PREDICTORS OF CHOLERA OUTBREAKS AMONG HOUSEHOLDS IN MAZIMASA AND HIMUTU SUBCOUNTIES IN BUTALEJA DISTRICT – EASTERN UGANDA

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DEDICATION

This research project publication is dedicated to my family members, my fellow students more so the MPH-HP class of 2016, my dear wife Mrs. Rachael Akonya, and finally my three lovely children Akonya Comfort Esther, Akonya Chloe Shammah, and Akonya Cleopas Kadmeil for their social, moral and financial support during the course. I love you all and may the Lord Almighty bless you always.

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No man is an island. This study could not be accomplished without help from other participants. I am thankful therefore to the Lord Almighty for the gift of life. My heartfelt thanks go out to the respondents in this study. The residents of Mazimasa and Himutu sub-counties together with the Assistant District Health Officer Environmental Health-ADHO-EH of Butaleja district, All these people voluntarily took part in the study.

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Space here may not be enough to mention everybody, but all those who helped me during the study; God bless you abundantly.

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LIST OF ACRONYMS

SDG	Sustainable Development Goal
UNICEF	United Nation International Children's Emergency Fund
GTFC	Global Task Force On Cholera Control
WHO	World Health Organization
CPM	Central Pontine Myelinolysis
EED	Environmental Enteric Dysfunction
US$17.66–US	United States
OCV	Oral Cholera Vaccines
CDC	Centers for Disease Control and prevention
CFR	Case Fatality Rate
UN	United Nations

OPERATIONAL DEFINITIONS

Term	Definition
Cholera outbreak	This term was used to refer to the current or historical incidence of cholera among any member(s) of a given household
Household heads	This term was used to a person who had supreme decision-making authority in a given household
Intra-household predictors	This term was used to refer to the characteristics of the members of a given household, including their sanitation, health behavior, and demographic characteristics
Community predictors	This term was used to refer to the sanitation and demographic characteristics of the communities in Mazimasa and Himutu at large

ABSTRACT

Background: Cholera is an infectious disease of public health importance can't be overstated, given the hypovolemia it causes with its associated sequelae, in addition to the possible health ripple effects on the wider community. Whereas the disease is treatable with vaccines available, its treatment is associated with antibiotic resistance, while the vaccination is also contraindicated among children less than 2 years, yet it is ineffective among some older children. Prevention thus remains the most potent approach for the global target to eliminate cholera and has indeed been embraced. However, cholera outbreaks are still rampant, with active cases apparent in 2020.

Objective: This study aimed at assessing predictors of cholera outbreaks in Mazimasa and Himutu sub-counties in Butaleja district - eastern Uganda

Method: An analytical cross-sectional study was used, involving 368 household heads, Mazimasa and Himutu sub counties were stratified, parishes therein randomly sampled and also stratified so as to randomly sample villages. Households were conveniently sampled, household heads sampled purposively, and engaged in structured interviews. Document reviews were also done, and the data collected analyzed in SPSS version 25

Findings: Slightly more than a tenth of the households sampled had had a member diagnosed with the disease previously 41/368 (11.1%), with slightly more than three quarters of the cases in Mazimasa sub county 31(75.6%).

Having a household member with HIV/AIDS (aPR = 1.638, CI = 1.465 - 1.877, p = 0.006), malaria being a common illness in a household (aPR = 1.892, CI = 1.847 - 2.940, P = <0.001), being a male headed household (aPR = 0.933, CI = 0.879 - 0.991, P = 0.023), having one male member in a household (aPR = 0.767, CI = 0.662 - 0.889, p = <0.001), boiling water for drinking (aPR = 0.931, CI = 0.888 - 0.976, P = 0.003), boiling water sometimes (aPR = 0.767, 0.642 - 0.916, P = 0.003), always consuming fish (aPR = 1.143, CI = 1.011 - 2.869, P = <0.001), use of flood water for any purpose (aPR = 0.894, CI = 0.832 - 0.961, P = 0.020), and use of communal toilets constructed with local materials (aPR = 1.223, CI = 1.083 - 1.380, p = 0.001) predicted cholera outbreak at an intra-household level.

Flooding frequency being once a year (aPR = 0.928, CI = 0.907 - 0.950, P = <0.001), having a tap as the main water source in the villages (aPR = 1.059, CI = 1.009 - 1.112, P = 0.021), water shortages (aPR = 1.058, CI = 1.005 - 1.115, P = 0.032) in communities, and the frequency of being once per year (aPR = 0.780, CI = 0.645 - 0.943, P = 0.010) predicted cholera outbreaks from an environmental perspective

Conclusion: About 1 in every 10 households in Mazimasa and Himutu sub-counties has had a cholera outbreak, predicted by both intra-household and community characteristics. However, intra-household characteristics happened to be more important of the two, with the implication that whereas preventive interventions ought to target both intra-household and community entities, relatively more emphasis should be put on the intra-household entity

CHAPTER ONE: INTRODUCTION

1.0 Introduction

Ending epidemics of communicable diseases within the next 10 years is one of the priority targets of the health sustainable development goal (SDG 3.3), given their infectious, morbidity, and mortality propensity (International Institute of sustainable development, 2019). Among those diseases, one of the most virulent is cholera, whose effects cuts across all demography, with direct health implications on children (Lauer et al., 2020; Amicizia, 2019), adults, and even pregnant women (Khan et al., 2019). That makes cholera an important disease, whose prevention will aid the achievement of targets 3.1 (reduction of maternal mortality, 3.2 (reduction of child mortality) as well. Its public health importance is further buttressed by the fact that it is responsible for 3 million to 5 million cases and 100,000-120,000 deaths per year worldwide (UNICEF, 2020; Singh, 2020), with a case fatality rate that ranges from 0.4% to 0%.

With 1.4 billion people at risk in endemic countries (UNICEF, 2020; Singh, 2020), and children constituting about half of the cases, its control has been made a priority by local and international policymakers to control this disease (Khan et al., 2018). This resulted in the setup of the Global Task Force on Cholera Control (GTFC) meant to end cholera in at least 20 countries by 2030, via the reduction of cholera deaths by 90% (Legros et al., 2018). However, whereas the control of cholera aims at prevention, treatment, and vaccination, prevention remains the most viable option given that antibiotic resistance to cholera medications is on the rise (Mashe et al., 2020; Das et al., 2020; Jäckel et al., 2020) and yet the vaccines are still contraindicated among some children (WHO, 2020d) and still not globally spread (WHO, 2019a). Prevention efforts can however efficient with the establishment of all environmental predictors of the disease, to inform interventions.

1.1 Background of the study

Cholera is one of the most virulent communicable diseases currently, responsible for more than 100,000 deaths annually (UNICEF, 2020), given its substantially high case fatality rate. What makes cholera a disease of public health importance is the severe health sequelae that it is associated with, once incident. First, cholera causes severe fluid depletion that most often than not progresses to hypovolemic shock and metabolic acidosis (Ojeda, 2020), at which point mortality risk can increase to 50% (Fanous, 2020). That in part happens due to the occurrence of both hypokalemia and hyponatremia, following hypovolemia. Hypokalemia alone is associated with rhabdomyolysis, myoglobinuria, and cardiac dysrhythmia (Castro, 2020), while hyponatremia is associated with Central pontine myelinolysis (CPM) (Danyalian, 2020), thromboembolism, aspiration pneumonia, that results into a coma, and death (Rondon, 2020; Danyalian, 2020). Whereas cholera can affect and hence cause mortality across all age groups, very young children remain as the most vulnerable, in part because among them, it causes severe gastroenteritis (Amicizia, 2019), and hence increasing their risk of severe malnutrition and death (WHO, 2020b).

Cholera does not only have direct effects on the victim but can also affect other persons in the patient's environment. Persons diagnosed with cholera usually defecate in the open, with the implication that their presence in a given environment increases the risk of incidence of not only cholera but also environmental enteric dysfunction (EED), among other people therein. Children remain as the most at risk to such community infections, as they are more prone to EED, typified by systemic inflammation (SI), and altered intestinal permeability/inflammation (Lauer et al., 2020), and reduced ileal absorptive (Lauer et al., 2020). That then further increases their risk of chronic malnutrition (stunting), wasting (Rahman, 2020; Chakrabarti, 2020; Budge et al., 2019) and reduced vaccine efficacy among children living in low-resource settings (Tickell et al., 2019). The fact that 45% of the 5 million annual deaths in children under 5 years are attributed to malnutrition (WHO, 2020b; WHO, 2017b) makes any of its predictors, notably cholera to be important . Nonetheless, pregnant women, besides children can also be severely affected by cholera; cholera infections during pregnancy are associated with high risks of spontaneous abortions, premature delivery, and fetal death (Khan et al., 2019).

Cholera is, therefore, a disease with both maternal and child health implications, one of the reasons for which its control and elimination was made a priority in the years 2017, with the launch of the Global Task Force on Cholera Control (GTFC). The task force and all its implementing partners are fronting the use of prevention focusing on sanitation, hygiene, nutrition, and safe drinking water (Das et al., 2020), treatment, and vaccination in all their cholera control efforts. However, the treatment of severe cholera is currently marred with several challenges, the most notable being the increasing resistance to antibiotic treatment among vibrio cholera species (Mashe et al., 2020; Das et al., 2020; WHO, 2020a; Jäckel et al., 2020; Mwape et al., 2020; Lepuschitz et al., 2019; Verma, 2019 WHO 2019; Rijal et al., 2019; Chatterjee et al., 2019; Amicizia, 2019). That is further compounded by the fact that cholera treatment is costly; it costs between US$14.49–US$18.03 for patient's ≤15 years old and US$17.66–US$35.16 for older patients (Tembo et al., 2019).

Cholera vaccination is also still marred with challenges, one being its cost (Khan et al., 2018) that may not be affordable to persons in endemic low-income countries. Despite reports of being effective (Lee et al., 2020; Shaikh, 2020), cholera vaccines have been reported to be less immunogenic among infants in low-income countries (Zimmermann, 2019; Parker et al., 2017), and those that are less than 5 years old in general (WHO, 2020d). That is in addition to still being contraindicated among children below 2 years (WHO, 2020a), and still being widely used among adults (CDC, 2019). Further still, Oral Cholera vaccines (OCV) are still not widely available, Despite more than 1 billion people being at risk, about 25 million doses have been administered through mass vaccination campaigns in 19 countries since 2013 (WHO, 2019) and only 60 million doses have been shipped worldwide (WHO, 2019a). As such, cholera is still poorly controlled in many epidemic and endemic globally (Ganesan, 2020), to the extent that some areas experience recurrences, that are even more devastating (Tembo et al., 2019; Lauer et al., 2020). Its prevention, given the limitations in vaccination and treatment, has thus been given more priority, through the in the statement of various health promotion strategies (WHO, 2019), more so in developing countries.

However, cholera outbreaks are still apparent, with the missing link potentially being the gap in knowledge as regards what predicts cholera outbreaks. There are up to 5 million cases registered globally, annually (UNICEF, 2020), with most of them appear in Africa (Lessler et al., 2018). Half (50%) of the Eastern and Southern Africa countries have been affected by cholera outbreaks since the beginning of 2019, with a Case Fatality Rate of 0.4% (UN Children's Fund, 2019). These countries include; Angola, Burundi, Kenya, Malawi, Mozambique, Tanzania, Somalia, Uganda, Zambia, and Zimbabwe (UN Children's Fund, 2019). Most of the cholera cases have been registered in Mozambique (69.5%), followed by Kenya (16.3%, n = 1,350) (UN Children's Fund, 2019). As of June 2020, Kenya had 642 cases including 13 deaths (CFR: 2.1%) and Uganda had 682 cases including six associated deaths (CFR: 0.9%) were reported (ECDC, 2020). In Uganda, one district has stood out as being one of the most affected, having consistently registered more than five outbreaks over the past 10 years. That district is Butaleja, where more than 100 cases are reported per outbreak with a CFR of up to 7%.

1.2 Statement of the problem

In the year 2008, Butaleja district registered 111 cases, with a case fatality of 11%, of which about 45% of the cases (50) were from Mazimasa alone, and 23% (26) were from Himutu (Minister for Relief, Disaster Preparedness, and Refugees, 2016). The district continued registering cholera outbreaks through the years but had a major outbreak in the year 2016, during which the number of cases increased by 110% compared to the 2008 outbreak incidence, to 233 cases. Still, the sub-counties of Mazimasa and Himutu were the most affected at that time, with a combined caseload of about 142 (61%) (Ministry for Relief Disaster Preparedness, and Refugees, 2016). The CFR at the time was reported to have been 3%less than that in the previous outbreak, but still higher than global CFRs (1.8%) (WHO, 2020c) and even those in Africa (4%)(ECDC, 2020). Butaleja district and particularly, Mazimasa and Himutu sub-counties have continued to be the most hit by cholera outbreaks despite still being the greatest beneficiaries of both government and non-government aided cholera prevention programs over the years.

The lapse in the effectiveness of those programs could be related to the still-existent knowledge gaps as regards what the actual incidence of cholera outbreaks is, at the household level and what predicts them. What is known, as evidenced about are the number of cases, registered per outbreak, but not their incidence, with households in context, which could be a significant obstacle to the effectiveness of the interventions. All that is known about the predictors is anecdotal, although still linked, subjectively, to the flooding and poor hygiene practices on the part of the residents of the two sub-counties. Without the establishment of outbreak incidence and its predictors, and the district still being prone to flooding, more outbreaks will certainly happen, along with severe maternal and child morbidity, and higher CFRs despite any interventions, which may turn out to be a burden to the national health system at large.

1.3 Research questions

1. What is the incidence of cholera outbreaks among households in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda?
2. What are the intra-household predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda?
3. What are the environmental predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda?

1.4 Objectives of the study

1.4.1 General objective

To assess predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda.

