SCHOOL OF PUBLIC HEALTH
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EPIDEMIOLOGICAL LINK OF THE 2014 CHOLERA OUTBREAK IN THE GREATER ACCRA REGION

BY

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JULY, 2015

DECLARATION

I hereby declare that this dissertation except for references to other peoples work which have been duly cited, this work is the result of my own research and that this dissertation has neither in whole nor in part been presented for any other degree.

Candidate

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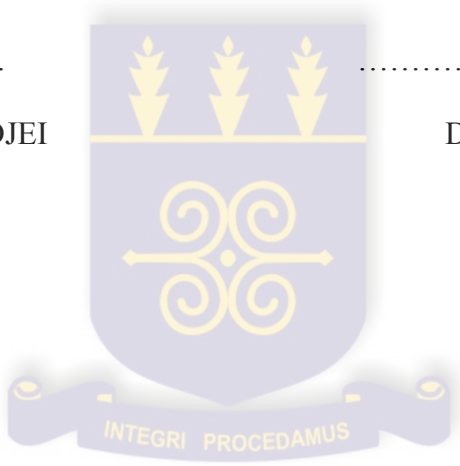
KENNEDY OHENE-ADJEI Date

Academic Supervisor



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DEDICATION

This work is dedicated to my dear wife Ella Akoto Dankwah and to my wonderful formal director and a mother; Dr. Emily Onuoha.

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ABSTRACT

Background

Cholera is an intestinal disease caused by the bacterium vibro cholerae. The disease is characterized by severe watery diarrhoea with vomiting and severe dehydration. It is spread through faecal-oral route from an infected person and fomites (surfaces). In 1982, Ghana recorded as many as 15,032 cases considered as the highest in a single year. Since 1970, the trend of cholera outbreak has changed, from the usual occurrence of one in every 4 - 6 years to a more frequent type, usually a protracted form of outbreak. In Ghana investigations are done for almost every cholera outbreak but no systematic effort has been put in place to measure the link that may exist between the index cases. This study sought to describe the epidemiological link of the 2014 cholera outbreak in the Greater Accra region.

Methods

A descriptive cross sectional study was conducted in all affected districts in the Greater Accra region. Records of all the cases (line list) were reviewed while the index case for each district regardless of their demographic characteristics were investigated and linked to a source of the outbreak in the Greater Accra region. Data was analyzed using STATA version 13 and Arc GIS version 10. They were used to generate simple descriptive statistics regarding the cholera cases, draw epidemic curves and generate maps to show pattern and trend of current cholera outbreak distribution.

Results

Greater Accra region recorded a total of 20,199 cases with 121 deaths, an attack rate of 445 per 100,000 population with a CFR of 0.6%. About 52% of the total cases came from the Accra Metropolitan areas. The mean age of the cases was 29 years

with SD of 6.87. About 60% of the total cases were between the age group 20-40yrs. Males form 58% of the total cases. The 2014 cholera outbreak in Greater Accra region can be linked to a point source; Accra Metropolis (a 10-year-old girl from Agbado). High urbanization and overcrowding in the region that results in insanitary conditions in the environment can be attributed to the cause of the outbreak.

Conclusion

The study has shown that the 2014 cholera outbreak was a point source epidemic that can be linked to the Accra metropolis. This was largely due to urbanization and overcrowding in the metropolis.

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LIST OF ABBREVIATIONS

AMA	-	Accra Metropolitan Assembly
CFR	-	Case Fatality Rate
CDC	-	Centre for Disease Control
GAR	-	Greater Accra Region
GHS	-	Ghana Health Service
GIS	-	Geographic Information System
MDG	-	Millennium Development Goals
WHO	-	World Health Organization

DEFINITION OF TERMS

Index case - The first documented case of a contagious disease in a group or population that serves to call attention to the presence of the disease.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Cholera is an intestinal disease caused by the bacterium vibro cholerae. The disease is characterized by severe watery diarrhoea with vomiting and severe dehydration. The main mode of transmission of cholera is through drinking water or eating food contaminated with the bacterium. (Bertuzzu et al., 2010; Sack et al., 2004).

Environmental spread is through faecal-oral route from an infected person. Flies may carry *Vibro Cholerae* which later contaminate food. There are other numerous social factors that comprise of several human activities that favours water and food pollution. Poor personal hygiene, poor quality of life and lack of education contribute to cholera outbreak (Wanyama, 2010). Water source contamination (29%), rainfall and flooding (25%), and refugee settings (13%) are the most common risk factors for cholera worldwide (Griffith et al., 2006).

Transmission can also occur through the uncontrolled water sources such as the lakes, rivers, wells, ponds and streams. Bottle-feed can also be considered as another means through which the bacterium can be transmitted to infants. Again fruits and vegetables washed with contaminated water can also cause outbreaks (Nevondo and Cleoto, 2010).

Epidemics of cholera often has a high potential to spread quickly and cause deaths since it induces acute severe diarrhoea which can result in death when rehydration is not given immediately. Due to this nature of cholera, by the time control measures are effected the epidemic would have already reached its peak and has began to wane (WHO, 2010). It affects all ages and both sexes. Attack rates may be seen to be higher

among children in endemic areas.

Cholera continues to be a global health threat. Pandemics of cholera have been experienced in some countries and sporadic attacks through the world especially in areas where water supply, sanitation, food hygiene and safety continue to be a challenge. This is seen to be true through the amount of morbidity and mortality cholera has contributed in low-income countries.

WHO reveals that globally about 317,534 cases of cholera were reported from 2008 to 2010 with 52 percent increase in deaths, of which half occurred among children who were less than five years. Critically speaking, this number is likely to be an under reporting due to differences in case definitions used by different countries and poor surveillance systems (Ali et al., 2012).

Cholera continues to be a major public health problem in African, Asia, the Middle East, south and central and Latin America. The true annual burden of the disease is estimated 100,000 to 120,000 deaths in every 3 to 5 million cholera cases globally (WHO, 2014). According to the World Health Organization (WHO), in 2012, a cumulative total of 245,393 cases were reported worldwide with 3,034 deaths and in 2011 alone, a total of 589,854 cases were notified from 58 countries with 7816 deaths. In places where cholera is non endemic, cholera usually occur as a results of civil unrest which destroys the public's sanitation services or are due to natural disasters as flooding, earthquakes, volcanic eruption, etc. which disrupt the normal balance of nature (Qadri, 2005).

Significant improvements in the area of water and sanitation are key. Medical care for cholera patients is equally important and crucial since without adequate treatment the

disease can kill within few hours. Cholera control is effective and cheaper than a curative one by means of instituting a preventive strategy. WHO reported in 2010 that the main contributors to cholera outbreak include poor sanitation, lack of potable water and poor food hygiene. Once cholera outbreak occurs, there are simple and effective intervention to prevent infections such as hand washing with soup and water before eating and handling food and after visiting the toilet and boiling or chlorinating drinking water.

The first cholera case to be recorded in Ghana was in 1970 when an infected Togolese national collapsed at the Kotoka International Airport in Accra, Ghana (Pobee & Grant, 1970). In 1982, as many as 15,032 cases (the highest number of cases recorded in a single year).

Cholera outbreaks in the country usually occur every 4 – 6 years since 1970. According to Opare 2010, there were over 9,000 cholera cases in 1999 with about 250 deaths (CFR 2.8%). In an outbreak from September 2010 to April 2011, there were over 8000 cases with 89 deaths from three regions of the country; Central, Eastern and Greater Accra (GHS, 2010).

The trend of the disease outbreak seem to have changed, from the usual occurrence of one every 4 – 6 years to a one year free interval between two year continues outbreaks (protracted form). Ghana has experienced cholera in 2005, 2006, 2008, 2009, 2011, 2012 and again in 2014. (GHS, 2014) There were no outbreaks in 2007, 2010 and 2013. Ghana recorded 9,174 cases in 2011 and 9,566 in 2012.

By October 2014, the outbreak in the country has hit 20,279 Ghanaians with 164 deaths (CFR of 0.8%). The attack rate stands at 790/100,000 Ghanaians. The 2014 outbreak had affected 101 districts in 9 regions of Ghana.

As at October 2014, Greater Accra region has recorded the highest cases so far with a number of 16,552 cases with 111 deaths (CFR of 0.7%). The other regions have also recorded cases: central (1811, CFR of 1.8%), Eastern (1,064, CFR of 0.4%), Volta (357, CFR of 2.0%), Western (161, CFR of 0.0%) Ashanti (173, CFR of 1.2), Brong Ahafo (144, CFR of 5.6%), Upper East (10, CFR of 0.0%) and Upper West (7, CFR of 0.0%). (GHS, 2014.)

