yes	2 = No
Watery diarrhea	1=Yes	2 = No
Abdominal cramps	1=Yes	2 = No
Bloody diarrhea	1=Yes	2 = No
Dehydration	1=Yes	2 = No
Other, specify	1=Yes	2 = No
Don't Know	1=Yes	2 = No

C. ENVIRONMENTAL HEALTH FACTORS

14 What is your main source of drinking water?

1= Piped water 2 = Protected spring 3= Borehole 4 =River 5= others, specify ……

15 Distance house hold to water source 1=less 1km 2= 2-3 km 3= 3-4 km 4=4-5km 5=More than 5 Km

16i) Do you treat the water you drink at household level? 1= Yes, 2= No

ii) If No 17i) to the previous question, what is the main reason as to why you do not treat your drinking water? 1=It takes a lot of time, 2= It is costly, 3=water is ok, 4=don't know 5=N/A

iii) If Yes to 17 i), how consistent do you treat the water you drink? 1=Always, 2=Sometimes 3=N/A

17 Is the water adequately available throughout the year 1=Yes 2= No

18i) Does your household own a toilet? 1=Yes, 2=No.

ii) If yes in 18i), does it have hand washing facility (leaky taps) with water in 3metres radius ? 1=Yes 2=No 3=N/A

iii) If No in 18i), give reason for not owning a toilet 1= costly 2= not important 3= others, specify 4=N/A

iv) If No 18i), where have you been you been using as a toilet? 1=Bush 2= Sharing with neighbors toilet 3= others, specify 4=N/A

19 How does your HH dispose of daily refuse? 1= Compost pit 2= Special place in the compound 3= Burning 4= Bush 5 = Road side 6= others, specify……

20 Type of house 1= Permanent 2= Semi permanent 3= Grass thatched 4= others, specify

21 Do you share a house with domestic animals 1=Yes 2=No

If Yes, why 1= Insecurity 2 = Limited Space 3= others, specify……

22 When do you wash your hands?

After using the toilet	1=Yes	2 = No
Before and after eating	1=Yes	2 = No
Before and after handling food	1=Yes	2 = No
After handling children faeces/ diapers	1=Yes	2 = No
Others, specify	1=Yes	2 = No

D.HEALTH SYSTEM FACTORS

23 Have you ever received health education on prevention and treatment of cholera? 1=Yes 2 =No

If Yes, What were you taught? (Tick many) 1= Water treatment and storage 2= Personal Hygiene 3 =General cleanliness 4 =Hand washing with soap during critical times 5 = Solid waste management 6= Latrine usage (1=yes, 2=No, 3=N/A) for each response

24 Have you ever gone to health facility for cholera/diarrhea treatment? 1=Yes 2=No

If yes, were you given medication? 1=Yes 2= No

25. Have you ever received any of the following support from department of health?

Choose ones that you have ever received from the table.

Oral rehydration solution	1=Yes	2 = No
Chlorine solution	1=Yes	2 = No
Soap	1=Yes	2 = No
Chlorine tablets/water	1=Yes	2 = No
Print materials	1=Yes	2 = No
Jerricans	1=Yes	2=No
Others, specify	1=Yes	2 = No

26 How long does it take for you to get to the nearest hospital from your HH? 1=< 1/2hr, 2=1/2-1hr, 3=2hrs, 4=>2hrs, 5=don't know

27i) Have you heard of cholera vaccine? 1= Yes 2= No

ii) Have you or anyone received cholera vaccine in the last 6 months 1= Yes 2= No,

4.6 If a vaccine against cholera was available, would you be willing to let your child get it?

1= Yes. 2= No

APPENDIX IV: INTERVIEW GUIDE FOR KEY INFORMANTS

Introduction

The purpose of this interview is to learn about the factors associated with cholera outbreak in Isiolo County from your perspective. Nine professionals with expertise in cholera prevention and control in the county will participate in the interviews. The interview will take about 45 minutes and will be completely confidential. Your name will not be connected to your responses in any way and any information that you provide will be released only as group summaries. With your permission I would like to record our interview. Tape recordings and transcriptions of the interview will be stored in a secure location and destroyed upon completion of this study. Do you have any questions about the research study or the interview before we begin? May I record the interview?

Opening

1. What roles and responsibilities have you had related to cholera prevention and control?

2. How long have you been involved in activities related to cholera prevention and control?

    a. [Probe] How long in Isiolo County and how long in the target ward specifically?

Topic Area 1: Interventions

I would like to ask you about interventions that have been implemented in Isiolo County to prevent or control cholera.

3. What interventions do you think have been particularly effective in preventing or controlling cholera in the County?

    a. [Probe] what contributed to their effectiveness?

4. What information is available for evaluating the effectiveness of interventions?

5. What new interventions, if any, do you think should be implemented in Isiolo County and why?

    5a. Are you familiar with oral cholera vaccines and WHO's stockpile?

    5b. has there been consideration of using this vaccine in Isiolo County, and do you see any barriers to implementation?