1.4.2 Specific objectives

1. To determine the incidence of cholera outbreaks among households in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda
2. To establish the intra-household predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda
3. To identify the environmental predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda

1.5 Justification of the study

With the challenges of cholera treatment and vaccination still looming, the Global Task Force on Cholera Control (2017) is currently aiming for early detection and quick response to contain any outbreaks. Most importantly, the task force and its implementing partners are primarily utilizing a targeted multi-sectoral approach meant to prevent cholera recurrence, given that prevention is arguably the most cost-effective approach. That is being done with the improvement of water, sanitation and hygiene (WASH), health education and promotion, and social mobilization (WHO, 2017; Yates et al., 2017; Taylor et al., 2015). However, cholera outbreaks are still rampant, with more than 20 outbreaks being active this year alone (2020) (ECDC, 2020). This is by all means related to pre-intervention knowledge gaps as regards what the predictors of the occurrence of such outbreaks, which thus reduces their (intervention) effectiveness. The lack of pre-intervention evidence is compounded by the fact that there are currently more descriptive epidemiological studies on cholera as opposed to analytical inferential ones that aim at establishing the environmental drivers of cholera (Gwenzi, 2019), more so in endemic areas. Such countries include Uganda, where despite having several in-country studies that have assessed cholera outbreaks (Lauer et al., 2020; Bwire et al., 2016; Bwire, 2013; Bwire et al., 2017; Legros, 2000; Alajo et al., 2006; Dorlencourt et al., 1999; Cummings et al., 2011; Okello et al., 2016; Iramiot et al., 2019), virtually none focused on the predictors of those outbreaks. That leaves studies from Iran (Karami et al., 2019; Moradi et al., 2016), Bangladesh (Saha et al., 2017; Burrowes et al., 2017; Grandesso et al., 2017; Bi et al., 2016; Colombara et al., 2014), Haiti (Aaron et al., 2018; Richterman et al., 2018; Grandesso et al., 2014; Matias et al. 2017), Cameroon (Nsagha et al., 2015), and Ethiopia (Dinede et al., 2020; Endris et al., 2016) as the only sources of evidence for prevention interventions, yet the inferential dynamics in those countries may not be the same in countries like Uganda. There was therefore a research gap as regards the predictors of cholera outbreaks in Uganda that justified the conduction of this study taking Butaleja district as a study area.

1.6 Significance of the study

As a country that has had numerous cholera outbreaks, Uganda through its ministry of health set up operational Guidelines for the prevention and Control of Cholera, meant to be used by National and District Health Workers & Planners. One of the objectives of those guidelines is to prevent new cases of cholera through the promotion of intensive public health education, sanitation, hygiene, food safety, and ensuring safe water complemented by Oral Cholera Vaccination (OCV) for vulnerable groups. The Ministry of Health conducts cholera surveillance to guide cholera outbreak control activities, and since such activities can only be effective with evidence of what predicts cholera outbreaks, this study will be of significance to the ministry of health. With the establishment of both intra-household and community predictors of the cholera outbreak, the ministry of health will get to know community entry points for intervention, targeting only those that increase outbreak risk. That may significantly augment outbreak prevention efforts on the part of the ministry.

Besides the ministry of health, the findings of the study will also be of significance to the residents of Butaleja, more so those in Mazimasa and Himutu sub counties, given that the study has highlighted 8 intra-household predictors of cholera outbreak, with which it is expected that household heads in the district will be empowered to know characteristics that are protective and un-protective cholera outbreak so that they can minimize the former and uphold the latter. That will in the in long run minimize the risk of their households being part of those with cholera cases in the event of another district outbreak.

The study will also be of significance to the local leadership in Butaleja district, particularly the district health office and the district environmental health office, who may benefit from the identification of the community predictors of cholera outbreaks. Such information will certainly enable them mount evidence based local cholera outbreak prevention interventions, or to inform those that are already running. That same information may be used by the district health educators, to inform their sensitization campaigns, as they will be furnished with points of emphasis (outbreak protective community predictors) for such sessions.

The study will certainly be of significance to the health promotion community at large, given that it may draw their attention to the fact that the assessment of cholera outbreak predictors is still a less studied area. That may trigger the conduction of similar studies in other districts that have had cholera outbreaks and those that have currently active ones, with the current study being source of literature.

1.7 Scope of the study

1.7.1 Geographical scope

This study was conducted in Butaleja District, one of the districts in Uganda that has registered cholera outbreaks more frequently (more than five between 2008 and 2019) than many others in the country. The district is located in Eastern Uganda, bordered to the north by Budaka District to the east by Mbale District, to the south east by Tororo District, to the south by Bugiri District and to the west by Namutumba District (Minister for Relief, Disaster Preparedness and Refugees, 2016). The district is comprised ten sub-counties including; Busaba, Budumba, Naweyo, Busabi, Busolwe, Himutu, Kachonga, Mazimasa, Nawanjofu, and Butaleja sub-counties, with two Town Councils; Busolwe and Butaleja (Minister for Relief, Disaster Preparedness and Refugees, 2016). The district is covered by wetlands (Doho Namatala, and

Mpologoma), in the large part, and is typified by the peculiar geographic features that make it a significant drainage area for the Elgon region, and hence very susceptible to floods.

Within the district administrative areas, two sub-counties stand out as those that have been most affected by cholera outbreaks, they are; Mazimasa and Himutu sub-counties both of which register more than 200 cases per outbreak and more than 10 related mortality cases. Those two sub-counties were the study areas that were purposively sampled. Mazimasa is comprised of 4 parishes, while Himutu Sub County is comprised of 6 Parishes and 28 villages.

1.7.2 Content scope

This study was delimited to assessing cholera outbreak, and its predictors in two sub-counties of Butaleja district. Cholera outbreak was assessed within a household context, that is, if a sampled household had had any member or members (dead or alive) that had ever been diagnosed with cholera over the past 10 years (member had acute watery diarrhea and vomiting), then that household was considered to be an outbreak case. A household outbreak assessment was chosen as opposed to a community-based outbreak assessment approach because, with the former, it could be easier to compute incidence and hence make statistical inferences tailored to an actual case in a given household with cognizance of the entire environment in which they live. That hence made it possible to assess the predictors, most of which are related to intrahousehold characteristics (Dinede et al., 2020; Dureab et al., 2019; Richterman et al., 2018; Endris et al., 2016; Dan Nwafor et al., 2019; Saha et al., 2017; Uthappa et al., 2015; Biswas et al., 2014; Colombara et al., 2013; Nguyen et al., 2017) and the characteristics of the immediate community in which the household is situated (D'Mello-Guyett et al., 2020; Burrowes et al., 2017; Bi et al., 2016; Fredrick et al., 2015; Blackburn et al., 2014). As such, the study had two explanatory variables, the intra-household predictors and community predictors.

1.7.3 Time scope

The study was conducted over 1 month in Butaleja district, during which the second time consideration was the assessment cholera outbreak, which covered a retrospective period of 10 years. That was because Butaleja district had registered the highest number of outbreaks in the period 2008 and 2019, and since the study was conducted in the year 2019, a 10 year retrospective period was appropriate for outbreak assessment.

1.8 Theoretical framework

This study was informed by the socio-ecological theory that was initially developed by Urie Bronfenbrenner in the1970s as a conceptual model for understanding human development and later formalized as a theory in the 1980s (Bronfenbrenner, 1977; Bronfenbrenner, 1986; Bronfenbrenner, 1989). As a theory, the SEM has been modified for use in various health promotion efforts by various organizations, to include levels/spheres of influence on health-related behavior, health outcomes (American College Health Association, 2020; CDC, 2015a; CDC, 2015b), and even infectious disease patterns (Smith, 2005). The theory is comprised of five levels of influence including; individual, interpersonal, and organizational, community, and policy (Sallis et al., 2008).

The theory has particularly become one of the most used in the field of infectious disease control and prevention in which it has been used in the development and implementation of those programs (Smith, 2005), notably the establishment of the spatial dynamics of pathogen spread and the determining the impact of host sub-population characteristics on pathogen spread. That is in addition to the use of that theory in the prediction of the emergence of infectious diseases like cholera using demography and distribution, and the prediction of pathogen-host shifts (Smith, 2005). Its use is based on the fact that it provides for a multi-level approach for predicting disease outbreak and spread, the same supposition for which it was chosen as the most suitable theoretical foundation for this study. In the current study, the theory was used to predict the cholera outbreak at household level, with the adoption of two of its five constructs. Those two constructs were the interpersonal level, and the community level, of which the former was adapted as intra-household predictors and the latter as community predictors. The intra-household predictors (objective 2) covered all characteristics within and between the members of a given household, while the community predictors (objective 3) included the environmental characteristics of a given community in which a sampled household was situated.

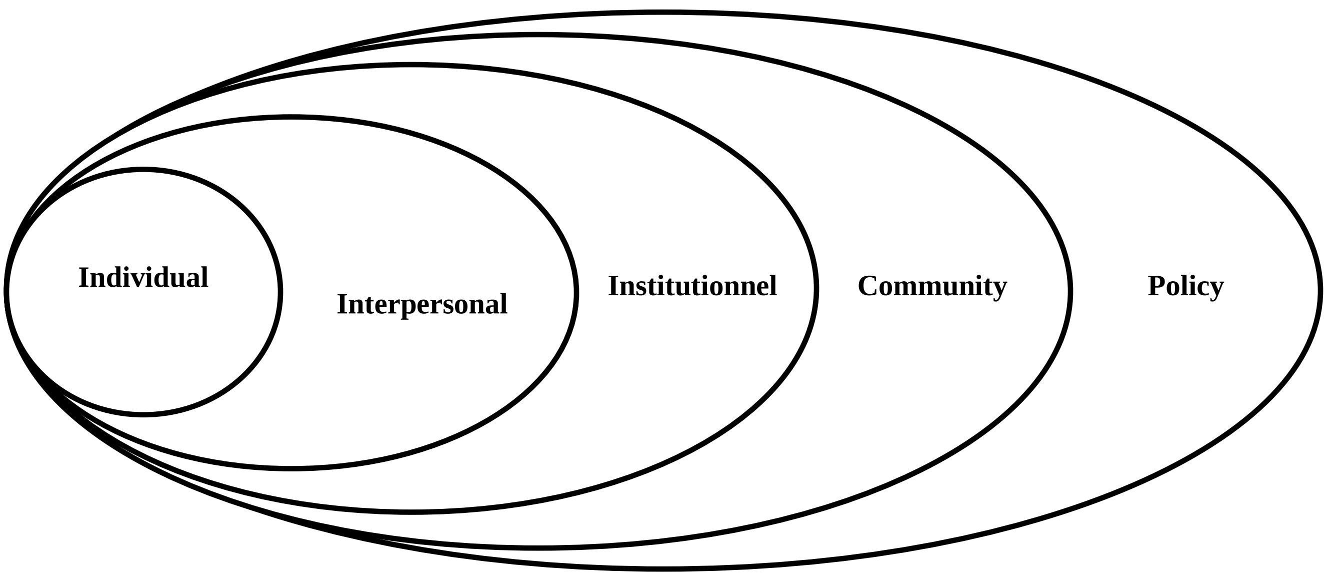
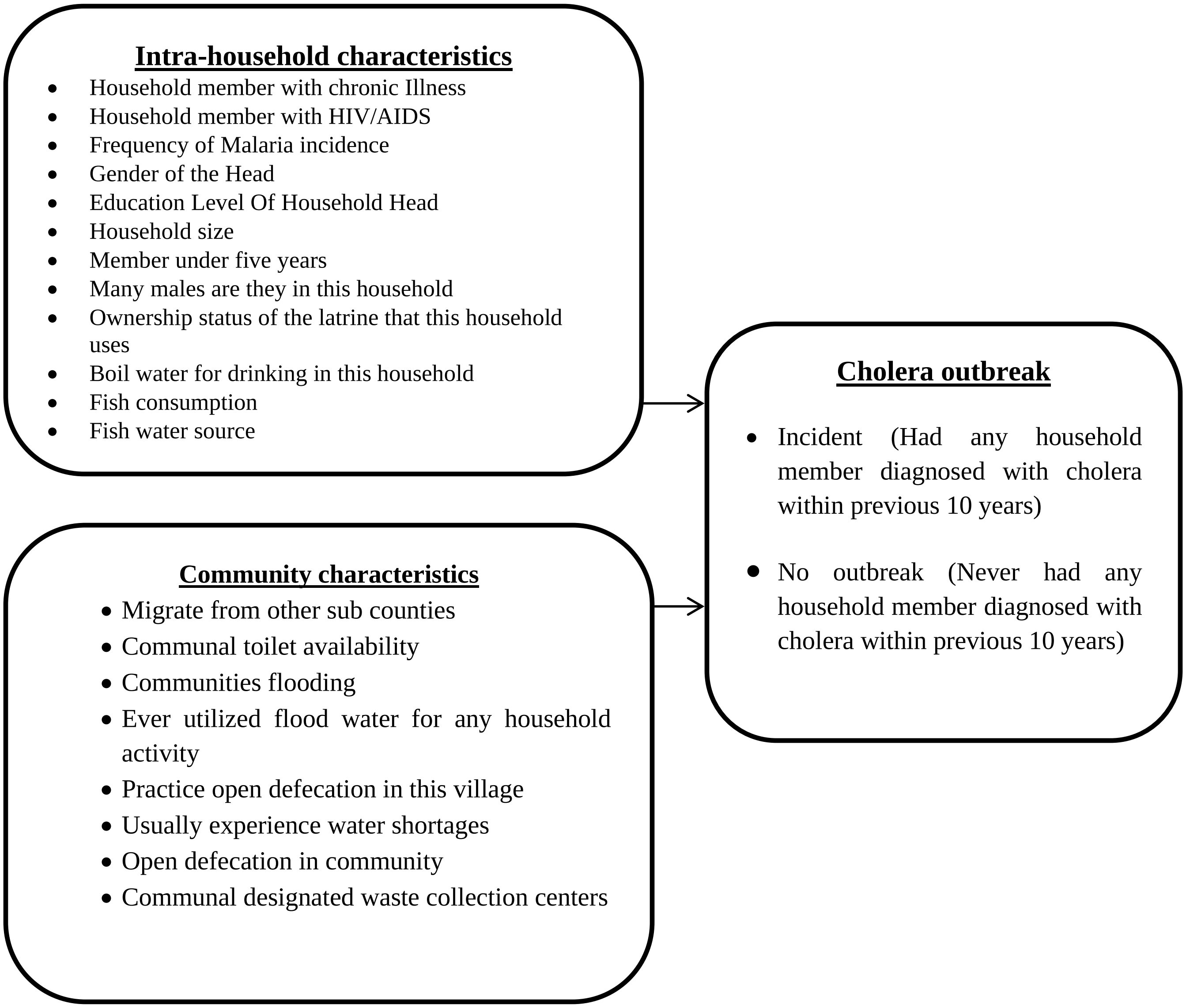


Figure 1: Socio ecological model by Bronfenbrenner (1989)

1.9 Conceptual framework

Figure 2 below shows a conceptual framework that was adapted from the socio ecological theory. Shown are two variables that were considered to be independent variables, including intra-household characteristics and community predictors. Although socio-ecological model illustrations do not include provisions for an outcome variable, all the constructs always influence an outcome, which in this study was cholera outbreak at the household level.



CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter presents a review of literature related to the study, and presented in three sections in consonance with the three study objectives. The first section 2.1, contains literature related to the incidence of outbreak of cholera, the second section 2.2 contains literature related to the intra-household predictors of cholera outbreak while section 2.3 contains literature related to the environmental predictors of cholera outbreak.