Greater Accra region with an estimated total population of 4,530,905 from the 2010 population census is privileged to be equipped with all forms of modern telecommunications and mass media, international and intercity trade and commercial investments such as shops and small and medium scale enterprises. This has resulted in the steady increase in urbanization towards the cities and towns in Ghana recent times; there has been the formation of unplanned settlements in certain areas of the cities. This has resulted in densely population of the urban areas mostly Accra. This is another contributing factor of the frequent outbreaks. This has contributed to street vending and accumulation of refuse in the city.

A number of peri-urban settlements have severe water and sanitation problems. Most of these peri-urban rely on ordinary pit latrines (Allafrica, 2010). Once these pit latrine is filled up residence are faced with problems of space for locating a new pit hence they end up with no latrines.

The Ghana water company mostly manages water supply whiles private companies like zoom lion manages waste in the country. The water company is unable to serve all households in the country, which makes access to safe drinking water difficult. The available method of waste disposal is the onsite disposal mechanism such as the septic tank and due to inadequate funding.

1.2 PROBLEM STATEMENT

Cholera continues to be a major public health problem in African, Asia and Latin America. The true annual burden of the disease is estimated at about 100,000 to 120,000 deaths in every 3 to 5 million cholera cases globally (WHO, 2014). The World Health Organization (WHO) reported in 2012 a cumulative total of 245,393 cases worldwide with 3,034 deaths and in 2011 alone, a total of 589,854 cases were notified from 58 countries, including 7816 deaths (WHO, 2014).

Ghana has never experienced an outbreak in which its magnitude and extent is overwhelming like that of the 2014 cholera outbreak. It is the worse in experience over the past three decade. With increase in urbanization, inadequate water and sanitation, cholera will continue to be a public health challenge in the country.

Several studies all over world on cholera have shown and reconfirmed the known risk factors of the disease and the perception levels, attitudes and practices of individuals towards the disease are all well known. In Ghana investigations are done for almost every cholera outbreak but no systematic effort has been put in place to measure the link that may exist between the index cases.

Even though the current outbreak has been investigated extensively on the environmental factors and other risk factors associated with the outbreak, what it failed to do was to link the index cases to the source of infection to help break the transmission process. This study therefore turns to show how the index cases from the various districts of the Greater Accra region may be linked.

1.3 JUSTIFICATION

Instituting interventions for the control of cholera mainly result from knowing the risk factors and the link between the index cases. Cholera outbreak can either be from a common source or a propagated source, if we know the type of outbreak by linking the index cases, we can institute interventions that can curtail it and prevent future outbreaks.

Several pandemics have happen in different parts of the world and have been epidemiologically linked by different researchers to illustrate how the cases are spread and how they are related to the index cases. Results from such studies have informed decision-making and effective interventions. This was initiated by the work of John Snow in 1854 on Cholera when his findings informed fundamental changes in water and waste systems in London (Coelho et al., 2006).

Different other epidemiological studies have also been conducted, for instance during the 2009 pandemic H1N1 influenza, Wang et al. in 2011 conducted a research to describe the epidemiological link and clinical characteristics of the H1N1 influenza in China and found that the most affected people were students and employees. Due to these findings the government closed down the various affected schools and workplaces in order to prevent further spread of the disease (Wang et al., 2011).

Results from this study will inform Ghanaians that the over 20,199 cholera cases in Greater Accra may be linked to a common source and that these cases could have been prevented if early investigations were carried out and appropriate interventions instituted. It will depict the importance of early investigations and how it can be used to lessen the magnitude of cholera cases to a certain level. In addition, findings from this study will also inform decision-making about the appropriate interventions to be

instituted to prevent subsequent outbreaks in the country.

1.4 OBJECTIVES

1.4.1 Main Objective

The main objective of this study was to describe the epidemiological link of the 2014 cholera outbreak in the Greater Accra region of Ghana.

1.4.2 Specific Objectives

1. To describe the epidemiological link that exist between the index cases in the various affected districts in Greater Accra.
2. To describe demographic characteristics of the Greater Accra region's cholera outbreak transmission by person, place and time.
3. To describe the environmental factors associated with the current cholera outbreak.

CHAPTER TWO

LITERATURE REVIEW

2.1 NATURE AND EPIDEMIOLOGY OF CHOLERA

2.1.1 History of cholera

Cholera emerged out of contaminated water and poor living conditions of people in the early 1800s where millions of people were killed. Studying cholera has led to the development of new epidemiological methods that have helped to illuminate not only cholera transmission but the whole science of infectious disease epidemiology. It was John Snow in London in the 1800s who originally established a causal link between cholera transmission and exposure to contaminated water. His work on cholera was fundamental in many ways: he proposed methods and ideas that are still part of the basic toolkit of modern epidemiology, such as time–spatial analysis and notions of source of exposure and incubation periods. More recently, researchers have begun to understand more about the mechanisms of infectiousness of the cholera pathogen.

Cholera is caused by the toxin-producing bacterium *Vibrio cholerae*. In endemic regions, such as South Asia, cholera is seasonal, with explosive outbreaks occurring once or twice a year, depending on the region. Periodically, pandemic waves of cholera roll across the world causing a heavy death toll.

Cholera pandemics are pandemics that usually last for many years to decades and which spread to many countries and across continents. There have been a total of eight cholera pandemics in the world since 1800. The first pandemic occurred between 1817 and 1923 from India to Southeast Asia, Central Asia, Middle East and Russia. Six subsequent pandemics killed millions of people across all continents. The

seventh pandemic spread from South Asia in 1961 and got to Africa and America in 1971 and 1991 respectively (WHO, 2014).

The eighth pandemic started from Pohnpei, one of the Senyavin Islands added some more sad numbers to the tragic statistics in the history of cholera. This spread to Peru, Southern Africa and Marshall Islands.

Cholera initially spread to the West Africa during the seventh pandemic in 1970 and appeared in Ghana in September the same year when a Togolese national collapsed at the Kotoka International Airport in Accra.

Ghana experienced its first share of the pandemic in 1971.(Pobee & Grant, 1970; Ashitey, 1994). It is believed that cholera was smuggled into the country when some Ghanaian fishermen went fishing in Togo, Liberia and Guinea. One of the fishermen died and his family smuggled the corpse into his hometown for their usual burial rites to be performed. Cholera then began to spread along the coast until July 1971 when the Ashanti region began to report cholera cases. During the outbreak, reported cases were investigated and treated through camps while health education on measures to prevent further spread of the disease were also done.

Since then cholera has been experienced in Ghana in both epidemic and endemic forms in Ghana. Cholera has now become endemic in most coastal areas of Ghana; Greater Accra, central and western regions.

2.1.2 Nature of the disease

Cholera is a bacterial infection caused by *Vibrio Cholerae*. There are two sero-groups of the bacterium; *V. cholerae* - 01 and 013. *V. Cholerae* is usually responsible for outbreaks and it was first identified in Bangladesh in 1992 and has been confined to South-East Asia (WHO, 2014). The bacterium is usually found in food and water

contaminated with the faeces of an infected person. Common sources of infection include food, drinks and water sold by street vendors, vegetables grown or washed with contaminated water, raw or uncooked fishing seafood, etc.

Cholera is characterized by profuse rice water diarrhoea and vomiting that leads to severe dehydration. It has a short incubation period of between few hours to 5 days. The main reservoir for the bacteria is human and about 80% of infected people never develop symptoms. However, the bacterium stays in their faecal matter for up to 7-14days (Wanyama, 2010).

Cholera transmission is closely linked to inadequate environmental management. The consequence of a disaster such as disruption of water and sanitations or displacement of human population to inadequate and overcrowded areas can increase the risk of cholera transmission. Risk areas include peri-urban slums and camps where basic infrastructure are not available as well as displaced people where minimum requirement of clean water and sanitation are not met (Wanyama, 2010).

Cholera is an extremely virulent disease. It affects both children and adults and can kill within hours. The main signs and symptoms of cholera include profuse watery diarrhoea and vomiting. The severity of the diarrhoea and associated vomiting can lead to rapid dehydration and electrolyte imbalance, which can eventually lead to death. Among those who develop symptoms 80% are mild to moderate while between 10% and 20% develop severe diarrhoea. If left untreated, about 50% of cholera cases can die. 80% of the cases can be treated with oral rehydration salt and other cholera replacement fluids. In most severe cases when patients are severely dehydrated, treatment can be through intravenous fluids and antibiotics (WHO, 2014).