Topic Area 2: Policy Space

I now have a few questions about policies and strategies related to cholera prevention and control at County level, feel free to mention any that applies at national level that you know of. These may be policies and strategies specific to cholera, or they may be broader public health policies and strategies.

6. What policies or strategies have contributed to successful prevention and control of cholera in Isiolo County?

a. [Probe] Kenyan government policies or strategies, these may be national, regional, or local

b. [Probe] other policies or strategies, these may be international or organization specific within the County

c. [Probe] how does the policy or strategy contribute to success?

7. What weaknesses do you see in existing policies and strategies or their implementation?

8. What suggestions do you have for improving cholera prevention and control through policy and strategy formulation?

Topic Area 3: Data for decision-making

I would like to ask you about the availability of data for decision-making.

9. What data is available to decision makers to enable informed decisions on cholera prevention and control strategies?

10. What data is lacking for informed decision-making?

Topic Area 4: Communication and coordination

I would like to ask you some questions about communication and mechanisms of coordination among organizations engaged in cholera prevention and control in Kenya.

11. How does your organization communicate with other organizations that are involved in cholera prevention and control activities?

a. [Probe] what structures exist for communication and coordination?

12. What challenges have you seen with respect to communication and coordination among organizations?

13. What suggestions do you have for improving communication and coordination among organizations?

Topic Area 5: Multi-sectoral Cholera Prevention and Control Plan

14. Are you familiar with the Multi-sectoral Cholera Prevention and Control Plan developed by the Ministry of Health with stakeholders? If YES, proceed to the next question, if NO, proceed to the next section.

15. What has been achieved by this plan?

16. What challenges exist in implementing this plan?

17. What suggestions do you have for improving implementation of this plan?

Topic Area 6: Devolution

Given that responsibility for health, water, and sanitation services has been devolved to county governments, I would like to ask you a few questions about the implications of devolution with respect to cholera.

20. What opportunities does devolution present for improving cholera prevention and control?

21. What challenges does devolution present to cholera prevention and control?

Closing

We are nearing the close of the interview, but I would like to give you an opportunity to talk about any other successes and challenges of cholera prevention and control in Isiolo County that we have not already covered.

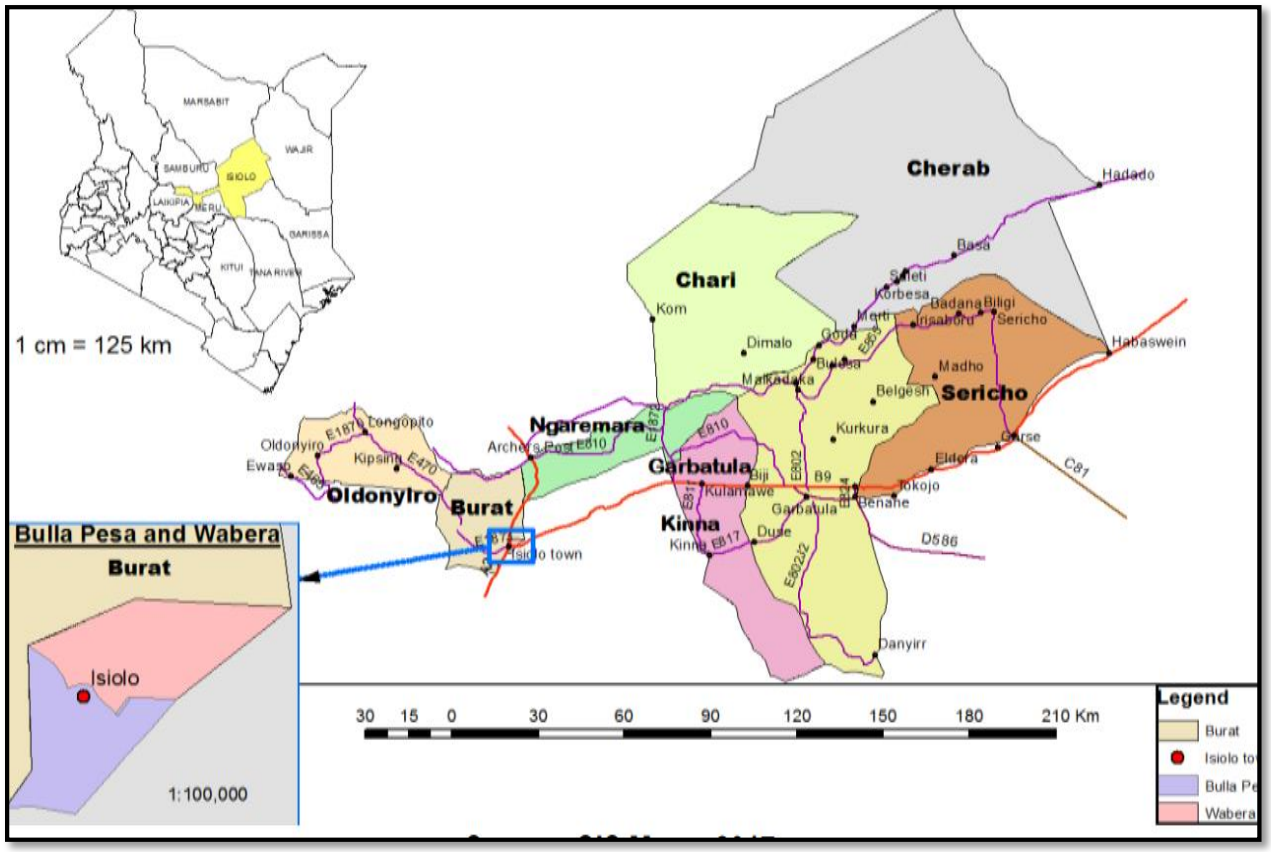
22. Is there anything else you would like to tell me about cholera prevention and control?