2.1 Incidence of outbreak of cholera

Cholera is currently recognized as one of the most devastating disease responsible for more than 100,000 deaths and productivity losses due to premature deaths estimated to be upwards of $985.7 million (I$3,638.6 million) (Mogasale et al., 2020). Despite all prevention and control efforts, however, cholera outbreaks are still rampant, with more such outbreaks forecasted especially in low and middle-income countries. Given that Cholera treatment costs between $20 to $50 with the costs significantly increasing depending on severity (Ingelbeen, 2019; Awalime, 2014) and more outbreaks may lead to catastrophic health expenditure, that in low and middle-income countries may hamper universal health coverage at a wider scale.

The World Health organization estimates that there are about 1.4 billion people that are at risk of cholera worldwide (WHO, 2020a), most of whom are in low and middle-income counties. Half of the cholera cases (54%) in 2016 (132,121) were registered in Africa, 32% were from Hispaniola and 17% of them from Asia (WHO, 2016). It is not only Africa that has been affected however, in the Americas, Haiti still has registered some of the highest numbers of cases of cholera, and still had an active outbreak as of June 2020 (ECDC, 2020). Richterman et al. (2019)

used 2012 Demographic and Health Survey in Haiti to conduct a secondary analysis that involved 13,181 households. The findings they obtained showed that 2,104 of the households (16%) reported at least one household member with a history of cholera.

In India, the Indian National Centre for Disease Control, reported cholera cases in Kerala (1), Assam (1) and Karnataka (1), as of March 2020 (ECDC, 2020). The Indian CDC did not however provide outbreak incidence. However, Goswami et al. (2019) whose study was conducted in a slum area of urban Wardha, India reported an overall attack rate of 27% and a case fatality rate of 0%.

Yemen, in the Middle East reported 2,309,859 suspected cholera cases and 3 786 deaths (CFR: 0.2%), over the past three years (2020). As of February 2020, 56 220 cases have been reported, including 20 associated deaths (ECDC, 2020).

Nonetheless, all evidence points to the fact African countries are still the most affected, with recurrent cholera outbreaks. African countries reported 3,221,050 suspected cholera cases to the World Health Organization between the years 1970 and 2011, representing 46% of all cases reported globally (Mengel, 2014). Zambia for instance had its first outbreak in 1978 and has continuously experienced outbreaks, since; it registered 13,000 cases reported in 1991 and over 11,000 in 1992 and 1999 (Siziya, 2017). From 1999 to 2013, major outbreaks were reported every year in Lusaka, the country’s capital (Siziya, 2017). In the year 2016, a total of 1,079 cases and 20 deaths were reported (Tembo et al., 2019), and between 2017 and 18 there were 5,414 cumulative cases and a Case Fatality Ratio (CFR) of 1.8% (Sinyange et al., 2018; Ali et al., 2015). Kabwe et al. (2017) however reported a slightly higher CFR at 1.9%, with the AR at 45.2 cases/100,000 population in Lusaka.

The ECDC (2020) reported that Cameroon had 1773 cholera cases including 91 associated deaths (CFR: 5.1%), as of the years 2020, which was an increase of 409 cases and 29 deaths since the previous update. In Nigeria, Elimian et al. (2019) whose study was based on data that had been collected between January 1st and November 19th, 2018 reported that there had been 43,996 cholera cases and 836 cholera deaths across 20 states in Nigeria during the outbreak. That made an attack rate (AR) of 127.43/100,000 population and a case fatality rate (CFR) of 1.90%. However, the ECDC (2020) reported that Nigeria, despite registering 1003 suspected cases, had not had any deaths as of June 2020.

Dan-Nwafor et al. (2019) whose study was also conducted in Nigeria, including persons aged ≥5 years and above with acute watery diarrhea reported an attack rate of 4.3% with a case fatality rate of 13%.

Mozambique in Southern Africa has been noted to be one of the most affected countries (Cambaza et al., 2020; WHO, 2016). The country experienced a series of outbreaks between 25 December 2014 and 22 March 2015 in 18 of its districts that resulted in 7073 cases reported and 53 deaths (CFR 0.7%) (Vanormelingen, 2015). The country still has an active outbreak currently; as of 12 June 2020, the country had 2,625 cases and 21 associated deaths (CFR: 0.8%) in two of its provinces

Ethiopia has however registered a higher CFR than Mozambique; in 2020 and as of 10 May, 8 191 cases including 112 associated deaths (CFR: 1.4%) have been reported in Ethiopia. Somalia reported 13,528 suspected cholera cases including 67 associated deaths (CFR: 0.5%) between 2017 and 2020 (WHO, 2020).

Another country in the horn of Africa, Somalia is also one of the most affected; the Ministry of Health (MoH) of Somalia announced 41 new suspected cases of cholera the although with no deaths as of the year 2019 (World Health Organization, 2020b). However, starting with the year 2017, 8912 cases have been reported in Somalia, including 46 associated deaths from 27 districts.

The democratic republic of Congo, like Mozambique, is one of the most affected; it accounts for an estimated 189,000 (5%–14%) of the 1.34–4.01 million cholera cases worldwide annually (Ali et al., 2017; Global Task Force on Cholera Control, 2015). In 2017, the country registered >53,000 cases and 1,145 deaths in 20 of its 26 provinces (WHO, 2018). The country had registered 10 533 cases including 147 deaths (CFR: 1.4%) as of June 2020. For the whole of 2019, DR Congo reported 30 304 suspected cholera cases, including 514 deaths (CFR: 1.7%) (ECDC, 2020).

In East Africa, almost all countries currently have active cholera outbreaks; in Kenya, there were 642 cases including 13 deaths (CFR: 2.1%) as of June 2020, and a year earlier, in 2019, there had been 5,150 cases including 39 associated deaths (CFR: 0.8%) (ECDC, 2020). Previously, the ministry of health in Kenya reported that between December 2015 and January 2018, the country had 21,066 cases and 325 deaths (CFR 1.5%) (Ministry of Health - Kenya, 2018). In one year (2017), about 20/47 (43%) of the counties in Kenya had reported 3,967 cases including 76 deaths (case fatality rate = 1.9%) (WHO, 2017c).

About three years earlier, Stoltzfus et al. (2014) had conducted a study in eight provinces and 69 administrative districts in Kenya the country, based on secondary data that had been collected from 1999 to 2009 by the Division of Disease Surveillance and Response (DDSR). Within that time frame, 31,001 cases of cholera were reported among the 35,514,544 at-risk persons that were living in 69 districts in the country. The authors found that the annual incidence was 10.91 cholera cases per 100,000 persons.

In Uganda, a cholera outbreak was reported in Moroto district, in May 2020, and as of 12 June 2020, 682 cases including six associated deaths (CFR: 0.9%) were reported in that district

An earlier Ugandan study by Bwire et al. (2016) which included a review of weekly surveillance data, across three borders; Uganda – Malawi, Uganda-Democratic Republic of Congo, and Malawi-Mozambique borders. They found that there had been 603 cross-border cholera cases with 5 deaths in Malawi and Uganda in 2015, with Uganda recording 118 cases and 2 deaths and (CFR of 1.7%)

2.2 Intra-household predictors of the cholera outbreak

Many studies (Dinede et al., 2020; Mwenda et al., 2017; Nsagha et al., 2015; Matias et al., 2017; De Guzman 2015; Colombara et al., 2014; Grandesso et al., 2014; Matias et al., 2017; Nsagha et al., 2015; Saha et al., 2017; Okello et al., 2019; Karami et al., 2017; Dureab et al., 2019; Richterman et al., 2018; Dan-Nwafor et al., 2019; Uthappa et al., 2015; Colombara et al., 2014) have found significant relationships between several intra-household variables and cholera outbreak. One such variable that has been tested is the source of water used by a given household.

Some studies (Burrowes et al., 2017; De Guzman et al., 2015; Ishaku et al., 2014; Saha et al., 2017; Nguyen et al., 2014; Nsagha et al., Health 2015; Moradi et al., 2016) have evaluated the risk of cholera based on the source of water, with somewhat discrepant findings. In the study by

Nsagha et al. (2015) the use of tap water as the main source of drinking water was found to be a risk factor for cholera, and the use of springs as the main source of drinking water as protective. The authors linked the predisposition by tap water users to the irregular water supply they usually had. However, Mwenda et al. (2017) found that drinking unchlorinated water, and having drunk untreated water increased the odds of a cholera outbreak in a given household. Karami et al. (2017) also reported that the consumption of unreliable water increased the risk of cholera by more than 50 times. Similarly, the study by Dureab et al (2019) reported that cholera cases were less likely to use indoor municipal tap water as their main source of drinking water and to use chlorine to treat water in the household. Most cholera cases in that study were those who used a common-source water source as the primary source of drinking water. Somewhat similar studies were reported by Okello et al. (2019) and Dan-Nwafor et al (2019) who found that most cases were those who collected water usually collected drinking water from a river. However, Okello et al. (2019) also found that the use of borehole water reduced the risk of cholera infection.

Having a private toilet at home was found to reduce cholera cases by 0.69 times in the study by Nsagha et al. (2015). Surprisingly, many studies have found the possession of a flush toilet to be a risk factor for cholera outbreak (Matias et al., 2017; De Guzman 2015; Colombara et al., 2014; Grandesso et al., 2014; Matias et al., 2017; Nsagha et al., 2015; Saha et al., 2017). Grandesso et al. (2014), Matias (2017), and De Guzman et al. (2015) however found that there was no significant difference in cholera risk with access to a latrine

Studies by Karami et al. (2017) and Moradi et al. (2016) found relationships between a history of travel to other areas and cholera outbreak risk. Households with a member who had traveled out of the area of residence were more likely to have a cholera case.

Endris et al (2016) found a relationship between open defecation and cholera outbreak; they found that people who practiced open defecation were eight times as likely to be cases.

Being HIV positive or having an HIV-positive member in a household was found to increase the risk of a cholera outbreak in a study by Richterman et al. (2018). In that study, having an HIV positive member increased cholera risk by three-fold.

There are also many studies (Uthappa et al., 2015; Colombara et al., 2014; Grandesso et al., 2014; Colombara et al., 2014; Grandesso et al., 2014; Matias et al., 2017; Saha et al., 2017) that have found a relationship between household size and cholera outbreak risk. Some of the studies have found a household size exceeding 3 to increase the risk of cholera outbreak (Uthappa et al., 2015; Colombara et al., 2014). Dan-Nwafor et al. (2019) also found that compared to controls, cases were more likely to come from households with > 5 persons

Fish consumption could also be one of the predictors of cholera outbreak in a given household. A number of studies have reported that fish are potential carriers for V. cholera (Nyambuli et al., 2018) during outbreak periods. Other studies have also confirmed that Tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) harbor toxigenic and non-toxigenic strains of V. cholerae even during non-cholera outbreak period (Hounmanou et al., 2016). In Bangladesh, Hossain et al. (2018), reported that fish are a potential vehicle for V. cholerae transmission to humans and Rabia et al., 2017) also postulated that marine fish were significant players in pathogen transmission. Fishing communities have actually been found to be some of the most affected during cholera epidemics (Plisnier et al., 2015; Ajayi and Smith, 2018).

2.3 Community-related predictors of cholera outbreaks

Like intra-household characteristics, there have also been studies (Asadgol et al., 2019; Asadgol et al., 2019; Martinez et al., 2018; Jeandron et al., 2015; Pezeshki et al., 2016; Ramírez et al., 2015; Yue et al., 2018; Jeandron et al., 2015; Matias et al., 2017; De Guzman 2015; Colombara et al., 2014; Grandesso et al., 2014; Matias et al., 2017; Nsagha et al., 2015; Saha et al., 2017; Chowdhury et al., 2017; Iramiot et al., 2019; Iramiot et al., 2019; Kimberlin et al., 2018; Amin et al., 2017) that have found wider community and environmental characteristics to affect the outbreak of cholera. Some of the environmental variables that are associated with cholera outbreaks are high temperatures, and low precipitation typical in dry seasons (Pezeshki et al., 2016). Such conditions are related to an increased risk of cholera infection (Asadgol et al., 2019). In that study by Asadgol et al. (2019), the highest number of cholera cases were observed during the summer, with hotter temperatures, to early fall (June to October). The authors supposed that during hotter climates, there were better climatic conditions for bacterial growth and pathogen proliferation.

Similarly, Martinez et al. (2018) and studies from East Africa, Zambia, and South China (Yue et al., 2018) also found environmental variables to be the most significant factors in predicting the incidence of cholera. However, Ramírez et al. (2015) found that heavy rainfall was an important parameter in cholera incidence prediction, with links to flooding that then affected water quality and sanitation systems. Flooding alone has been found to have effects on clean water supply, displacement of person, which then causes overcrowding, that increases exposure to infectious disease (World Meteorological Organization and Global Water Partnership, 2015; Brown et al., 2013; Stoltzfus et al., 2014; Snow et al., 2015; Maes et al., 2014). In the study by Iramiot et al. (2019), the authors hypothesized that the cholera epidemic in Kasese 2017 was sparked off by contaminated water consumption following heavy floods that washed away latrines into water sources in Bwera, Isango, and Nakiyumbu sub-counties (Iramiot et al., 2019).

Water supply interruptions, in communities, have been found to have significant predictive effects on cholera incidence (Iramiot et al., 2019; Jeandron et al., 2015). One study by Jeandron et al (2015) found with a single interruption in tap water supply, there was an incidence increase of over 155%. The authors added that it was neighborhoods with higher consumption of tap water that were more affected by water supply interruptions.

Community water contamination has also been found to be independently linked to cholera outbreaks (Ramamurthy et al, 2014). Such contamination arises from having improper sewage and waste disposal systems and improper water supply (Iramiot et al., 2019), all of which provide ideal transmission conditions for cholera once it is introduced into a community (Chowdhury et al., 2017).

Human feces are a known primary source of pathogens that cause diarrheal diseases such as cholera (Kimberlin et al., 2018), which makes open defecation incidence in a given community to be a risk factor for a cholera outbreak. This has been confirmed in studies by Matias et al. (2017), De Guzman (2015), Colombara et al. (2014), Grandesso et al. (2014), Matias et al. (2017), Nsagha et al. (2015), Saha et al. (2017). Amin et al. (2017) reported that, due to open defecation, coastal eutrophication, and hence single-cell microorganism proliferation increased.