2.2 RISK FACTORS / DETERMINANTS

2.2.1 Source of water supply

Several researchers have conducted studies to find out the relationship that exist between sources of water and cholera outbreaks. Contaminated water source and untreated water will predispose the community to cholera and other diarrheal diseases.

A study conducted in Bangladesh by Emch in 2008 on the cause of cholera outbreak in the country revealed that Bangladesh depend on untreated surface water for domestic use especially during flooding times. They also found out that Bangladesh surface water has been polluted years ago with high levels arsenic content. A recent study by WHO in Bangladesh in 2010 reveals that about 30 million people were exposed to high levels of arsenic in their drinking water and as a result 20% of the people turned into the consumption of untreated surface water. These findings indicated that surface water became an important source of water for household consumption despite its contamination when no safe water was available (Emch et al., 2008).

Even though the simple boiling of water before drinking is an effective way of treating water because it kills all pathogens and microorganisms, the people in Bangladesh did routine boil their water because the cost of fuel wood was also high.

According to the study conducted in Zanzibar (Tanzania) on the sources of water and cholera, it was revealed that the majority of the population (71%) had access to piped water while a minority had to rely on drinking water from wells (27%) and other sources like street vendors, rainwater, spring water, and open water courses (2%). Such deteriorating environmental conditions subsequently exposed the

majority of the inhabitants to an increased risk of water-borne diseases. This was due to the scarcity of safe drinking water supplies and a generally poor or lacking sanitation infrastructure in peri-urban and rural areas (Schaetti et al., 2009).

A study conducted in Kalemie city, Democratic Republic of Congo (DRC) located on the side of Lake Tanganyika, North Eastern border of Katanga, which experienced the highest number of cholera cases in the province. It was revealed that each year, several outbreaks were identified in Kalemie, occurring each time in areas lacking sustainable access to safe drinking water. Epidemiological studies, conducted by the 4th Direction of the Congolese Ministry of Health and a North-South university network, in Eastern DRC clearly pointed out the role of seven cities located on the lake's shore that act as the main source of cholera epidemics especially among the fishermen. In the same area, more precise epidemiological surveys have shown that a great majority of cases occurred in the areas deprived of adequate access to safe drinking water. In these areas, contaminated surface water (mainly lakes) used by thousands of people for drinking and for personal use was obviously the source of cholera epidemics. Thus, remote or lack of access to safe drinking water in some of the limited areas located in lakeshore cities appears to be the primary cause of cholera outbreaks (Pirarroux, 2009).

Similar studies were conducted in Uganda to determine the cholera outbreak after the Health authorities reported about the disease outbreak towards the end of April. The disease had affected 21 villages and reported cholera cases in one week showed about 70 admissions. The results of the study reviewed that the epidemic was attributed to the lack of clean water for human consumption because many villages did not have

pit-latrines around their settlements hence cholera was spread through water contaminated with human excrement. The other factor discovered was that cholera spread quickly due to the regular movement of a highly nomadic population and unprotected water sources which were in the interior and inaccessible (Wanyama, 2010).

A study conducted in South Africa revealed that Cholera usually occurs in epidemic form when there was rapid urbanization without adequate sanitation and access to clean drinking water. Other risk factors included poor hygiene, overcrowded living conditions and lack of safe food preparation and handling. The situation was worsened when the municipal government had put locks on people's taps, forcing them to take water from the lake and river. People were made to pay for the water but due to high poverty levels, they could not afford and resorted to drinking water from contaminated wells. This made the situation worse and the epidemic spread throughout the entire community. According to a national survey in 2002, two million people were evicted from their homes for not paying for water. The water cut-offs forced thousands of poor people to seek water from polluted rivers and lakes and led to South Africa's worst outbreak of cholera, in which thousands of people were affected and hundreds died because the boreholes were dry and the people had no choice but to get water from the rivers and ponds contaminated with cholera bacterium, and the disease spread like wildfire (Nevondo and Cleote, 2010).

A senior environmental science lecturer at the University of Pretoria, South Africa, pointed out that besides the biological factors, Floods caused by heavy rains contaminated drinking water with the bacterium and in droughts, the bacterium can grow more easily in stagnating water in ponds and river (Nevondo and Cleote, 2010).

A study conducted in Zimbabwe revealed that cholera outbreak was as a result of Zimbabwe's dilapidated water system. It is one symptom of the collapse of a country that has been wracked by political turmoil and violence. Media reports suggested that residents were forced to dig shallow wells that rapidly became contaminated by the raw sewerage on Harare's streets. During its rapid spread across the southern African country, cholera killed 4,288 people and infected 98,592 according to the Zimbabwean Ministry of Health and Child Welfare's Rapid Disease Notification System. At its peak in February, the Ministry reported over 8,000 cases per week. This has been described as Africa's worst cholera epidemic in 15 years. This is also the area where the country's highest number of cholera infections was reported during the height of the epidemic (Anderson, 2009).

Similarly to South Africa, another study conducted in Zimbabwe revealed that residents were cut off water supplies due to none payment of outstanding water bills. Harare Water, which operates in the areas most affected by the cholera epidemic, said it owed US$23million unpaid bills according to press reports. The threats were made despite the fact that cutting off water supplies could force residents to find alternative water sources, and spark another cholera epidemic (Anderson, 2009). Despite the Zimbabwean government signing the Millennium Development Goals (MDGs), to have the proportion of the world's population without access to clean water and proper sanitation by 2015, little has been done due to the political and economic circumstances which has created a situation where the availability of clean water and proper sanitation is no longer routine.

In Zanzibar a study was conducted to determine the contributing factors to cholera

outbreak and it was reviewed that 71% of the population were having access to piped water while 27% had to rely on drinking water from wells and 2% depended on other sources like rainwater, spring water, and open water courses (Schaetti et al., 2009).

In Ghana, several researches have been conducted to point the various risk factors that predispose Ghanaians to contracting cholera and cause outbreaks. Most of these researches found that contamination of water sources is a major cause of cholera outbreak.

Opare et al conducted a research in November 2010 to investigate the cause of cholera outbreak in the East Akim municipality following the activities of the small-scale miners. They carried out an environmental survey of households of cases and controls as they inspected their sources of water supply principally observing activities around the community-wide Birim River, the drainage system, the sewage lines, general sanitation along the water bodies and collected water specimens for laboratory investigation. In their study they found that the main water source, which was the Brim River, was polluted by small-scale miners through defecation, post-defecation baths and sand-washings (Opare et al., 2010).

In a more recent cholera investigation, while determining the environmental risk factors in the Greater Accra, Dzotsi et al. found that there were inadequate water supply from the Ghana Water Company; taps were closed and people normally fetch with buckets and gallons and further stored in rubber bowls, gallons and polytanks for use. The affected persons were six times more likely to have drunk from street-vended sachet water which was identified as the main source of contamination for the outbreak (Gershon, et al., 2014).

2.2.2 Environmental Factors

It is common knowledge that cholera thrives in dirty environments and cholera mostly affects people living in unplanned settlements, refugee camps and slums commonly in the low-income settings. The situation in most of the towns and cities is frightening especially when one looks at the chocked sewer systems coupled with the poor drainage systems as they contribute to the poor environmental sanitation. The generation of millions tones of garbage everyday in the cities has made the local authorities fail to cope with the situation leading to their inability to collect and dispose off garbage regularly and efficiently.

Cholera outbreaks in Ghana usually occur in every 4-6years but in recent times the frequency of outbreaks has increased. The worst outbreak in Ghana was in 1982 when 15,032 people were affected and has been considered as the highest cholera cases in a single year (Dzotsi, et al., 2012). Meanwhile the current (2014) outbreak has recorded the highest cases (20,279; October 2014) and it is the worst epidemic Ghana has experienced since 1982.

In the 2014 outbreak investigation by Dzotsi et al, in Accra, they realized that there was generally poor environmental sanitation at all the communities where the cases reside. They observed crude dumping of refuse in most places and refuse containers full and overflowing, drains were shocked with people openly defecating in them, and some water pipe lines laid directly through some of the drains. There were also broken sewage pipes with sewage leaking into the environment at some places (Gershon, et al., 2014).

Other parts of the world where cholera outbreaks have been experienced may have had issues with environmental sanitation. According to reports from AlterNet, flooding from violent storms aggravated the spread of cholera in Cameroon, leaving

at least 100 people dead and another 1,500 infected. Heavy rains caused extensive flooding and sparked landslides that destroyed sanitary facilities as well as contaminated water sources (WHO, 2009).