Thank you very much for your time

APPENDIX V: STUDY BUDGET

Activity/Item	Quantity	Unit Cost (KES)	Total Cost (KES)
Printing papers	8 reams	800	6,400
Printing, photocopy and Binding	-	23,000	23,000
Internet	-	6,000	6,000
Pencils and Erasers	10	50	500
Calculator	1	1,200	1,200
Cost of training assistants	7	500	3500
Lunch and transport	1	500 (5 days)	2500
Hiring research assistants	7	1,000 (5 days)	35,000
MUERC Fees	-	-	3,000
Contingency 10% of the total cost	-	-	8,810
Total			89,910

APPENDIX VI: STUDY AREA MAP



APPENDIX VII: MASENO UNIVERSITY SCHOOL OF GRADUATE STUDIES APPROVAL LETTER

MASENO UNIVERSITY
SCHOOL OF GRADUATE STUDIES
Office of the Dean

Our Ref: EL/ESM/01236/2017

Private Bag, MASENO, KENYA
Tel:(057)351 22/351008/351011
FAX: 254-057-351153/351221
Email: sgs@maseno.ac.ke

Date: 16th October, 2019

TO WHOM IT MAY CONCERN

RE: PROPOSAL APPROVAL FOR PATRICK MUSYOKA MARTIN — EL/ESM/01236/2017

The above named is registered in the Master of Public Health, Maseno University. This is to confirm that his research proposal titled "Assessment of Factors Associated with Cholera outbreak in Isiolo County Kenya." has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

Prof. J.O.Agure
DEAN, SCHOOL OF GRADUATE STUDIES

APPENDIX VIII: MUERC APPROVAL LETTER

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221

Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

FROM: Secretary - MUERC

DATE: 22nd May, 2020

TO: Patrick Musyoka Martin
EL/ESM/01236/2017
Department of Public Health
School of Public Health and Community Development
P. O. Box, Private Bag, Maseno, Kenya

REF: MSU/DRPI/MUERC/00806/19

RE: Assessment of Factors Associated with Cholera Outbreaks in Isiolo County, Kenya. Proposal Reference Number MSU/DRPI/MUERC/806/19

This is to inform you that the Maseno University Ethics Review Committee (MUERC) determined that the ethics issues raised at the initial review were adequately addressed in the revised proposal. Consequently, the study is granted approval for implementation effective this 22nd day of May, 2020 for a period of one (1) year. This is subject to getting approvals from NACOSTI and other relevant authorities.

Please note that authorization to conduct this study will automatically expire on 21st May, 2021. If you plan to continue with the study beyond this date, please submit an application for continuation approval to the MUERC Secretariat by 15th April, 2021.

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach the MUERC Secretariat by 15th April, 2021.

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

MASENO UNIVERSITY SECRETARY ETHICS REVIEW COMMITTEE
22 MAY 2020

Dr. Bonuke Anyona,
Secretary,
Maseno University Ethics Review Committee.

Cc: Chairman,
Maseno University Ethics Review Committee.

APPENDIX IX: NACOSTI RESEARCH LICENSE

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 389612

Date of Issue: 07/January/2021

RESEARCH LICENSE

PATRICK MUSYOKA MARTIN

This is to Certify that Patrick Musyoka Martin, has been licensed to conduct research in Isiolo County, on the topic: Assessment of factors associated with Cholera Outbreaks in Isiolo County, Kenya.

License No: NACOSTI/P/21/14237

389612

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is Guided by the Science, Technology and Innovation(Research Licensing) Regulations, 2014

CONDITIONS

1. The License is valid for the proposed research, location and specified period
2. The License any rights thereunder are non-transferable
3. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research
4. Excavation, filming and collection of specimens are subject to further necessary clearence from relevant Government Agencies
5. The License does not give authority to transfer research materials
6. NACOSTI may monitor and evaluate the licensed research project
7. The Licensee shall submit one hard copy and upload a soft copy of their final report (thesis) within one of completion of the research
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice

National Commission for Science, Technology and Innovation
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