2.4 Literature gap

As earlier mentioned, there have been many studies that have descriptively assessed cholera outbreak incidence; however, some of them have not made inferences at intra-household and environmental levels. Some of the studies that have made inferences are case-control studies, and so did not take into consideration the wider influence of intra household and environmental characteristics, but rather considered intrapersonal (Case) characteristics more. What is even of more concern in the literature gap context is the fact that in the Ugandan context, there are more descriptive epidemiological studies than inferential ones, with the implication that literature related to the predictors of cholera outbreak are not fully known in the country. The current study has endeavored to close that gap by using both descriptive and inferential approached in order to achieve the objectives.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter presents a description of the methodology that was used to obtain data which was used to achieve the study objetives. The chapter commences with a description of the study design, followed by the study population, sample size calculation, sampling procedures, study variables, data collection methods, data collection tools and quality control techniques. The chapter also includes a description of the data management and analysis plan taht was followed, and ethical considerations.

3.1 Study design

This study adopted a cross sectional survey design, because with the study aim being the assessment of predictors of cholera outbreak, there was need for the quantification of the incidence of that outbreak, followed by the inferential analysis of possible predictors, a quantitative study design was adopted. A cross-sectional study design was particularly used, given that it was possible to target a representative sample of households in Mazimasa and Himutu, and ascertain their cholera outbreak status history in addition to obtained other required characteristics, concurrently and at one instance. Therefore, no households had to be followed up. The choice of a fully quantitative design was also informed by the fact that disease causation or incidence risk factors/predictors could not be opinionatedly ascertained, but rather numerically, with the use of appropriate inferential statistics.

3.2 Study population

The study targeted residents of Mazimasa and Himutu sub-counties as they have experienced at least five cholera outbreaks over the past 10 years, with case fatality rates exceeding 4%. That made such people unquestionable potential beneficiaries of health promotion activities meant to prevent further cholera outbreaks, and hence the need a target population for the assessment of environmental predictors of such outbreaks. The study population was, however, household heads or persons occupying positions of authority in a given household within Mazimasa or Himutu sub-counties. Such persons (household heads or their equivalent) were studied because (1) they were presumed to have ample knowledge of any history of cholera within their household (2) with a case fatality rate exceeding 4%, some of them would be respondents (the patients) were possibly dead, living household heads as the viable population (3) they had ample knowledge of the intra-household dynamics, making them a suitable population for the achievement of objective 2 of the study.

3.2.1 Eligibility criteria

Inclusion

The study included household heads or their equivalent who had been inhabitants of a given household for the past 10 years. Such household heads or their equivalents were included in the study because the study had to assess the cholera outbreak at the household level of a 10 year retrospective period.

Exclusion

The study excluded household heads, which reported having had a cholera case in their households, over the past 10 years, but while they had been residents in any other sub-county other than Mazimasa or Himutu. This criterion was considered because there was a need to report cholera outbreaks and their predictors, within the context of only the two aforementioned sub- counties, to avoid data bias. Inclusion of cases that had been incident in a household at the time it was not situated in Mazimasa or Himutu could have yielded findings that would have been non-reflective of the situation in the two sub-counties.

3.3 Sample size

Sample size calculation in this study was done following the evidence that (1) the number of households that have ever had a case of cholera over the past 20 years and hence the incidence of outbreak (P) was not documented, implying that formula for estimating single proportion sample sizes like Kish Leslie could not be used (2) that the number of household in Himutu and Mazimasa (N) was known and that (3) the computation of the incidence of cholera outbreak required that the denominator was a representative sample of the target population size (N). With those assumptions, a formula by Krejcie and Morgan (1970), that incorporates target population size (N) substitution factor, was used. The formula is given by;

$$s = \frac{X^2 N. P (1 - P)}{d^2 (N - 1) + X^2 . P (1 - P)}$$

Which is true when;

s = required sample size.

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841).

N = the population size = number of households in Himutu and Mazimasa sub-counties = 8878 (UBOS, 2017)

P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (.05).

$$s = \frac{1.96^2 \text{ x } 8878 \text{ x } 0.5\ (1 - 0.5)}{0.05^2\ (16210 - 1) + 1.96^2 \text{ x } 0.5\ (1 - 0.5)}$$

$$s = \frac{3.8416 \text{ x } 8878 \text{ x } 0.25}{0.0025\ (16209) + 0.9604}$$

$$s = \frac{8526.4312}{22.195 + 0.9604}$$

$$s = \frac{8526.4312}{23.1554}$$

s = 368 Households

3.4 Sampling procedures

As earlier deliberated and justified in section 1.7.1, Butaleja district and its two sub-counties, Mazimasa and Himutu were purposively sampled. To ensure maximum and unbiased representation of both sub-counties, a multi-stage sampling approach was used, commencing with the stratification of the two sub-counties. This resulted in two strata, one being Stratum 1 for Mazimasa sub-county, comprised of 4 parishes and the second being Stratum 2 comprised of 6 parishes. At stage two, a simple random sample of 50% of the constituent parishes per stratum was made, to still ensure that an unbiased representative cross-section of parishes per sub-county is obtained.

The simple random sample was conducted using the lottery method, without replacement. The names of the parishes in each of the sub-counties were written on small-sized pieces of paper, folded and placed in a polythene bag. Ruffling was done, and a piece was picked without replacement per stratum. A second ruffle was made for Mazimasa Sub County to allow for the picking of the second piece, while three ruffles were made for the Himutu stratum. At that stage, the following parishes were sampled per Sub County

Mazimasa sub county	Himutu sub county
Kapisa	Kanyenya
Wanghale	Kangalaba
	Namulo

At the third stage, stratified random sampling was still used, to stratify each of the resultant parishes per sub-county (2 in Mazimasa, and 3 in Himutu), to allow for the random sample of half of the villages in each. The same simple random sampling procedure described earlier was used to sample one village per parish, which resulted in the sampling of seven villages, in total as shown below.

Mazimasa sub county		Himutu sub county	
Parishes	**Village sampled**	**Parishes**	**Village sampled**
Kapisa	Mugulu,	Kanyenya	Kanyenya A
Wanghale	Bukusi	Kangalaba	NalusagaTownship
Muyago	Kanganyi	Namulo	Muninge
Bufujja	Nasogo		

In each of the villages sampled, it was practically impossible to conduct random sampling given the nature of housing settlement that each of the villages had; none of the villages had a systematic type of housing arrangement. Therefore, a convenience sampling method was the only sampling method of choice at the household level, as it could allow for the sampling of a given household, obtainment and interview of an eligible member, and then the sampling of the nearest household to that that had been sampled. Such a sampling method maximized the chances of obtaining the required number of respondents per sub-county and as well as the obtainment of more reliable data regarding outbreak incidence. That is because, as opposed to random sampling that could have led to the skipping of a given household that may have potentially had a cholera case or history hence leading to underestimation of outbreak incidence, convenience sampling allowed for the sampling of all of them.

At each of the households sampled, the respondents were sampled purposively, on the premise of being the household head or an equivalent of a household head (a person that also had authority in the household for instance the wife to the household head).

3.5 Study variables

Table 1 show that the study had two independent variables, intrapersonal and institutional characteristics, both of which mainly had nominal type variables and one dependent variable which also had nominal type variables. The independent variables were analyzed inferentially while the dependent variable was analysed descriptively.

Table 1: Description of the study variables

Variable	Indicators	Scale of measurement during analysis	Data analysis type
Independent variables			
Intrapersonal characteristics			
	Household member with chronic Illness	Nominal	Descriptive and inferential
	Household member with HIV/AIDS	Nominal	Descriptive and inferential
	Frequency of Malaria incidence	Nominal	Descriptive and inferential
	Gender of the Head	Nominal	Descriptive and inferential
	Education Level Of Household Head	Nominal	Descriptive and inferential
	Household size	Scale	Descriptive and inferential
	Member under five years	Nominal	Descriptive and inferential
	Many males are they in this household	Nominal	Descriptive and inferential
Institutional characteristics			
	Migrate from other sub counties	Nominal	Descriptive and inferential
	Communal toilet availability	Nominal	Descriptive and inferential
	Communities flooding	Nominal	Descriptive and inferential
	Ever utilized flood water for any household activity	Nominal	Descriptive and inferential
	Practice open defecation in this village	Nominal	Descriptive and inferential
	Usually experience water shortages	Nominal	Descriptive and inferential
	Open defecation in community	Nominal	Descriptive and inferential
	Communal designated waste collection centers	Nominal	Descriptive and inferential
Dependent variable			
Cholera outbreak	Had a household member diagnosed with cholera, over the past 10 years	Nominal	Descriptive

3.6 Data collection method

This study involved the assessment of the cholera outbreak, which in itself had to include incidence and case fatality rate quantification. That was, in addition, to the need for the obtainment of predictors of that outbreak, with the implication that the study had to collect only quantifiable data. Therefore, the data collection method of choice had to be structured interviews, as they are the only data collection method that involves the asking of close-ended questions and hence the solicitation of responses that can be captured in a close-ended, and quantifiable format.

Structured interviews also came with the advantage of being relatively quick to conduct, a trait that allowed for the conduction of interviews spanning all the sampled villages, without risking respondent fatigue.

Also, to the structured interviews, however, document reviews were also made where possible, to come up with confirmatory evidence as to whether a given household had had a cholera case within the previous decade. The document review focused on the verification of whether the diagnosis made, and treatment received to that effect was aligned to cholera.

3.7 Data collection tool

Structured questionnaires were used to capture all the required data, as they are designed with close-ended questions, meant to capture close-ended responses obtained from structured interviews. The questionnaire (Appendix A) was designed with five sections, A, B, C, D and E in which was captured socio-demographic, cholera outbreak assessment, intra-household, and community characteristic assessment questions. The choice of items in each of the aforementioned sections was informed by a review of literature, related to each of the sections. The items for the assessment of cholera outbreak were informed by studies by Tembo et al. (2019), Siziya (2017), Sinyange et al. (2018), Ali et al. (2015), Kabwe et al. (2017), Elimian et al. (2019), Cambaza et al. (2020), WHO (2016), Vanormelingen (2015), Stoltzfus et al. (2014), Bwire et al. (2016) while the items for the assessment of intra-household and community characteristics were informed by studies including Dinede et al. (2020), D'Mello-Guyett et al. (2020), Burrowes et al. (2017), Dureab et al. (2019), Richterman et al. (2018), Endris et al. (2016), Dan Nwafor et al. (2019), Saha et al. (2017), Uthappa et al. (2015); Biswas et al., 2014; Colombara et al. (2013) and Nguyen et al. (2017).

3.8 Quality control

Research assistant training

Since the study was conducted in two separate sub-counties, in more than 5 villages, research assistants were recruited to help with the data collection process. A total of four research assistants, all graduates, with experience in survey data collection, were trained for a day, and were required to participate in the pretesting and thereafter conduction of interviews under supervision. The training covered the aims of the study, how to use the research instrument, and the easier way to collect data from respondents. This was important for the familiarization of the assistants with the research goals, questions and procedures and it gave them enough experience in collecting information in the field. The training was also provided for data collectors and supervisors on data collection procedures to ensure the quality of the field operation. The training mainly focused on how to fill the questionnaire, assess cholera outbreak, assess intra-household characteristics, and as well as those in the community and make effective interviews. The issues which are of relevance to the study, about the confidentiality of the information, informed consent were also a part of the training.

Pretest

Before the study, the developed questionnaire was pre-tested among 36 households in Bwaise, which was one of the areas that were affected by the Kampala cholera outbreak in the year 2019. Bwaise was thus a suitable study site, as the residents therein had almost similar dynamics like those in Butaleja. The pretest helped to ensure feasibility and clarify questions, words, and sentences that might are unclear or requiring explanations. For example, during the pretest, it was reported by the assistants that some of the respondents wanted a lot of clarification on questions 26, 33 and 42, of the questionnaire and therefore, before the main data collection was done, the three questions were simplified, and the assistants trained on how they were to better help the respondents comprehend them. Furthermore, it allowed the researcher to determine whether the intended data analysis can be carried out and whether the data collected will help achieve the research objectives.

Reliability of the study tools

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. Sections C and D of the questionnaire had items that had already been part of pre-tested and reliability tested tools from other studies with the implication being that reliability of the study questionnaire was in part assured. However, a full reliability test was still conducted for the entire tool, using data that had been collected during the pretest. The Split – half technique was used to assess reliability, in SPSS version 25 for windows. The split-half has the advantage in that it requires only one testing and therefore eliminates chance error due to different test conditions (Mugenda and Mugenda, 2003). The items in the questionnaire were divided into two parts; even and odd-numbered items. The questionnaire was then administered to the pilot group. The scores from the two groups of items were then correlated using spearman-Brown prophecy formula. The resulting coefficient indicates the degree to which the two halves of the test provide the same result and hence describe the internal consistency of the test. The reliability coefficient was calculated using the Spearman Rank correlation;

$$\text{Reliability of scores on total test} = \frac{2 + \text{reliability for } \frac{1}{2} \text{ test}}{1 + \text{reliability for } \frac{1}{2} \text{ tests}}$$

The computation of the correlation coefficient yields a statistic that ranges from -1 to +1. This statistic is called a correlation coefficient (r). The bigger the coefficient the stronger the association between the two variables, and hence reliability, and as seen in the table below, the correlation coefficient for Guttmann was found to be 0.631, which showed acceptable reliability

Cronbach's Alpha	Part 1	Value	6130
		N of Items	15[a]
	Part 2	Value	.456
		N of Items	17[b]
	Total N of Items		32
Correlation Between Forms			.252
Spearman-Brown Coefficient	Equal Length		.673[c]
	Unequal Length		.403[c]
Guttmann Split-Half Coefficient			.631

3.9 Data management and analysis

3.9.1 Data management

The data management process was done in three stages that included, verification of questionnaire filling and completion, data entry and coding, code entry verification, and dummy frequency runs. Each of the questionnaires was checked for completion, in terms of valid response presence and response to all questions, before entry. Following that ascertainment, the data was entered in Epi info and exported to SPSS version 25. It was in the SPSS data screen that further data management was done; all code fields were scanned through manually to find out if there had been any coding entry errors, and any found was rectified there and then. Also, each of the variables entered were descriptively analyzed first, to find out if all of them had tallying totals, even for follow up questions. This process allowed for the identification of two more entry omissions, which were both rectified.

3.9.2 Data analysis

The analysis process was carried out using both descriptive and inferential statistics in SPSS version 25. Descriptive statistics were run for all the study objectives (1, 2 and 3), given that for all of them, frequency distributions and valid percentages had to be obtained before further analysis could be carried out. For the first objective, however, it is only descriptive statistics that were run since the aim of that objective was to obtain values for computing the incidence and the case fatality rate, both of which had to be reported descriptively.