A report from Zambia stated that among the contributing factors to the spread of cholera was the poor management of solid waste disposal. The high-density areas are the most affected and have very poor and in some cases no system for disposal of collected garbage from the various households. As a result, communities resorted to erratic dumping covering even the road networks. Households dig and bury or burn the waste while others wait for the night and throw the garbage along the roads or any vacant spaces within the community. These are breeding grounds for various diseases carrying pathogens, compromising the overall community hygiene and sanitation (WHO, 2010).

In Zanzibar (coast of East Africa, part of Tanzania) a research conducted showed that about 53% of the population had access to pit latrines, while 28% had no toilet facility and 12% mainly in urban areas were using a flush toilet. Poor sanitation contributed to the cholera outbreak (Schaetti et al., 2009).

Similarly a study conducted in Uganda reviewed that cholera outbreak was also be due to people defecating in the dry river bed since most of them lack pit-latrines and when it rained, the water carried the waste to the water sources situated on the river bank. According to the district health officer, he noted that the outbreak was due to lack of safe areas of waste disposal, as many households especially in the villages did not have pit-latrines around their settlements. Such deteriorating environmental

conditions subsequently exposed the majority of inhabitants on both islands to an increased risk of diseases due to poor or lacking sanitation infrastructure in peri-urban and rural areas (Schaetti et al., 2009).

2.2.3 Climate Change

Recent studies indicated that global warming creates a favourable environment for the cholera bacteria to multiply. When these conditions are coupled with the rise in temperature and heavy rainfalls caused by climate change, ideal conditions are created for the bacterium that causes cholera to multiply, bringing about a global resurgence of the disease.

A similar study conducted in Bangladesh reviewed that the lowest occurrence of the disease is in the winter (January to March). Cholera was four times higher during the summer (April-June) and autumn (October-December), which is before and after the monsoon season respectively. During the monsoon season (July-September), the occurrence of cholera was two times higher than in the winter season. A World Health Organization (WHO) study found that during the 1997-1998, a rise in sea surface temperature coupled with excessive flooding emerged as two significant factors in cholera epidemics in Bangladesh, Djibouti, Somalia, Kenya, Tanzania, and Mozambique (Schaetti et al., 2009).

Apart from the poor water and sanitation in Zambia, it was discovered that climate change had a role to play in the cholera outbreak. According to a recent press release from Alpha Galileo, a resource for European research news, a study lead by researchers from the Madrid Carlos III Institute of Health associated the increase of

cholera cases in Zambia with climate factors. Their study results confirmed that an increase in environmental temperature six weeks before the rainy season also increased the number of people affected by cholera at a rate of 4.9%. This was the first time that it had become evident in the sub-Saharan region that the increase in environmental temperature was related to the increase in cholera cases (WHO, 2009).

The research project, which was done in Zambia between 2003 and 2006, analyzed data from three cholera epidemics. The results showed that climatic variables such as rain and environmental temperature, were related to the increase in cholera cases during the epidemic period because it allows the bacteria to multiply in enhanced conditions, leading to almost 5 percent more cholera cases, while a 50mm increase in rainfall three weeks ahead of an outbreak pushed up the number of cases by more than 2 percent. The study also showed that a 100C increase in temperature six weeks before the beginning of the outbreak explains the 5.2% increase in cholera cases during an epidemic. Since the beginning of the outbreak in August of 2008 until March 17th of 2009, 91,164 cases were reported in this country alone, 4,037 of them Were fatal (WHO, 2009).

According to the study done by WHO in 2010, it was analyzed that there is an association between cholera epidemics and rainfall in Lusaka, because cholera outbreaks usually start during the month of October and end between mid-May/beginning of June of the following year corresponding to the rainy season (WHO, 2010).

A similar research conducted in the South Africa, Johannesburg revealed that rise in temperature and heavy rainfalls caused by climate change create conditions for the

bacterium that causes cholera to multiply, bringing about a global resurgence of the disease. Warmer surface temperatures increase the abundance of phytoplankton, which supports a large population of zooplankton-animal-like microorganisms, which serves as a reservoir for cholera bacteria, a water born disease (Colwell, 2009).

2.2.4 Other Risk Factors

There are several other factors that predispose people to getting cholera. These factors directly or indirectly contribute to the spread of the disease and also cause outbreaks. Such factors may include demographic and geographic factors (increase in population, urbanization, overcrowding, etc.), knowledge, attitudes and practices of people towards cholera, poverty, food supply, etc.

A study by Osei and Duker in 2008 on the spatial and demographic pattern of cholera in the Ashanti region, their findings suggested that high urbanization, high overcrowding, and neighborhood within the Kumasi Metropolis were the most important predictors of cholera in Ashanti region-Ghana (Osei; Duker, 2008).

The knowledge on cholera and its prevention by community members will enable them to prevent cholera outbreaks in their various places. However, a study was conducted to determine knowledge, attitudes and practices regarding cholera outbreaks and measure socio-cultural practices that influence cholera outbreaks in Ilala Municipality in Tanzania. The study revealed that the main practices associated with cholera occurrence among respondents with low knowledge and water source were: shallow well 28.6% and deep well 11.7%. The proportions of respondents by low knowledge and water quantity were: adequate water 13.6% and inadequate water

18.3%. About 14% of the respondents with low level of knowledge on cholera, drink water from wells without boiling while 31.8% drink unboiled piped water and 21.6% wash their hands in a common container. Furthermore, the proportion of the hygienic practices concerning cholera prevention was lagging behind knowledge and attitudes (Borus, 2004).

On poverty, cholera remains a serious public health problem in low-income countries and affects the people living in the low socio economic status because they cannot afford to pay for water bills and to pay for descent accommodation hence resort to stay in the shanty compounds where water and sanitation is poor. In 2007, the majority of worldwide cases (94%) and deaths (99%) were reported from Africa (WHO, 2010). A study conducted in Zimbabwe revealed that Harare residents had been informed that their new water supplies is being cut off if they do not pay outstanding water bills by Harare water. This made the residents to find alternative water sources from contaminated water wells, and another epidemic of cholera broke out (Anderson, 2009).

Another factor is the supply of food for consumption. Contamination of food will cause an outbreak and this may occur due to the absence of basic sanitary conditions. This is more common especially at the market places where thousands of people work and shop daily on a site that lacks latrines and running water and has chronic flooding due to blocked drains. Exposure could occur if the raw produce is handled in markets, which lack sanitary facilities particularly during an urban epidemic when *V. cholerae* counts are high. *Vibrio cholerae* can survive on raw produce for 2-5 days and produce can be exposed to these organisms at any time between the farm and the consumer's mouth (Dubois at el., 2006).

A study conducted in Peru on consumption of raw produce was strongly associated with cholera in a Peruvian city where fruits and vegetables were splashed with sewage-contaminated river water during transport to markets (CDC, 1991).

In Israel, a similar study was conducted and it was revealed that the use of raw sewage as fertilizer on vegetable farms was implicated in cholera transmission.

Between 28 November 2003 and 23 February 2004, 4343 cases and 154 deaths from cholera were reported in Lusaka, Zambia. A case-control study was conducted in February 2004 to assess potential transmission routes and prevention strategies. It was revealed that consumption of raw vegetables was strongly associated with cholera as it was related to food-borne exposures. However, consumption of any of the raw vegetables included in the composite variable was significantly associated with cholera and was about 95%. It was also revealed that eating leftover nshima (the local staple maize porridge) was associated with cholera (Dubois at el., 2006).

2.3 DISTRIBUTION OF CHOLERA BY PERSON, PLACE AND TIME

Several studies on cholera have tried to show how cholera cases are distributed across populations. The distribution is usually described by the various age group, sex and geography. Some studies have gone further to describe the distribution in terms of other demographic characteristics such as the socio-economic status, educational level, family size, level of income, etc.

A cholera outbreak investigation by Opare et al. in East Akim showed that the age group 20 - 29 years was the most affected with about 30.1% of the total age groups and the least affected age group is the age group 80 years and above (0.007%). Their findings also revealed that more males (56.6%) were affected than females (43.4%). They also realized that most of the cases were coming from areas that were close to

the Birim River. (Opare et al, 2010).

Oladele et al, carried out an assessment of emergency responses among health workers in northern Nigeria during cholera outbreak in 2010 found similar results as more male workers (64.3%) were affected than females and the most affected age group was between 18 and 28 years which forms 48% of the total age groups (Oladele et al., 2010).

Findings form a cross sectional study on knowledge, attitudes and preventive practices towards cholera by Wahed et al. in Bangladesh also supported the other researches on cholera distribution. Findings from their study revealed that males (59.4%) were more affected than females and the age group most affected was between 24 to 34 years. They also showed that cholera was more prevalent among the uneducated (57.9%) than the primary and secondary school levels (Wahed et al., 2013).

However, Regrading et al did a research on the knowledge, attitudes and practices regarding cholera outbreak in some part of Tanzania and found a contradicting results that showed that cholera mostly affected 30-34 age group (38.4) and more females (58.9%) than males (41.1%). They further showed how educational level and occupation influence cholera transmission; cholera was more common among those who have completed primary school (73.4%) as their highest education and more among housewives (40.3%). (Regrading, 2005).

Dubois et al. in 2006 did a study 'Epidemic cholera in urban Zambia; hand soap and dried fish, a protective factors'. Their findings revealed that the median age of those affected was 28years (ranges from 5-75years). They also recorded 58% of the total cases as males. Another study conducted by Okeke et al. in 2011 on the assessment of knowledge, attitude and prevention practices on cholera in Plateau State in Nigeria

also showed similar results as they recorded the mean age of those affected as 27.6 years and 61.5% of the total cases being males. These findings were confirmed and supported in a more recent study by Gershon et al. in 2014 in Ghana, where they found the median age to be 28 years and the most affected age group was 20 – 29 years followed by 30 – 39 years. Their results also showed that more males were affected than females.

2.4 EPIDEMIOLOGICAL LINK OF INFECTIOUS DISEASES

Few studies have tried to epidemiologically link cases of infectious diseases. For example Wang et al. in 2011 carried out a study in China during the H1N1 pandemic on the epidemiological link and clinical characteristics of the disease. In their study, they found that most of the people affected were students and workers and could be traced to a particular school and workplaces in China. With their findings, government interventions on closing down those places reduced the number of cases drastically.

Another epidemiological study was conducted by a group of researchers, Leroy et al. in 2007 in DR Congo on Human Ebola outbreak resulting from fruit bats. In their study they realized an annual massive fruit bats migration towards the southeast part of the country and settled in Ndongo and Koumelele islands as well as in palm trees of a largely abandoned plantation. They were able to trace back the human-to-human transmission events and they showed that in May 2010, the putative first human victim bought freshly killed bats from hunters to eat, which preceded the outbreak. Their finding supported the role of bats in the natural cycle of Ebola and indicates that a seasonal massive fruit bat migration should be taken into account.

CHAPTER THREE

METHODOLOGY

3.1 STUDY DESIGN

A descriptive cross sectional design was used to carry out this study in Greater Accra region. The index cases in the various affected districts in the region were included in the study.

3.2 STUDY AREA

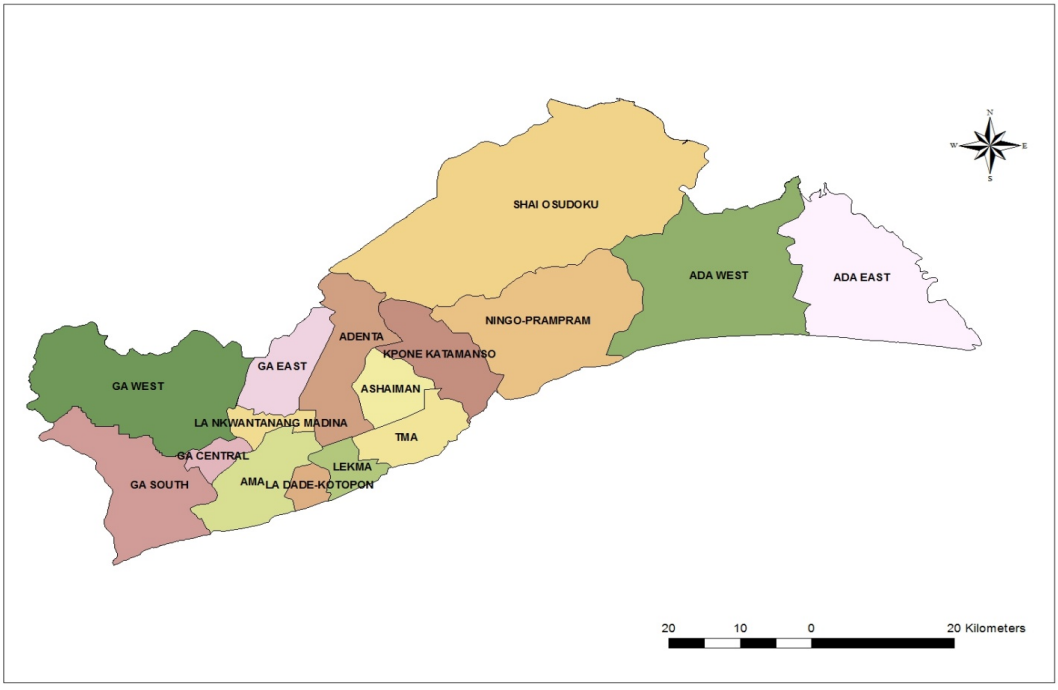
The study was conducted in the Greater Accra region of Ghana. The Greater Accra Region is the smallest of the 10 administrative regions in terms of area, occupying a total land surface of 3,245 square kilometers or 1.4 per cent of the total land area of Ghana. In terms of population, however, it is the second most populated region, after the Ashanti Region, with a population of 4,394,670 in 2010, accounting for 16.3 per cent of Ghana's total population.

The Greater Accra region is one of the ten administrative regions of Ghana. lt lies in the South East of the country along the Gulf of Guinea and has miles of beautiful coastline especially in the rural parts of the region. The shores in the capital city Accra are unfortunately mostly polluted. The Greater Accra region is challenged by problems of equitable access to an acceptable quality of health service. The region currently has 16 local government administrative districts namely: Accra Metropolis, Tema Metropolis, Ledzokuku-Krowor Municipality, Ashiaman Municipality, Adentan Municipality, Ga East municipality, Ga West municipality, Ga South municipality, Ada East district, Ada West District , La Dadekotopon

Municipality , La Nkwantang Madina Municipality , Ga Central Municipality, Kpone Katamanso District, Ningo Prampram District and Shai Osu Doku district. Accra metropolitan area which is the largest among the administrative districts is further sub divided into five sub metros namely Ablekuma, Ayawaso, Ashiedu Keteke, Osu Clottey and Okai Koi sub metros.

Towards the end of the year 2012, as part of decentralization, some of the more densely populated districts were broken up into several districts rather than what was existing at the beginning of the year. For example the La Nkwantanag Madina Municipality was carved out of the Ga East District. In the same regard the Ningo Prampram District was carved from the Dangme West district. This formation gave rise to six more administrative Districts at the end of the year 2012.

Figure 1: Map of Greater Accra Region Showing its Sixteen Districts



3.2.1 Population Size

The Greater Accra region is the second most populous region in the country and accommodates the capital city of Ghana, Accra. It has a rural urban ratio of 20:80. The provisional results of the 2010 national population and housing census give Greater Accra region a population of 3,909,764. This is up from the population of 2,905,726 in the 2000 National population census. The region contains 15.4% of Ghana's population, making it the second highest populated region after Ashanti region, which has 19.1% of the National population. The 2010 census data shows that all regions in Ghana experienced increases in population. However, the Northern (35.6%) and Greater Accra (34.6%) recorded the highest percentages. The intercensal growth rate in Greater Accra declined from 4.4% in 2000 to 2.8% in 2010. Its intercensal growth rate between the 2000 and 2010 census of 2.8% was above the national average of 2.4%, and was the second highest in the country after the northern regions growth rate of 2.9%.

The population density in Greater Accra is much higher than any other region in the country because of its small land area. The fact that the capital city of Ghana, Accra, is located within this region accounts for the high population and high urbanization. The provisional results of the 2010 census show a population density of 1,205 per square kilometer, up from 895 in 2000.

The Accra Metropolis is so densely populated and complex – with almost half of the region's population; that its sub-metropolitan areas are often more populated and complex than many districts. Ideally each of its five sub-metros should be treated as a district in its own right given this complexity. However, the vision and financing of

the health system has not made it possible to establish five administrations in Accra; and the Accra metro operates with 5 health sub-metros some of which are a merger of several local government sub-metros.

There is a Regional hospital, ten District hospitals, Twelve polyclinics, twenty one Health centres and about four hundred private and quasi health facilities and small clinics dotted all over the region.

3.2.2 Main source of drinking water

The main source of drinking water in the region for 80.9 per cent of households is pipe borne water, either inside or outside the house. At the district level, while 90.7 per cent of households in AMA and 85.9 per cent in Tema have this facility available to them, this does not seem to be the case in Ga (57.6%), Dangme West (64.2%) and Dangme East (24.4%). In all districts, it is more common for households to access pipe borne water from outside than from inside the house. It is noted that water tanker supply is prominent in Ga (19.2%) and Dangme East (21.2%). The main source of drinking water for Dangme East is the well (29.5%). It is also the district with a high proportion of households whose main source of drinking water is dugout (13.3).