For objectives 2 and 3 however, another form of descriptive analysis was additionally used, which is cross-tabulations. The cross-tabulations were used to show the disaggregation of each of the independent variables in the dependent variable. This was then followed by the analysis of relationships between the independent and dependent variables, first, at the bivariate level. Of all the possible analytical models that could be used for analysis, that robust Poisson distribution was the most suitable, given that the outcome of the study (cholera outbreak incidence) exceeded 10%. It is that level that all possible relationships between the independent and dependent variables were analyzed, with the findings being reported in terms of crude incidence ratios (cPR), at a 95% Confidence interval. Every variable that exhibited a p-value that was less than 0.05 in any of its attributes was considered to be statistically significant, was thus considered to fitting into the multivariable model.

In the multivariable model, each of the significant variables that were noticed at bivariate analysis was adjusted for confounders. The findings obtained were reported in terms of adjusted incidence ratios (aPR) still at a 95% confidence interval.

3.10 Ethical considerations

This study was sanctioned by the university ethical review committee (Appendix C) and the local government authorities in Butaleja district as well (Appendix D). Ethics were also observed during the engagement of the household heads. Each of them was thoroughly briefed about the study via the administration of a consent form (Appendix A). It is during that process that each of the potential respondents was made to know about the study and its procedures, including what their participation in the study would entail. Their responses were treated with confidentiality, right from the data collection process; all the questionnaires filled for a given day were mobilized from the assistants and kept with the principal investigator at all times. None of the respondents' names have been reported along with their findings, and none of their names was captured on the consent forms they appended emphasized to all the household heads that were sampled; they were told that their participation consent or on the questionnaires they filled. The ethic of voluntary participation was voluntarily, and so was their withdrawal from the study, an action that could not attract any penalties.

3.11 Dissemination plan

At completion, the principal investigator plans to provide a copy of the report to the University, a copy to the district health office of Butaleja, and a copy to the sub-county offices of Mazimasa and Himutu. For the wider audience, an article will also be prepared for publication in either the International journal of environmental research and public health or the British Medical Journal

CHAPTER FOUR: FINDINGS

4.1 Socio demographics

Table 1: Respondent socio demographic characteristics

Variable	Category	Frequency (n = 368)	%
Age			
	20-29 years	**144**	**39.1**
	30-39 years	91	24.7
	40-49 years	41	11.1
	50-59 years	56	15.2
	60-69 years	31	8.4
	>69 years	5	1.4
Gender			
	Male	63	17.1
	Female	**305**	**82.9**
Marital status			
	Married	**195**	**53.0**
	Cohabiting	122	33.2
	Single	25	6.8
	Widow	26	7.1
Formal education			
	Yes	**322**	**87.5**
	No	46	12.5
School level (n=322)			
	Primary (Lower)	*102*	*31.7*
	Primary (Upper)	***145***	***45.0***
	Secondary (O level)	*70*	*21.7*
	Post-secondary education	*5*	*1.6*
Religious denomination			
	Catholic	79	21.5
	Anglican	117	31.8
	Muslim	**132**	**35.9**
	Born Again	25	6.8
	Seventh Day Adventist (SDA)	15	4.1
Position in household			
	Household head	130	35.3
	Eldest child	5	1.4
	Other adult left in charge currently	**233**	**63.3**
Sub county of residence			
	Mazimasa	**215**	**58.4**
	Himutu	153	41.6

Source: Primary data

More than a third of the household heads who were sampled as shown in table 1 above were young people aged 20-29 years 144 (39.1%), and more than three-quarters of them 305 (82.9%) were female. More than half of them were married 195 (53.0%), and more than three-quarters of them had received formal education 322 (87.5%). Of those who were educated, however, almost half had received upper primary education 145 (45.0%). More than a third of the respondents were Muslim 132 (35.9%), and close to two-thirds of them were those who had been left in charge of the household at the time 233 (63.3%). More than half of the respondents 215 (58.4%) were residents of Mazimasa Sub County

4.2 Cholera outbreak

Table 2: Cholera outbreak assessment

Variable	Category	Frequency (n = 368)	%
Household ever had any member or members suffer from Cholera			
	Yes	41	11.1
	No	**327**	**88.9**
	Total	368	100.0
Case or cases within the past five years			
	Yes	41	100.0
Number of household members affected by the disease during that time			
	One	**36**	**87.8**
	Two	5	12.2
	Total	41	100.0
Mortality among those members			
	Yes	5	12.2
	No	**36**	**87.8**
	Total	**41**	**100.0**

Source: Primary data

Assessment of cholera outbreak at household level revealed that slightly more than a tenth of the households sampled had had a member diagnosed with the disease previously 41/368 (11.1%). However, all the respondents in households with cholera history indicated that the cases had been incident within the previous five years prior to the study 41/41 (100%), and for more than three quarters of those households, it had been only one member of that was affected 36/41 (87.8%). More than three quarters of the households with cholera historyhad not registered any deaths from among the members who had been diagnosed with cholera 36/41 (87.8%).

Table 3: Distribution of cholera outbreak characteristics by sub county

Variable	Sub county		Total
	Mazimasa n = 215	Himutu n = 153	
Household ever had any member or suffer from Cholera			
Yes	31(75.6%)	10(24.4%)	41(100.0%)
No	184(56.3%)	143(43.7%)	327(100.0%)
Case or cases within the past five years			
Yes	31(75.6%)	10(24.4%)	41(100.0%)
Number of household members affected by the disease during that time			
One	26(72.2%)	10(27.8%)	36(100.0%)
Two	5(100.0%)	0(0.0%)	5(100.0%)
Mortality among those members			
Yes	5(100.0%)	0(0.0%)	5(100.0%)
No	26(72.2%)	10(27.8%)	36(100.0%)

Source: Primary data

Of the households that had ever had any member suffer from Cholera, slightly more than three quarters of them were in Mazimasa sub county 31(75.6%).All cholera cases that had been incident within the previous five years prior to the study were in Mazimasa sub county 31(75.6%), and as well as all the mortality among those members 5(100.0%)

4.3 Bivariate analysis

4.3.1 Intra-household

Table 4: Bivariate analysis of the relationship between intra-household characteristics and cholera outbreaks at the household level

Variable	N	%	Outbreak status		cPR (95% CI)	P Value
			Experienced outbreak (n = 41)	Not Experienced outbreak (n = 327)		
Had anyone in household in a chronic illness state						
Yes	157	42.7	16(10.2%)	141(89.8%)	1.009 (0.975 - 1.044)	0.614
No	211	57.3	25(11.8%)	186(88.2%)	Ref	
Member with HIV/AIDS						
Yes	11	3.0	6(54.5%)	5(45.5%)	1.765 (1.624 - 2.937)	0.010
No	357	97.0	35(9.8%)	322(90.2%)	Ref	
Malaria a common illness in household						
Yes	338	91.8	41(12.1%)	297(87.9%)	1.939 (1.922 - 4.957)	<0.001
No	30	8.2	0(0.0%)	30(100.0%)	Ref	
Gender of the head of this household						
Male	233	95.9	26(11.2%)	207(88.8%)	0.944 (0.924 - 0.965)	<0.001
Female	10	4.1	0(0.0%)	10(100.0%)	Ref	
Education level of the household head						
Primary (Lower)	52	21.4	6(11.5%)	46(88.5%)	0.942 (0.900 - 0.987)	0.011
Primary (Upper)	99	40.7	10(10.1%)	89(89.9%)	0.949 (0.920 - 0.980)	0.001
Secondary (O level)	77	31.7	10(13.0%)	67(87.0%)	0.935 (0.898 - 0.973)	0.001
Secondary (A level)	10	4.1	0(0.0%)	10(100.0%)	1.000 (1.000 - 1.000)	1.000
Post-secondary education	5	2.1	0(0.0%)	5(100.0%)	Ref	
Household size						
Less than five	115	31.3	11(9.6%)	104(90.4%)	1.012 (0.977 - 1.049)	0.501
More than five	253	68.8	30(11.9%)	223(88.1%)	Ref	
Children under five years in household						
Yes	292	79.3	31(10.6%)	261(89.4%)	1.014 (0.969 - 1.060)	0.554
No	76	20.7	10(13.2%)	66(86.8%)	Ref	
Number of children in household						
One	104	35.5	11(10.6%)	93(89.4%)	1.002 (0.946 - 1.060)	0.958
Two	86	29.4	5(5.8%)	81(94.2%)	1.027 (0.973 - 1.084)	0.338
Three	57	19.5	10(17.5%)	47(82.5%)	0.965 (0.898 - 1.037)	0.328
More than three	46	15.7	5(10.9%)	41(89.1%)	Ref	
Children/child practice indiscriminate defecation						
Yes	161	54.9	21(13.0%)	140(87.0%)	0.972 (0.937 - 1.008)	0.121
No	132	45.1	10(7.6%)	122(92.4%)	Ref	
Number of males in household						
One	51	13.9	11(21.6%)	40(78.4%)	0.929 (0.868 - 0.994)	0.033
Two	117	31.8	10(8.5%)	107(91.5%)	0.996 (0.961 - 1.033)	0.848

Three	73	19.8	10(13.7%)	63(86.3%)	0.970 (0.923 - 1.018)	0.217
More than three	127	34.5	10(7.9%)	117(92.1%)	Ref	
Ownership status of the latrine household uses						
Household	246	66.8	36(14.6%)	210(85.4%)	0.946 (0.918 - 0.975)	<0.001
Communal	122	33.2	5(4.1%)	117(95.9%)	Ref	
Boil water for drinking						
Yes	95	25.8	21(22.1%)	74(77.9%)	0.923 (0.879 - 0.970)	0.002
No	273	74.2	20(7.3%)	253(92.7%)	Ref	
Frequency						
Always	39	41.1	11(28.2%)	28(71.8%)	0.859 (0.791 - 0.933)	<0.001
Sometimes	40	42.1	10(25.0%)	30(75.0%)	0.875 (0.810 - 0.945)	0.001
Rarely	16	16.8	0(0.0%)	16(100.0%)	Ref	
Fish consumption frequency						
Always	22	6.0	6(27.3%)	16(72.7%)	1.264 (1.175 - 4.962)	0.008
Sometimes	92	25.0	15(16.3%)	77(83.7%)	0.918 (0.882 - 0.957)	<0.001
Rarely	212	57.6	20(9.4%)	192(90.6%)	0.953 (0.933 - 0.973)	<0.001
Never	42	11.4	0(0.0%)	42(100.0%)	Ref	
Fish water source						
Rivers	230	69.5	26(11.3%)	204(88.7%)	1.132 (0.980 - 1.309)	0.093
Streams	20	6.0	5(25.0%)	15(75.0%)	1.050 (0.877 - 1.257)	0.594
Swamps	66	19.9	5(7.6%)	61(92.4%)	1.155 (0.997 - 1.337)	0.055
Lakes	15	4.5	5(33.3%)	10(66.7%)	Ref	
Ever use flood water for any purpose						
Yes	117	31.8	21(17.9%)	96(82.1%)	1.948 (1.209 - 4.989)	0.013
No	251	68.2	20(8.0%)	231(92.0%)	Ref	

Source: Primary data

More than half of the respondents reported that none of their household members had had a chronic illness 211 (57.3%), and almost all of them had no member living with HIV/AIDS 357 (97.0%). However, almost all of the respondents reported that malaria was a common illness in their households 338 (91.8%). Almost all the respondents reported that they were from male headed households 233 (95.9%), with more than a third of the households being educated to primary (Upper) level 99(40.7%). More than two thirds of the households that were sampled were comprised of more than five members 253 (68.8%), with more than three quarters of them having children under five years 292 (79.3%). More than two thirds of the households with children under the age of five years have only one of them 104 (35.5%), and half of those households had children or a child who practice indiscriminate defecation 161 (54.9%). More than a third of the respondents hailed from households who had more than three men 127

(34.5%). More than two thirds of the respondents reported that that the latrine their households used were owned by themselves 246 (66.8%), although almost three quarters of the reported that they do not boil water for drinking 273 (74.2%). Of those who boiled however, more than two thirds reported that they did so sometimes 40 (42.1%). More than half of the respondents reported that they consumed fish rarely 212 (57.6%) as households, with more than two thirds of them getting the fish from rivers 230 (69.5%). More than two thirds of respondents reported that they had never used flood water for any purpose 251 (68.2%).

Households that had a member with HIV/AIDS had 23% lower incidence of cholera outbreak (cPR = 0.765, CI = 0.624 - 0.937, P = 0.010) and those in which malaria was a common illness exhibited a 7% lower incidence (cPR = 0.939 CI = 0.922 - 0.957, P = <0.001). Households in that were male headed had a 5% less incidence of cholera outbreak (cPR = 0.944, CI = 0.924 - 0.965, P = <0.001), with those that had the household head with secondary (O level) education having 6% less (cPR = 0.935, CI = 0.898 - 0.973, P = 0.001) and those with one male in the household having 7% less incidence (cPR = 0.929, CI = 0.868 - 0.994, P = 0.033). The incidence was less by 5% among households that owned a private latrine (cPR = 0.946, CI = 0.918 - 0.975, P = <0.001). The incidence was less by 8% among those who boiled water for drinking (cPR = 0.923, CI = 0.879 - 0.970, P = 0.002), but less by 14% among those who boiled the water always (cPR = 0.859, CI = 0.791 - 0.933, P = <0.001). The incidence was higher by 26% among those who always consumed fish (cPR = 1.264, CI = 1.175 - 4.962, P = 0.008) and less by 6% among those who had ever use flood water for any purpose (cPR = 1.948, CI = 1.209 - 4.989, P = 0.013).

4.3.2 Environmental characteristics

Table 5: Bivariate analysis of the relationship between environmental characteristics and cholera outbreaks at the household level

Variable	n	%	Outbreak status		cPR(95% CI)	P Value
			Experienced outbreak (n = 41)	Not Experienced outbreak (n = 327)		
Communal toilets in sub-county or village						
Yes	61	16.6	5(8.2%)	56(91.8%)	1.019 (0.978 - 1.061)	0.371
No	307	83.4	36(11.7%)	271(88.3%)	Ref	
Nature of communal toilets						
Constructed with local materials	27	44.3	0(0.0%)	27(100.0%)	1.079 (1.012 - 1.151)	0.020
Constructed with modern materials (Mortar and bricks)	34	55.7	5(14.7%)	29(85.3%)	Ref	
Migration from sub-counties Himutu to Mazimasa or vice versa						
Yes	270	73.4	30(11.1%)	240(88.9%)	1.001 (0.963 - 1.040)	0.976
No	98	26.6	11(11.2%)	87(88.8%)	Ref	
Migration a common occurrence						
Yes	175	64.8	15(8.6%)	160(91.4%)	1.039 (0.993 - 1.087)	0.096
No	95	35.2	15(15.8%)	80(84.2%)	Ref	
Frequency of flooding annually						
Once a year	251	68.2	36(14.3%)	215(85.7%)	0.928 (0.907 - 0.950)	<0.001
Twice a year	82	22.3	5(6.1%)	77(93.9%)	0.970 (0.944 - 0.996)	0.023
Thrice a year	30	8.2	0(0.0%)	30(100.0%)	1.000 (<0.001 - <0.001)	<0.001
More than thrice a year	5	1.4	0(0.0%)	5(100.0%)	Ref	
Some households use flood water for any household activity						
Yes	286	77.7	35(12.2%)	251(87.8%)	0.974 (0.940 - 1.010)	0.154
No	82	22.3	6(7.3%)	76(92.7%)	Ref	
People practice open defecation in village						
Yes	47	12.8	5(10.6%)	42(89.4%)	1.003 (0.954 - 1.054)	0.905
No	321	87.2	36(11.2%)	285(88.8%)	Ref	
Commonest water sources that households in this villages use						
Ground water sources (Springs, wells, boreholes, rivers)	255	69.3	36(14.1%)	219(85.9%)	0.984 (0.933 - 1.038)	0.559
Tap water	68	18.5	0(0.0%)	68(100.0%)	1.059 (1.009 - 1.112)	0.021
Rain water	45	12.2	5(11.1%)	40(88.9%)	Ref	
Community water shortages						
Yes	291	79.1	26(8.9%)	265(91.1%)	1.058 (1.005 - 1.115)	0.032
No	77	20.9	15(19.5%)	62(80.5%)	Ref	
Annual experience of water shortages						
Once	12	4.1	6(50.0%)	6(50.0%)	0.780 (0.645 - 0.943)	0.010
Twice	149	51.2	10(6.7%)	139(93.3%)	1.005 (0.974 - 1.037	0.752
More than twice	130	44.7	10(7.7%)	120(92.3%)	Ref	
People in community who practice open defecation						
Yes	57	15.5	5(8.8%)	52(91.2%)	1.015 (0.972 - 1.059)	0.499
No	311	84.5	36(11.6%)	275(88.4%)	Ref	
Observed human waste near or in a water source in community						
Yes	31	8.4	5(16.1%)	26(83.9%)	0.971 (0.903 - 1.044)	0.430
No	337	91.6	36(10.7%)	301(89.3%)	Ref	
Designated waste collection centers						
Yes	214	58.2	20(9.3%)	194(90.7%)	1.023 (0.987 - 1.060)	0.210
No	154	41.8	21(13.6%)	133(86.4%)	Ref	

From a community perspective, it was found that more than three quarters of the respondents were residents in a community where there were no communal toilets 307 (83.4%). More than half of those who had community toilets had them constructed with modern materials (Mortar and bricks) 34 (55.7%). Almost three quarters of the respondents reported that there was migration from sub counties of Himutu to Mazimasa or vice versa 270 (73.4%), with the majority reporting that that was a common occurrence 175 (64.8%). More than two thirds of the respondents reported that their communities flooded once a year 251 (68.2%) and more than three quarters of them reported that their households use flood water for some household activities 286 (77.7%). More than three quarters of the respondents reported that there were no people in their villages that practiced open defecation in village 321 (87.2%).

More than two thirds of the households used ground water sources (Springs, wells, boreholes, rivers) 255 (69.3%), and more than three quarters of them experienced community water shortages 291 (79.1%), with half of those reporting that they experienced water shortages twice 149(51.2%). More than three quarters of the respondents reported that they were no people in the community who practiced open defecation 311 (84.5%), and all of them had not observed human waste near or in a water source in community 337 (91.6%). More than half of the respondents reported that they had designated waste collection centers 214 (58.2%).

Five community related characteristics were found to have significant relationships with the outbreak of cholera. The incidence of cholera outbreak at household level was higher by 8% among households that were using communal toilets constructed with local materials (cPR = 1.079, CI = 1.012 - 1.151, P = 0.020). The incidence of cholera outbreak at household level was less by 7% among households in areas that flooded once a year (cPR = 0.928, CI = 0.907 - 0.950, P = <0.001), but higher by 6% among households whose commonest water sources in the villages was tap (cPR = 1.059, CI = 1.009 - 1.112, P = 0.021). The incidence of cholera outbreak at household level was higher by 6% among households in communities that experienced water shortages (cPR = 1.058, CI = 1.005 - 1.115, P = 0.032), but less by 22% among those in communities that experience water shortages once per year (cPR = 0.780, CI = 0.645 - 0.943, P = 0.010).

4.4 Multivariate analysis

Table 6: The predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda

Variable	cPR(95% CI)	P Value		aPR(95% CI)	P Value
Member with HIV/AIDS					
Yes	1.765 (1.624 - 2.937)	0.010		1.638 (1.465 - 1.877)	0.006
No	Ref			Ref	
Malaria a common illness in household					
Yes	1.939 (1.922 - 4.957)	<0.001		1.892 (1.847 - 2.940)	<0.001
No	Ref			Ref	
Gender of the head of this household					
Male	0.944 (0.924 - 0.965)	<0.001		0.933 (0.879 - .991)	0.023
Female	Ref			Ref	
Education level of the household head					
Primary (Lower)	0.942 (0.900 - 0.987)	0.011		0.979 (0.898 - 1.067)	0.624
Primary (Upper)	0.949 (0.920 - 0.980)	0.001		0.974 (0.879 - 1.080)	0.623
Secondary (O level)	0.935 (0.898 - 0.973)	0.001		0.974 (0.930 -1.020)	0.265
Secondary (A level)	1.000 (1.000 - 1.000)	1.000		1.188 (0.069 - 1.319)	0.221
Post-secondary education	Ref			Ref	
Number of males in household					
One	0.929 (0.868 - 0.994)	0.033		0.767 (0.662 - 0.889)	<0.001
Two	0.996 (0.961 - 1.033)	0.848		0.919 (0.865 - 0.977)	0.007
Three	0.970 (0.923 - 1.018)	0.217		0.866 (0.779 - 0.962)	0.007
More than three	Ref			Ref	
Ownership status of the latrine household uses					
Household	0.946 (0.918 - 0.975)	<0.001		0.946 (0.878 - 1.019)	0.144
Communal	Ref			Ref	
Boil water for drinking					
Yes	0.923 (0.879 - 0.970)	0.002		0.931 (0.888 - 0.976)	0.003
No	Ref			Ref	
Frequency					
Always	0.859 (0.791 - 0.933)	<0.001		0.839 (0.707 - 0.995)	0.044
Sometimes	0.875 (0.810 - 0.945)	0.001		0.767 (0.642 - 0.916)	0.003
Rarely	Ref			Ref	
Fish consumption frequency					
Always	1.264 (1.175 - 4.962)	0.008		1.143 (1.011 - 2.869)	<0.001

Sometimes	0.918 (0.882 - 0.957)	<0.001		0.825 (0.764 - 0.890)	<0.001
Rarely	0.953 (0.933 - 0.973)	<0.001		0.879 (0.824 - 0.937)	<0.001
Never	Ref			Ref	
Ever use flood water for any purpose					
Yes	1.948 (1.209 - 4.989)	0.013		1.894 (1.832 - 3.961)	0.002
No	Ref			Ref	
Nature of communal toilets					
Constructed with local materials	1.079 (1.012 - 1.151)	0.020		1.223 (1.083 - 1.380)	0.001
Constructed with modern materials (Mortar and bricks)	Ref			Ref	
Frequency of flooding annually					
Once a year	0.928 (0.907 - 0.950)	<0.001		0.863 (0.771 - 0.966)	0.011
Twice a year	0.970 (0.944 - 0.996)	0.023		0.902 (0.813 - 1.000)	0.051
Thrice a year	1.000 (<0.001 - <0.001)	<0.001		0.948 (0.863 - 1.040)	0.257
More than thrice a year	Ref			Ref	
Commonest water sources that households in this villages use					
Ground water sources (Springs, wells, boreholes, rivers)	0.984 (0.933 - 1.038)	0.559		0.960 (0.870 - 1.060	0.422
Tap water	1.059 (1.009 - 1.112)	0.021		1.110 (0.999 - 1.235)	0.053
Rain water	Ref			Ref	
Community water shortages					
Yes	1.058 (1.005 - 1.115)	0.032		1.100 (1.009 - 1.199)	0.030
No	Ref			Ref	
Annual experience of water shortages					
Once	0.780 (0.645 - 0.943)	0.010		0.705 (0.572 - 0.869	0.001
Twice	1.005 (0.974 - 1.037	0.752		1.011 (.962 - 1.063)	0.670
More than twice	Ref			Ref	

Source: Primary data

The findings in table 6 above show findings of the predictors of cholera outbreak before and after adjustment for confounders. The findings indicate that of the 15 variables, 13 remained as statistically significant, and so were considered to be predictors of cholera outbreaks. Households that had a member with HIV/AIDS had 36% higher incidence of cholera outbreak (aPR = 1.638, CI = 1.465 - 1.877, p = 0.006) and those in which malaria was a common illness exhibited an 11% lower incidence (aPR = 1.892, CI = 1.847 - 2.940, P = <0.001). Households in that were male headed had a 7% less incidence of cholera outbreak (aPR = 0.933, CI = 0.879 - 0.991, P = 0.023), compared to those that were females headed. Households that had one male member had 23% less incidence of outbreak (aPR = 0.767, CI = 0.662 - 0.889, p = <0.001), compared to those that had more than one male member. The incidence was less by 8% among those who boiled water for drinking (aPR = 0.931, CI = 0.888 - 0.976, P = 0.003) and even lesser by 23% among households that boiled sometimes (aPR = 0.767, 0.642 - 0.916, P = 0.003) compared to those who rarely boiled. The incidence was higher by 14% among those who always consumed fish (aPR = 1.143, CI = 1.011 - 2.869, P = <0.001) and less by 6% among those who had ever use flood water for any purpose (aPR = 0.894, CI = 0.832 - 0.961, P = 0.020). The incidence of cholera outbreak at household level was higher by 22% among households that were using communal toilets constructed with local materials (aPR = 1.223, CI = 1.083 - 1.380, p = 0.001). The incidence of cholera outbreak at household level was less by 7% among households in areas that flooded once a year (aPR = 0.928, CI = 0.907 - 0.950, P = <0.001), but higher by 6% among households whose commonest water sources in the villages was a tap (aPR = 1.059, CI = 1.009 - 1.112, P = 0.021). The incidence of cholera outbreak at household level was higher by 6% among households in communities that experienced water shortages (aPR = 1.058, CI = 1.005 - 1.115, P = 0.032), but less by 22% among those in communities that experience water shortages once per year (aPR = 0.780, CI = 0.645 - 0.943, P = 0.010), compared to those in communities that experienced water shortages more than twice a year

CHAPTER FIVE: DISCUSSION

5.0 Introduction

This chapter presents a discussion of the significant findings of the study as was obtained from each of the study objectives. The discussion has been made following the STROBE guidelines.

5.1 The incidence of cholera outbreaks among households in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda

With the potential to cause between 3 and 5 million cases, among which 100,000 to 120,000, most of whom happen to be children under the age of five years (UNICEF, 2020; Singh, 2020), cholera is with no doubt an epidemic of public health importance. That follows the fact that it is one of the threats to the achievement of SDG 3.2 (child mortality reduction), and although that is the primary effect of cholera, evidence has emerged that its incidence can have far reaching effects on maternal health as well, via environmental enteropathy. The fact that some cholera patients have been known to intentionally or unintentionally engage in open defecation, buttresses cholera as an even greater public health threat in this era of the Corona virus pandemic. That is because the stool of corona virus patients has been found to contain live and potent strains of Corona virus (Effenberger et al., 2020; Dhar et al., 2020; Gu et al., 2020; Heller et al., 2020; Tian et al., 2020), and hence can also be a transmission route of the disease in cases of open defecation and subsequent contact of that fecal matter with humans. On a positive note, cholera is treatable, although currently the increasing incidence of antibiotic resistance in its treatment makes the prevention of cholera outbreaks the most worthwhile public health intervention. Indeed, there have been quite a number of health promotion interventions instated in that line, however, cholera outbreaks still persist even in intervention areas like Butaleja district in Uganda.

Assessment of cholera outbreak at household level revealed that slightly more than a tenth of the households sampled had had a member diagnosed with the disease previously 41/368 (11.1%). This implies that about 1 in every 10 households in Mazimasa and Himutu sub counties had had a cholera outbreak previously registered, with all cases having been incident within the previous five years prior to the study 41/41 (100%). That therefore also implies that at least 1 in every 10 households in Mazimasa and Himutu sub counties had a member who most likely experience severe dehydration, subsequent hyponatremia, hypokalemia, with all their sequelae not limited to cardiovascular, neurological and muscular dysfunction. That is in addition to severe acute malnutrition, particularly on the part of children, and the risk of gastro-intestinal infections on the part of all other inhabitants. In case of another outbreak in any or both of the sub counties, particularly in this era where corona virus disease is apparent, the finding also implies that 1 in every 10 households in the two sub counties will be at risk of COVID19 as well, that is the cholera cases therein concurrently happen to be infected with the virus. The incidence of cholera outbreak in Butaleja district is inconsistent with what has been found in all other studies including Richterman et al. (2019) in Haiti (16%), Goswami et al. (2019) (27%) in India, ECDC (2020) in Yemen,Tembo et al. (2019), Siziya (2017), Sinyange et al. (2018), Ali et al. (2015), Kabwe et al. (2017) in Zambia, Nigeria, Elimian et al. (2019), Cambaza et al. (2020) in Mozambique, WHO (2016), and Ali et al. (2017) in Zambia. This implies that were as cholera outbreaks are a concern in Butaleja district; they are a greater concern in other parts of the world. However, there are justifications for the difference in the findings between the current study and the other studies. Unlike the current study, almost all the other studies (ECDC, 2020; Richterman et al., 2019; Vanormelingen, 2015; Cambaza et al., 2020; WHO, 2016; Ali et al., 2017; Global Task Force on Cholera Control, 2015) were conducted with wider geographical scopes, that is with a focus on entire countries or more than one country, concurrently. Such studies were thus bound to report more cases of cholera and hence relatively higher incidence's of the same.