3.2.3 Toilet facility

In general, households in the region use mainly public toilet facility (27.0%) or water closet in their houses (22.1%). In the AMA, Dangme West and Dangme East, the use of public toilet facility exceeds that of the use of the water closet in houses. While the public toilet is the most widely used in the AMA (32.7%), a large proportion of households in Dangme East (53.1%) and Dangme West (43.8%) have no toilet facility and use the bush, beach or the field. Households in Dangme West (20.9%) use pit latrines as a second choice, while those in Dangme East (15.7%), use public toilet as the second choice.

The toilet facility that is widely used by households in Ga (30.8%) is the pit latrine. About a fifth (18.3%) of households have no toilet facility of any kind and an equal proportion use water closet in their houses. In the Tema district, however, the use of the water closets in the house (29.2%) is close to that of the public toilet (27.5%) and the proportion for households with no toilet facility (16.9%) is not too different from that in Ga (18.3%). While the Kumasi ventilated improved pit (KVIP) is common in both AMA (11.7%) and Ga (11.6%), the use of bucket or pan as a toilet facility is more common in AMA than in any other district.

Even though there is a plan that is almost 20 years old to phase out the use of pan toilets in AMA and there are bye-laws for all new dwellings to convert to either water closet or in-house KVIP, AMA has a very high proportion (12.7%) of households still using the bucket/pan toilet system, with all its attendant problems of inefficient collection and disposal. AMA has to have the political will to enforce its own byelaws, not only on the toilet facilities, but also on environmental and sanitation issues.

3.2.4 Liquid waste disposal

Liquid waste is produced as a result of cooking, bathing and washing, among others. If it is not properly disposed of it could lead to a lot of health hazards such as malaria, cholera which could bring social and economic problems to the people. Disposing of liquid waste into gutters is the most widely used method (38.9%) in the region. In the AMA, over half of the households dispose of their liquid waste into gutters, while almost a third of households in Tema also use this method.

In the more rural districts of Ga, Dangme East and Dangme West, over half of the households throw their liquid waste unto the compound in their houses. Another 32.8 per cent of households in Dangme West and 41.3 per cent in Dangme East also throw

their liquid waste onto the street. The best way of disposing of liquid waste, however, is the use of the sewerage system. In the Tema municipality 27.6 per cent of households use the sewerage system. This is because the modern Tema Township has a sewerage system. The use of the sewerage system in Dangme West (1.5%) and Dangme East (0.9%) is relatively low.

3.2.5 Solid waste disposal

Solid waste can also be a health hazard if not properly disposed of. Over half of households in the region dispose of solid waste at a public dump. Disposal of solid waste at a public dump is by far the most widely used method in all the districts except Dangme East. Top on the list is the AMA, where over 60 per cent of households use this method. Burning of solid waste as a method of disposal is the most widely used method in Dangme East and the second for households in Ga. In Dangme West, 32.8 per cent of households dump their solid waste elsewhere.

The introduction of waste management systems where vehicles are used to collect waste from households for disposal has also gained popularity in the region, as about 20 per cent of households in the region use this method. In Tema, close to a third of households use this method, while about 20 per cent of households in the AMA also have their waste collected. A very small proportion of households in both Dangme East and Dangme West patronize the collection of solid waste from households.

3.3 STUDY POPULATION

The study population consisted of all the index case, both males and females regardless of their demographic characteristics in all districts, municipals and metropolitans that experienced the 2014 cholera outbreak in the Greater Accra region.

3.4 SAMPLING PROCEDURE

Purposive sampling method was used to select the index cases from the various affected districts. There was review of records on the 2014 cholera outbreak in all the districts by the use of the line list. Each affected district was visited and their line lists were pulled out. The index case that the district recorded in the 2014 outbreak was identified. Identifying characteristics of the index cases were the date of onset, date seen at health facility, name, client's folder number and address. The folder number was then used to trace the client's folder for additional information such as contact persons and detailed residential address with telephone numbers. Based on the information retrieved from the line list and folder, the index case is then followed up in the community.

3.5 SOURCES OF DATA

Data for this study were obtained from both primary and secondary sources. The primary responses were drawn from the index cases within their respective communities within which they contracted the disease. These were all within the affected districts in the Greater Accra region. Primary data included information from the interview, observation of the general environment and GPS coordinates. Secondary data were drawn from records of the affected district by reviewing existing line lists and clients' folder at the various levels from the various facilities.

3.6 DATA COLLECTION TOOLS AND TECHNIQUES

Extensive record review on all the cholera cases in the various districts in the Greater Accra region was carried out. Index cases were identified with the help of the line list and the clients' folder for other detailed information. A questionnaire was administered to all the index cases in the various districts to elicit the possible modes by which they contracted the disease and their link to any of the cases from the other districts. The questions were based on mode of transmission, possible contacts, symptoms, prevention, etc. The linkage was drawn based on the history of visit, people contacted and food and water consumed obtained through the interviews.

The interview was conducted at any venue decided by participants. The interview took between between 30 minutes to 45 minutes. The interview directed questions to be able to elicit the required information on mode of transmission, possible contact, symptoms, etc.

An observation of the general and physical environment was also carried out while the GPS coordinates for all the index cases in their usual place of residence was also taken. GPS receiver (smart phone) was used to take the GIS co-ordinates and a digital camera to capture a photograph of the environment.

3.6.1 Summary Of Data Collection Tools And Techniques

DATA COLLECTION TOOLS	**TECHNIQUES**
Interview of index cases	Structured questionnaire Writing pad, pen
Observation/Physical inspection of general environment	Checklist, digital camera, pencil
Taking of GPS coordinates	GPS device, smartphone
Review Regional and district records	Patient records and line lists and data extraction template

3.7 DATA ANALYSIS

Data were analyzed using STATA version 13 and Arc GIS version 10. These were used to generate simple descriptive statistics such as frequency distribution tables with percentages, mean, Standard Deviation for age and sex. A chi square test was also run for the sex, age groups and outcome of treatment. Proportions were calculated to determine attack rates (using cases and those at risk), case fatality rates (using deaths and cases), drew epidemic curves to show patterns of 2014 cholera outbreak distribution for the region and the respective districts. Linkage was drawn based on the history of visit, people contacted and food and water consumed.

Maps were derived with Arc GIS to describe the pattern of transmission and show the areas where index cases live. Different geographic areas (districts and communities) were shaded in different colours for easy identification and comparisons.

3.8 ETHICAL ISSUES

A proposal protocol was first vetted and reviewed by the School of Public Health for appropriateness and scientific content. The proposal was then reviewed by the Ethical Review Committee of the Ghana Health Service for clearance and approval. Formal permission was obtained from the Greater Accra regional disease control unit as well as at the district health administrations

In addition, the objectives of the study was explained to the participants (index cases/first cases) and their informed consent was obtained; both verbal and written before soliciting information on a scheduled date, these activities were in respect of the participant's human dignity. Privacy was ensured during the interview; respondents were assured of confidentiality. Subject codes were used to hide

respondents' identity. Personnel involved in data collection were cautioned during training to ensure confidentiality throughout the study. Data collected were stored in locked cabinets and only accessed by the principal investigator when the need arises. The informed consent administered to the respondents was also explained the respondents on the confidentiality, voluntary participation, withdrawal and risk/benefits to them. (Appendix 1).

CHAPTER FOUR

RESULTS

4.1 DESCRIPTIVE CHARACTERISTICS OF THE 2014 CHOLERA OUTBREAK IN GREATER ACCRA REGION (GAR)

A total number of twenty thousand, one hundred and ninety nine (20,199) cases of cholera were recorded by the Greater Accra Region (GAR) in the 2014 cholera outbreak in Ghana. Records of cases were reviewed by line list at the various levels. From the line list records review, 52% (10,504/20,199) of the total cases were from the Accra Metropolitan areas. 60% (12,255/20,199) of the affected people fell within the age group 20-40 years. The mean age of the cholera cases was 29 with 6.87 SD. About 58% (11,694/20,199) of the total cases affected by the outbreak were males. There were a total number of 121 deaths with a Case Fatality Rate (CFR) of 0.6%.

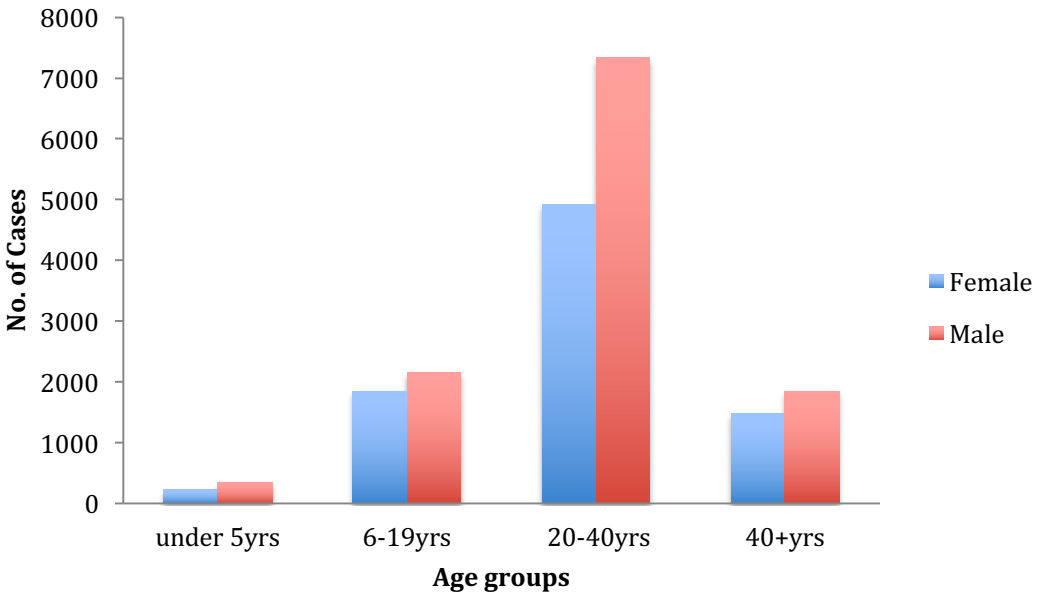
The following tables and figures show the summary of the demographic characteristics of the 2014 cholera outbreak in GAR.

Table 1: Demographic Characteristics of 2014 Cholera in Greater Accra

Characteristics	Frequency	Percent
Age group		
Under 5yrs	582	2.88
6-19yrs	4,023	19.92
20-40yrs	12,255	60.67
40+yrs	3,339	16.53
Sex		
Female	8,505	42.11
Male	11,694	57.89

About 60% (12,255/20,199) of the cases affected were between the age group was 20-40years. The same age group also recorded the highest number of the deaths representing 53% (64/121). Males form 57.8% (11,694/20,199) of the people affected.

Figure 2: Age group and Sex distribution of the 2014 Cholera by Districts in GAR



The most affected age group of the 2014 cholera outbreak was 20yrs to 40yrs. 2.8% (582/20,199) of the total cases fell under 5years which represent the least affected age group in Greater Accra region.

Table 2: Age group distribution of cholera cases by districts in GAR

District	Age Group				Total (%)
	< 5yrs	6 - 19yrs	20 - 40yrs	40+ yrs	
Accra Metro	210	2206	6512	1576	**10504(52)**
Ada East	1	18	56	28	**103(0.51)**
Adentan	5	10	29	5	**49(0.24)**
Ashaiman	0	10	49	9	**68(0.34)**
Ga Central	11	35	76	31	**153(0.76)**
Ga East	7	42	115	26	**190(0.94)**
Ga South	146	423	1089	297	**1955(9.68)**
Ga West	22	264	723	328	**1337(6.62)**
Kpone Katamanso	23	62	214	70	**369(1.83)**
La Dadekotopon	28	335	1747	217	**2327(11.52)**
La Nkwatanang	10	52	210	54	**326(1.61)**
Ledzoku Krowor	12	256	717	462	**1447(7.16)**
Ningo Prampram	0	2	14	6	**22(0.11)**
Shai Osu Doku	39	64	109	34	**246(1.22)**
Tema	68	244	595	196	**1103(5.46)**
Greater Accra	**582**	**4023**	**12255**	**3339**	**20199**

Accra Metropolitan was the district with the highest number of cholera cases. They form 52% (10504/20,199) of the total cases. La Dade Kotopon recorded the second largest number of cases with 11.5% (2,327/20,199). The least number of cases were seen in Ningo Prampram district with 0.11% (22/20,199) of the total cases. Ashaiman and Ningo Prampram did not record cases below the age of 5.

Table 3: Association between Age, Sex and outcome of treatment of 2014 Cholera

Characteristics	Alive	Died	Chi2	P-value
Age Group			42.26	<0.001*
Under 5yrs	582	0		
6-19yrs	4,011	12		
20-40yrs	12,191	64		
40+yrs	3,294	45		
Sex			6.64	0.01*
Male	11,610	84		
Female	8,468	37		

*Fisher's exact test

The result of the analysis shows that there is an association between age groups and outcome of treatment. There was also an observed association between sex and the outcome of treatment.

4.2 DISTRIBUTION OF CASES BY PERSON

Table 4: Attack Rates and Case Fatality Rate of 2014 cholera by districts in GAR

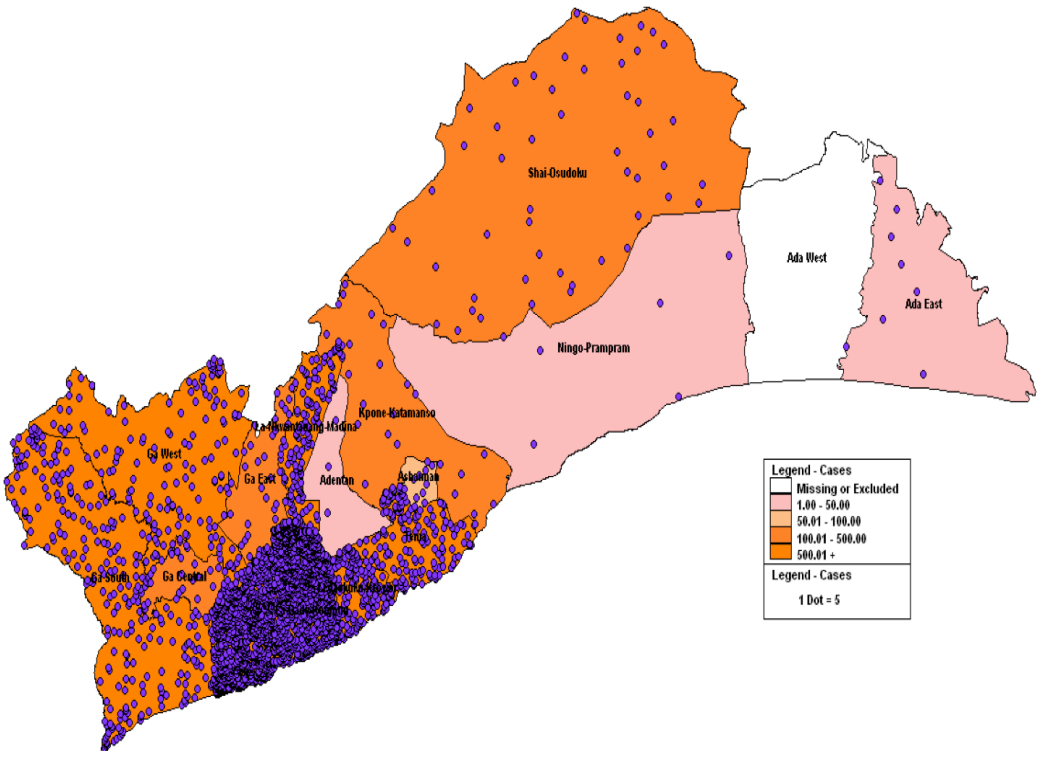
DISTRICT	2014 POP.	TOTAL CASES	DEATHS	AR/100,000 POP	%CFR
Accra Metro	1,857,558	10,504	65	565.47	0.62
Ada East	83,515	103	1	123.33	0.97
Adentan	88,374	49	0	55.45	0.00
Ashaiman	215,777	68	1	31.51	1.47
Ga Central	116,926	153	1	130.85	0.65
Ga East	165,274	190	0	114.96	0.00
Ga South	431,795	1,955	5	452.76	0.26
Ga West	296,868	1,337	2	450.37	0.15
Kpone Katamanso	109,184	369	0	337.96	0.00
La Dadekotopon	231,166	2,327	15	106.64	0.64
La Nkwatanang	128,120	326	6	254.45	1.84
Ledzoku Krowor	257,538	1,447	14	561.86	0.97
Ningo Prampram	78,006	22	0	28.20	0.00
Shai Osu Doku	60,785	246	1	404.71	0.41
Tema	345,750	1,103	10	319.02	0.91
Ada West	0	0	0	0.00	0.00
Greater Accra	4,530,905	20,199	121	445.80	0.60

Accra metro was the most affected district. The least affected districts were Ningo Prampram, Adenta and Ashiaman municipality. Ada West district did not report any case. The districts with high case fatality rates were La Nkwantanang, Ashiaman,

Ledzokuku Krowor, Ada East and Tema metro. The region recorded an attack rate of 445 per 100,000 population with Case Fatality Rate (CFR) of 0.60%.