Contrary to what has been reported in studies like Bwire et al. (2016) (case fatality rate = 1.9%) in Uganda-Democratic Republic of Congo, and Malawi-Mozambique borders, WHO (2017c) (CFR = 8%) in Kenya, ECDC (2020) (CFR: 2.1%) in Kenya, ECDC (2020) (CFR = 1.7%) in DR Congo, WHO (2018) (CFR = 1.4%) in Congo, Dan-Nwafor et al. (2019) (CFR = 13%)in Mozambique, ECDC (2020) (CFR = 5.1%) in Nigeria, Elimian et al. (2019) in Nigeria (CFR = 1.90%), Tembo et al. (2019) (CFR = 1.8%) in Lusaka Zambia, Sinyange et al. (2018) (CFR = 1.8) in Zambia, Ali et al. (2015) (CFR = 1.8) in Zambia, and Kabwe et al. (2017) (CFR at 1.9%) in Zambia, this study found a case fatality rate of only 1.3%. That implies that in Butaleja, for every 100 cases, only 1 dies of cholera, which is rather a positive finding. The relatively lower CFR in Butaleja district could be related to the timely treatment interventions that were made by both the Ugandan government and the Uganda red cros society. In some of the other studies, the cholera cases manifested after earth quakes, for instance in Haiti, or were in war zones, for instance in the Congo, which could have hampered timely access to curative care in those areas.

The findings that the study revealed were that between Himutu and Mazimasa and Himutu sub counties, Mazimasa was the most affected. More than three quarters of the affected households were in Mazimasa sub county 31(75.6%), and as well as all the mortality cases 5(100.0%). This finding is related to the fact that Mazimasa, as compared to Himutu sub county is more prone to floods, and thus potentially has more households that are exposed to polluted water and perhaps used it more. That is in addition to the fact that Mazimasa experienced more water supply interruptions within the past five years, compared to Himutu, given the water supply line constructions that were being done in Mazimasa. It is possible therefore those households in

Mazimasa were more prone to using alternative but risky water sources, as compared to those in Himutu Sub County.

5.2 The intra-household predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda

In consistence with the socio ecological theory, which supposes that one of the levels of influence on health outcomes is the interpersonal tier, the study found that a total of 9 intrahousehold characteristics were significant predictors of cholera outbreak. That also concurs with the findings by a number of other studies, which have found intra-household characteristics to be of importance in predicting cholera outbreaks (Dinede et al., 2020; Mwenda et al., 2017; Nsagha et al., 2015; Matias et al., 2017; De Guzman 2015; Colombara et al., 2014; Grandesso et al., 2014; Matias et al., 2017; Nsagha et al., 2015; Saha et al., 2017; Okello et al., 2019; Karami et al., 2017; Dureab et al., 2019; Richterman et al., 2018; Dan-Nwafor et al., 2019; Uthappa et al., 2015; Colombara et al., 2014; Burrowes et al., 2017; De Guzman et al., 2015; Ishaku et al., 2014; Saha et al., 2017; Nguyen et al., 2014; Nsagha et al., Health 2015; Moradi et al., 2016). One of the intra-household characteristics that was found to be of predictive importance in the cholera outbreak context was having a member that is HIV sero positive. The findings showed that households that had a member with HIV/AIDS had 36% higher incidence of cholera outreak (aPR =1.638, CI = 1.465 - 1.877, p = 0.006). This finding was expected, and is consistent with findings by Richterman et al. (2018), Sévère et al., (2016) and assertions by the WHO (2020). The human immunodeficiency virus as the noun goes severely compromises ones immune response to infections. The fact that immunoprotection from cholera involves mediation by locally produced secretory immunoglobulin A (SIgA) antibodies that hamper bacterial attachment and toxin binding in the intestine (Quadri et al., 2020) signifies the importance of the immune system , and also indiciates, therefore, the reason as to persons with immunodeficiency are at a higher risk of cholera infection. That is because their production of SIgA gets affected, and even when produced the immunoglobulin tends to have reduces antibacterial and antitoxic potency, hence providing room for intestinal attachement of vibrio cholera toxins and getting infected (Quadri et al., 2020). Therefore, having an HIV positive member in a given household that happens to have sub optimal sanitation practices, or happens to be in an outbreak prone community, increases the chances of that household having a cholera case. The same applies to diseases like malaria, which also greatly affect immune system response to infections sich as cholera (Nighina e t al., 2020; Sheila et al., 2017; Okosuna et al., 2014) and hence increase the risk of infection with vibrio cholera pathogens. Many studies (Nighina e t al., 2020; Sheila et al., 2017) have found plasmodium filaciparum infection to be an independent risk factor for vibrio cholera infections. That is why the findings also showed that which malaria was a common illness exhibited an 19% higher incidence of cholera outbreak (aPR = 1.192, CI = 1.847 - 2.940, P = <0.001) compared to households that did not have malaria as a common illnesses among their members.

The study also found a relationship between the gender of the household head and cholera outbreak. Households that were male headed had a 7% less incidence of cholera outbreak (aPR = 0.933, CI = 0.879 - 0.991, P = 0.023), compared to those that were females headed. This findings is related to the numersous merits of having a male as the household head, all of which reduce cholera outbreak risk at household level. One of those merits is the relatively higher socio economic stand that male headed households usually have. With the higher leverage soci economic stability comes a higher likelihood of that household to be in possession of a private water based toilet(s) which has been found to independently reduce the risk of cholera outbreak

(Nsagha et al., 2015). That is in addition to the higher likelihood of possessing an indoor municipal tap water source, which has also been found to reduce risk of infection (Dan-Nwafor et al., 2019; Okello et al., 2019; Dureab et al., 2019). Furthert still, male headed households have been found to be less likely to have members engaging in open defecation, perhaps due to the charisma they exhibit when incharge of a household. That alone reduces the risk of exposure to feces, which are significant reservoirs of the vibrio cholera bacteria. The effect of having a male head of a household also applies to the ther other finding that the study had, that is that households that had one male member had 23% less incidence of outbreak (aPR = 0.767, CI = 0.662 - 0.889, p = <0.001). By virtue of having only male member, chances of having that male member as the household head become compared to those that had more than one male member. That impliest that households that most if not all households that had one male member were male headed and so enjoyed all the aforementioned merits that are protective of sound intra-household sanitation and hence significant reducers of cholera outbreak risk.

Consistent with findings by Nsagha et al. (2015), the study found a significant predictive effect of use of communal toilets on cholera outbreak. It was found that the incidence of cholera outbreak at household level was higher by 22% among households that were using communal toilets constructed with local materials (aPR = 1.223, CI = 1.083 - 1.380, p = 0.001). Communal toilets come with a lot demerits that increase risk of cholera infection when used. First, such toilets are frequently in hygienic, given that they are usually infrequently cleaned because few to no people happen to take up their cleaning and maintenance responsibilities. They therefore get filled at at times and stay filled for long, to the extent of exposing fecal sludge at the surfaces, hence increasing the risk of human-fecal contact, and hence infection risk. Secondly, being communal, the users also rarely take the responsibility of setting up hand washing stations at such toilets, which hence decreases the practicing of hand washing among the users. That also increases the chances of the users ingesting viable cholera pathogens via the fecal-oral route. The finding is however inconsistent with findings by Grandesso et al. (2014), Matias (2017), and De Guzman et al. (2015) who found no significant difference in cholera risk with access to a latrine. All the three studies (Grandesso et al., 2014; Matias, 2017; De Guzman et al., 2015) were conducted in humanitarian settings with no sanitation structure. Therefore, it is highly likely that in those studies, respondents who had no access to communal latrines had the same hygienic practices as those who had access to latrines, hence the insignificant difference in cholera risk.

What was rather surprising was the finding that the incidence of cholera outbreak was higher by 14% among households that always consumed fish (aPR = 1.143, CI = 1.011 - 2.869, P = <0.001). However, there is a lot of evidence that attests to the fact that certain types of fish, particularly Tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) which are the most common type of fish consumed in Uganda, are some of the main reservoirs of Vibrio Cholerae pathogens, during any Cholera outbreak (Hounmanou et al., 2019; Plisnier et al., 2015; Hossain et al., 2018; Ajayi, et al., 2018; Hounmanou et al., 2016). That implies therefore, that in cases of open defecation, resultant water pollution, and eventual outbreak of cholera in areas with water bodies in which Tilapia and African cat fish are present, the two fish species can habor infectious doses of the cholera pathogen. When eaten , particularly durin the time of the cholera outbreak or up to a number of days following the outbreak, the consumers still remain at a high risk of getting infected with cholera

Consistent with studies by Burrowes et al. (2017), De Guzman et al. (2015), Ishaku et al. (2014), Saha et al. (2017), Nguyen et al. (2014), Nsagha et al. (2015), Mwenda et al. (2017), Karami et al. (2017) and Moradi et al. (2016), this study found a significant relationship between water sources and the outbreak of cholera. The findings showed that the incidence of cholera outbreak was higher by 89% among households that had ever used flood water for any purpose (aPR = 1.894, CI = 1.832 - 3.961, P = 0.020). This finding is almost overt, given that vibrio cholera microbes are almost entirely waterborne, and can only be destroyed with water treatment (chlorination) or boiling the water at or beyong 100^{o}C. Wereas all untreated water and/or unboiled water is at most times rich with disease causing pathogens, flood water happens to habor higher infectious doses of the same. That is because flood water unlike other forms of water happens to get into contact with fecal sludge and sewer systems, especially in rural residences were sanitation facilities are usually poorly constructed. Therefore, use of flood water for any household related purpose, and not boiling it, as was the case in some households in Butaleja (Table 3) puts household members at a high risk of V. Cholerae ingestion and subsequent infection. The risk posed by the use of flood water can however greatly reduce in when the flooding happens rarely or less often, which explains why the incidence of cholera outbreak at household level was less by 7% among households in areas that flooded once a year (aPR = 0.928, CI = 0.907 - 0.950, P = <0.001).

As earlier mentioned, the risk of infection from use of flood water only suffices if the water is used when unboiled, given that that boiling is one of the ways through which the water can be made safe for use, particularly drinking. Short of that the, consumer risks ingesting viable V. Cholera pathogens and subsequently getting sick. That is why the findings also showed that the incidence of cholera outbreak was less by 8% among those who boiled water for drinking (aPR =

0.931, CI = 0.888 - 0.976, P = 0.003) and even lesser by 23% among households that boiled sometimes (aPR = 0.767, 0.642 - 0.916, P = 0.003) compared to those who rarely boiled.

5.3 The environmental predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda

The study identified three environmental characteristics as being significant predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district. All the three characteristics were related to water dynamics in the communities of the two sub counties. It should be noted that the use of flood water is in most cases anteceded by water shortages, given that it is with the shortage of water that alternative but more risky water sources tend to be used, hence increasing chances of V.Cholera ingestion. Water shortages are more frequent in areas that have piped water, given that at times, maintenance companies turn off local pumps in order to carry out routine maintenance works or expand the piped water network, more so in rural areas. Besides routine maintenance works, pipes also tend to get blocked by foreign materials, increasing water shortage frequency, and also the chaces of using risk water sources at household level. That is why the incidence of cholera outbreak was higher by 6% among households in communities in which the commonest water sources was a tap (aPR = 1.059, CI = 1.009 - 1.112, P = 0.021), as compared to those whose commonest water sources was rain water or ground water sources (Springs, wells, boreholes, rivers). This finding is consistent with findings by Nsagha et al. (2015), and Okello et al. (2019) but inconsistent with findings by Mwenda et al. (2017), Karami et al. (2017) and Dureab et al (2019) who found that use of tap water reduced the risk of infection. The difference in the findings arises from the difference in the study settings; studies by Mwenda et al. (2017), Karami et al. (2017) and Dureab et al (2019) were all conducted in urban settings where piped water supply is relatively more regular as compared to rural settings.

In such areas therefore, there was less likelihood of using risky water sources like flood water by the residents

The second significant environmental predictor of cholera outbreak was unsurprisingly, flooding, similar to findings by the World Meteorological Organization and Global Water Partnership (2015), Brown et al. (2013), Stoltzfus et al. (2014), Snow et al. (2015), Maes et al. (2014) and Iramiot et al. (2019). It was found that the incidence of cholera outbreak at household level was less by 7% among households in areas that flooded once a year (aPR = 0.928, CI = 0.907 - 0.950, P = <0.001), compared to those who were residents in communities which flooded more than thrice a year. The findings particularly showed a trend of increasing incidence of outbreak with increasing frequency of flooding. Flooding in its self, as earlier mentioned, leads to high chances of contact between fecal sludge and flood water, with that effluent at most time finding its way into households and other water sources used by humans. It is the use of such contaminated water that increases chances of ingestion of the V. cholera pathogens and hence infection (Chowdhury et al., 2017; Iramiot et al., 2019; Ramamurthy et al, 2014), given that flood water use is quite frequent occurrence in areas like Butaleja (Table 3). It should be noted that the incidence was less by only 7% in communities that flooded only once a year, which implies that a flooding frequency of once only offers slight protection from a cholera outbreak. With increasing flooding frequency nonetheless, exposure to and chances of use of polluted flood water increases and hence an increase in risk of V. cholera infection and thus and increase in incidence of cholera outbreaks.

The chances of use of flood water and hence infection increase more when communities experience water shortages, given that it is during such times that alternative water sources including flood water are usually sought. That explains why the incidence of cholera outbreak at household level was higher by 6% among households in communities that experienced water shortages (aPR = 1.058, CI = 1.005 - 1.115, P = 0.032). The effect of water supply interruptions on cholera outbreak has also been reported in other studies (Iramiot et al., 2019; Jeandron et al., 2015). The chances of getting infected following the use of flood water become even more certain when the flood water is not boiled, as was found to be the case among households in Butalejja district (Table 3).

However, the findings also showed that the incidence of cholera outbreak was less by 22% households those in communities that experience water shortages once per year (aPR = 0.780, CI = 0.645 - 0.943, P = 0.010), compared to those in communities that experienced water shortages more than twice a year. This finding, similar to the earlier finding on flooding frequency indicates that wereas water supply interruptions increase risk of cholera outbreak, more frequent water supply interruptions increase the risk of infection even more. That is premised on the fact that with increasing water supply interruptions comes increasing need to use alternative but unsafe water sources, and hence a heightened chance of getting infected, due the increased exposure to cholera causing pathogens.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter presents the conclusion of the study based on the key findings that were obtained from each of the study objectives, along with recommendations for policy and practice, still based on the key findings that were obtained by the study.

6.1 Conclusion

About 1 in every 10 households in Mazimasa and Himutu sub counties has had a cholera outbreak. However, about 5 in every 100 such cases in the two sub counties die when infected.

At an intra-household level predictors for cholera outbreak are: having a member with HIV/AIDS, malaria being a common illness in a household, number of males in the household, the practice of boiling water for drinking, frequency of boiling water, fish consumption, and use flood water for any purpose, and the water sources used.

From an environmental perspective,the predictors of cholera outbreaks are; the nature of communal toilets, frequency of flooding in a given community, community experience of water shortages, and the frequency of water shortages.

6.2 Recommendations

The prevention of further cholera outbreaks in Mazimasa and Himutu sub counties will be achieved with the consideration of the following suggestions by any parties that are or will be implementing any related interventions in those areas.

To the district health office

The effect of having a member who is sero positive, on the outbreak of cholera can be minimized with a two prong strategy, one long term and one medium term. In the long term, the district health office should augment its current efforts of preventing HIV transmissions, such that the number of new cases is reduced or brought to a halt. That will work towards reducing the number of households with sero positive members. For households that currently have HIVsero positive members, the district health office in conjunction with the facility in-charges in Butaleja could consider setting up strategies meant to ensure the achievement of virological suppression among HIV positive persons in the district. Some of those strategies include the provision of differentiated care to adolescents, and provision of adherence counseling to all persons on antiretroviral treatment. The achievement of virological suppression by all sero positive persons in Butaleja will ensure that all of them are immunologically sound enough to have intestinal attachment of V.cholera toxins stopped and hence infection averted.

Minimization of the effect of malaria on cholera outbreak can still be achieved with the intervention of the district health office through the local health facilities in its jurisdiction. Like sero positivity, the primary interventions in this line should be to prevent the incidence of malaria. That can be achieved by sensitizing masses about the need for them to embrace malaria vector control measures at household level, notably use of insecticide treated mosquito nets, indoor residual spraying, the clearing of bushes around homes, and the uptake of intermittent preventive therapy in pregnancy. Whenever possible, the district health office of Butaleja should also consider lobbying for free mosquito nets and indoor residual spraying for households in Butaleja whenever the government has them on offer. That will go a long way in preventing malaria incidence and hence cholera outbreak at household level. For households that have active malaria cases, it will be prudent for the to ensure that each cases receives full doses of antimalarials, in addition to educating the patients and their care takers about immune boosting foods that they should take during a disease episode.

Whereas the practice of boiling water is fairly high among households in Mazimasa and Himutu, it is not universal, with the implication that the district health office should still take on the mantle of urging the residents of the two sub counties to boil all water that they use for drinking. Effective communication in that direction should be made with the inclusion of messages that capture the importance of boiling water, its effectiveness in killing cholera causing pathogens in any water, and the fact that all non-piped water in the area is potentially contaminated and unsafe for drinking unless boiled. Most importantly, particular emphasis should be put on conveying the message that the effectiveness of boiling in preventing cholera can only be harnessed with its frequent practice

Frequent fish consumption should be encouraged by local authorities, it being preventive of cholera outbreaks. However, all households that consume fish should be encouraged to cook it thoroughly so as to ensure the death of any vibrio cholera pathogens that may be carried along with the fish.

To the ministry of water and environment

The ministry of water and environment through the district water authorities in Butaleja should endeavor to ensure that the piped water supply system set up therein is fully functional at all times with little or no interruptions. That can be achieved, in part, by improving the efficiency of emergency teams that respond to any outages, due to pipe breakages or bursts. With their augmented efficiency, it will be certain that even in cases of unavoidable piped water shortages, the shortage does not last 24 hours or more.

To the district local government

The district local government is urged to lobby for any modern public toilet construction programs, like the LVWATSAN type programs so that Butaleja can be a beneficiary as well. Doing so may lead to the elimination of communal toilets constructed with local materials and the rise of the number of modern toilets that may then reduce the incidence of open defecation and also reversal to it among those that are open defecation free.

To the ministry of disaster preparedness and management

Whereas flooding in Butaleja as a district may not be preventable in the medium or long term given its geographical set up, it is possible to reduce the cholera outbreak and transmission propensity of the flooding. This can be done first by the ministry of disaster preparedness who could set up flood early warning systems, to detect any floods, warn the residents so that they can temporally evacuate flood prone areas. In cases of gaps in flood early warning or inability to set them up, then sensitization should be carried out by the line ministries and the local government as well, aimed at educating the residents of Mazimasa and Himutu about the dangers of overcrowding in a bid to escape floods, and the dangers flood water use in the cholera context.

6.3 Strengths and limitations

This study excluded any households that had cholera cases that had been diagnosed, prior to being residents in Mazimasa or Himutu Sub County. This was one of the strengths in this study given that it ruled out any cases of over estimation of the cholera outbreak that may not have been reflective of the situation in the two sub counties. Secondly, the study had a satisfactory time scope that covered a 10 year retrospective period within which Butaleja experienced significant cholera outbreaks. That time scope hence allowed for the capture of any cholera outbreaks without any cases of under estimation or data bias, hence ensuring that the findings regarding cholera outbreak are reliable.

The main limitation that this study had was that during the assessment of the cholera outbreak, not all the household heads that reported having had a case in their households, had documentary evidence to support their report. Thus, self-reported cholera outbreaks were also relied on, which may have had an effect on the outcome measured. Nonetheless, such an effect was minimized by carrying out sign and symptom based diagnosis of the cases. A household head that reported a case, and had not records to that effect were asked to mention the signs and symptoms on which they based their case report, and if it matched that of cholera, then the case was affirmed.

6.2 Recommendations for further studies

With the still significant research gap as regards the predictors of cholera outbreaks in Uganda, it would be worthwhile to have similar studies conducted in other parts of the country, more so in districts where there have been outbreaks, like Moroto, Kasese and even Kampala.

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APPENDIX A: CONSENT FORM

Title of the study: PREDICTORS OF CHOLERA OUTBREAKS IN MAZIMASA AND HIMUTU SUBCOUNTIES IN BUTALEJA DISTRICT - EASTERN UGANDA

Purpose of the study: To assess predictors of cholera outbreaks in Mazimasa and Himutu sub counties in Butaleja district - eastern Uganda

Why you have been chosen as a study participant: You have been chosen as one of the participants in this study because you happen to be a household head or their equivalent, which has been part of this household for the past 10 years within this same sub county (Mazimasa or Himutu).

What the study will involve: If you agree to be a participant in this study, you will only be required to respond to about 43 questions that will be seeking to solicit from you, information related to your personal characteristics, those related to this household and those related to the community. The questions are close ended, and are expected not be tire you as you respond, since the interview its self is expected last between 30 and 40 minutes

Risk and benefits of the study: As previously mentioned, you will only be required to given your responses as regards the aforementioned characteristics; we are not going to subject you or your family members to any clinical tests for cholera. Your participation will entirely entail response to some few questions that you will be asked, and so you will not exposed to any risk during or following your participation in the study. Your participation on the other hand will have a lot of benefits. With the establishment of both intra-household and community predictors of cholera outbreak, the ministry of health will get to know community entry points for intervention, targeting only those that increase outbreak risk. That may significantly augment outbreak prevention efforts on the part of the ministry.

Besides the ministry of health, the findings of the study will also be of significance to the residents of Butaleja, more so those in Mazimasa and Himutu sub counties, given that the study has highlighted 8 intra-household predictors of cholera outbreak, with which it is expected that household heads in the district will be empowered to know characteristics that are protective and un-protective cholera outbreak so that they can minimize the former and uphold the latter. That will in the in long run minimize the risk of their households being part of those with cholera cases in the event of another district outbreak.

The study will also be of significance to the local leadership in Butaleja district, particularly the district health office and the district environmental health office, who may benefit from the identification of the community predictors of cholera outbreaks. Such information will certainly enable them mount evidence based local cholera outbreak prevention interventions, or to inform those that are already running. That same information may be used by the district health educators, to inform their sensitization campaigns, as they will be furnished with points of emphasis (outbreak protective community predictors) for such sessions.

Confidentiality, anonymity and privacy: You can be sure that this study is highly confidential; the responses you provide will be recorded but will be reported in an anonymous way. None of your personal information that could be used to identify you will be reported, and all the records will be kept by the principal investigator at all time. Additionally, this interview will only be conducted if privacy is certain; there will be no other person in the vicinity, save for the interviewer and you the respondent.

Voluntary participation: You can only participate in this study at your own discretion. You will not be forced or persuaded with incentives in order to participate in the study. In case you feel uncomfortable please feel free to inform the interviewer; you can withdraw from the study, an action that will have not repercussions whatsoever.

Contacts: In case of any inquiries or queries, please contact the principal investigator on Tel: 0782 762 949

Consent page

Patient Identification Number ………………………………………………………

CONSENT FORM

Name of Researcher: **Akonya Martin**

Please initial all boxes

1. I confirm that I have read and understand the information sheet dated **[**for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐
3. I understand that relevant sections of my responses may be looked at by individuals from**UMU**, I give permission for these individuals to have access to my records. ☐
4. I agree to take part in the above study. ☐

_____________________ _____________________ _____________________

Name of Participant Date Signature

_____________________ _____________________ _____________________

Name of Person Date Signature

taking consent.

APPENDIX B: QUESTIONNAIRE

PART A: Socio demographic characteristics

Number	**Question**	**Filter options**	**Choice code**
1	How old are you currently (in complete years)	…………………………………….. ………..	
2	Gender	1. Male 2. Female	
3	What is your current marital status	1. Married 2. Cohabiting 3. Single 4. Other…………………..	
4	Have you received any formal education?	1. Yes 2. No	
5	If yes, what school level did you attain?	1. Primary (Lower) 2. Primary (Upper) 3. Secondary (O level) 4. Secondary (A level) 5. Post-secondary education	
6	To what religious denomination do you subscribe?	1. Catholic 2. Anglican 3. Muslim 4. Born Again 5. Other…………………….	
7	What is your position in this household?	1. Household head 2. Eldest child 3. Other adult left in charge currently	
8	Sub county of residence	1. Mazimasa 2. Himutu	

PART B: Cholera outbreak history

Number	Question	Filter options	Choice code
9	Has this household ever had any member or members suffer from Cholera?	1. Yes 2. No	
10	If yes, was that case or cases within the past five years?	1. Yes 2. No	
11	How many household members have been affected by the disease during that time?	1. One 2. Two 3. Three 4. More time	
12	Was there any mortality among those members?	1. Yes 2. No	

PART C: Intra-household characteristics

Number	Question	Filter options	Choice code
12	Within the past three months, have you had anyone in this household in a chronic illness state?	1. Yes 2. No	
13	Is there anyone living with the human immunodeficiency virus/acquired immune deficiency syndrome in this household	1. Yes 2. No	
14	Is malaria a common illness in this household?	1. Yes 2. No	

15	If your response to question 6 is not 1, what is the gender of the head of this household?	1. Male 2. Female	
16	If your response to question 6 is not 1, what is the education level of household head	1. Primary (Lower) 2. Primary (Upper) 3. Secondary (O level) 4. Secondary (A level) 5. Post-secondary education	
17	How many members are you in this household, generally	1. Less than five 2. More than five	
18	Are there any children under five years in this household	1. Yes 2. No	
19	If yes, how many such children do you have in this household?	1. One 2. Two 3. Three 4. More than three	
20	Do those children or that child practice indiscriminate defecation	1. Yes 2. No	
21	How many males are they in this household?	1. One 2. Two 3. Three 4. More than three	

22	What is the average age of all males in this household	……………………… ………………………	
23	What is the ownership status of the latrine that this household uses?	1. Yes 2. No	
24	Do you boil water for drinking in this household?	1. Yes 2. No	
	If yes, how often do you do so?	1. Always 2. Sometimes 3. Rarely	
25	How often do you consume fish in this household?	1. Always 2. Sometimes 3. Rarely 4. Never	
26	From which water source are the fish you eat usually obtained from?	1. Rivers 2. Streams 3. Swamps 4. Lakes 5. Mud	
27	Do all members in this household use soap for hand washing?	1. Yes 2. No	
28	Does this household ever have visitors from sub couties like Mazimasa or Himutu	1. Yes 2. No	

29	From which water source does this household get water from	1. Ground water sources (Springs, wells, boreholes, rivers) 2. Tap water 3. Rain water 4. Other	
30	Does this household ever use flood water for any purpose	1. Yes 2. No	

PART D: Environmental characteristics

Number	**Question**	**Filter options**	**Choice code**
31	Are there communal toilets in this sub county or village?	1. Yes 2. No	
32	What is the nature of communal toilets in this community, in terms of construction	1. Constructed with local materials 2. Constructed with modern materials (Mortar and bricks)	
33	Do people usually migrate from sub counties like Himutu to Mazimasa or vice versa?	1. Yes 2. No	

34	If so, is that a very common occurrence?	1. Yes 2. No	
35	How often do communities in this sub county flood annually?	1. Once a year 2. Twice a year 3. Thrice a year 4. More than thrice a year	
36	When the floods happen, do some households in this sub county, ever utilized flood water for any household activity?	1. Yes 2. No	
37	Are there people who practice open defecation in this village?	1. Yes 2. No	
38	What are the commonest water sources that households in this villages use	1. Ground water sources (Springs, wells, boreholes, rivers) 2. Tap water 3. Rain water 4. Other	
39	Does this community usually experience water shortages?	1. Yes 2. No	
40	If yes, how often annually	1. Once 2. Twice 3. More than twice	

41	Are there people in this community who practice open defecation?	1. Yes 2. No	
42	Have you observed scenarios where human waste is visible near or in a water source in this community	1. Yes 2. No	
43	Does this community have designated waste collection centers	1. Yes 2. No	

END

APPENDIX C: AUTHORIZATION LETTER

GENERAL LINE: 0788101147
DEPUTY CAO: 0772645721
PAS: 0774525550
ACAO 0782574999
FACSIMILE:
E-mail: butaleja _district@yahoo.com.

IN ANY CORRESPONDENCE ON THIS SUBJECT, PLEASE QUOTE REF.NO: CR/167/1/1

THE REPUBLIC OF UGANDA

BUTALEJA DISTRICT LOCAL GOVERNMENT
OFFICE OF THE
CHIEF ADMINISTRATIVE OFFICER
BUTALEJA DISTRICT
P.O.BOX 1, BUTALEJA.

24th October 2019

The Dean
Faculty of Health Sciences
Uganda Martyrs University

RESEARCH PLACEMENT FOR MR. AKONYA MARTIN

I am in receipt of your letter concerning the above referenced subject.

Butaleja District Local Government is one of the consumers of the products from institutions of higher learning like yours.

In the same breath therefore, we are obliged to offer practical experience to these students who are potential employees of our organization so that the hands of experience they go through orient their attitudes and skills. Please take note that this placement does not have any financial implications attached.

I therefore have no objection to offer research placement to **Mr. Akonya Martin**. He will carry out his research work in Himutu and Mazimasa Sub Counties under the supervision of the District Health Inspector.

For: Chief Administrative Officer
24 OCT 2019
P. O. BOX 1,
BUTALEJA DISTRICT

Madete Richard
For: CHIEF ADMINISTRATIVE OFFICER, BUTALEJA

Copy to: District Health Inspector, **Butaleja**
Mr. Akonya Martin
File