4.3 DISTRIBUTION OF CASES BY PLACE

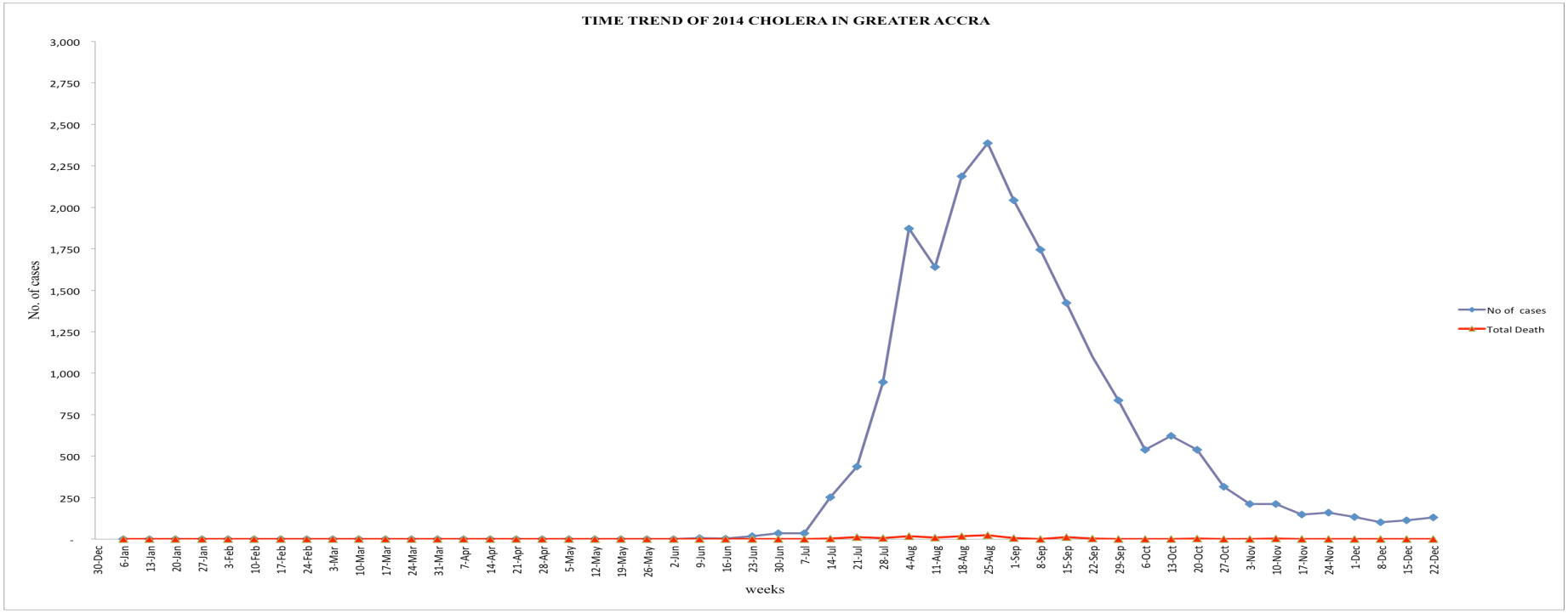
Figure 3: Spot map of 2014 cholera cases by districts in Greater Accra region



The Accra metropolis recorded the greater chunk of the total cases with 52% (10504) whereas Ada West district did not record any case.

4.4 DISTRIBUTION OF CASES BY TIME

Figure 4: Weekly Trend of 2014 cholera cases in GAR



The 2014 cholera outbreak in Greater Accra region can be described as a point source epidemic. The epidemic began steadily during the 24th week. It had its peak during the 35th week and steadily declined during the 49th week. Few cases still reported up to the end of year but at a slower pace.

4.3 LINK BETWEEN INDEX CASES FOR THE OUTBREAK AND IN THE VARIOUS DISTRICTS

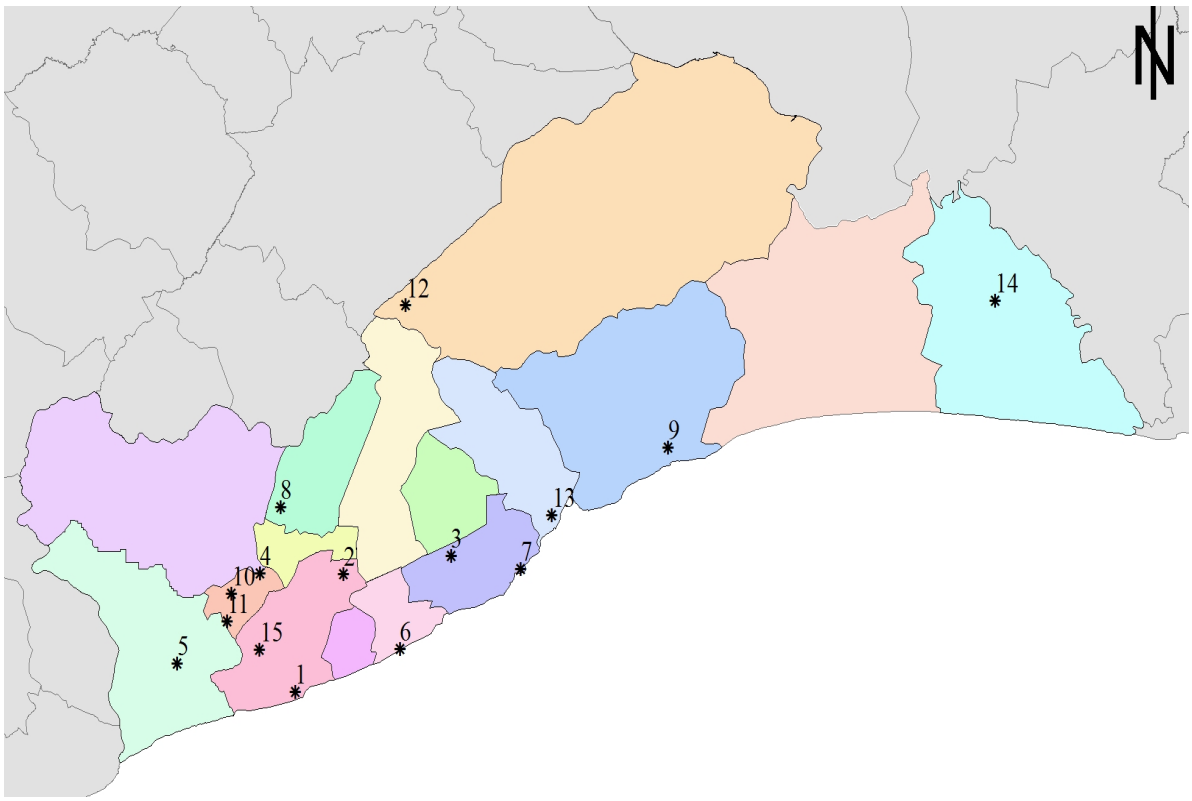
Index case for each affected district was identified and followed into their respective communities in GAR. History of food and water taken prior to onset of the disease were acquired. Places index cases visited or travelled to as well as the various contacts were ascertained through interviews. Summary is shown in table 5.

Table 5: Link between index cases of the 2014 cholera cases in GAR

Sequence of index/ first cases	District reporting index case	Community index case lived	Places traveled to/visited prior to symptoms	District (places visited)	Date of onset	Source of food/water
1	Accra Metro	Agbado	did not visit anyone	Accra Metro	9/6/14	Bought food across the street
2	Adentan	East legon	Mother is a trader, buys food stuff from Makola	Accra Metro	1/7/14	Bought food for the child at Makola
3	Ashiaman	Klagon	Visited some friends in Accra during his vacation	Accra Metro	4/7/14	ate in Accra during his visit
4	Ga West	Tentra Hill	Schools at Achimota	Accra Metro	7/7/14	Bought food from school
5	La Dade Kotopon	Weija	visted the auntie in Dansoman	Accra Metro	9/7/14	could not remember
6	Ledzokuku Krowor	Teshie Salem	didn't go anywhere apart from school	Ledzokuku Krowor	14/7/14	Bought food from outside
7	Tema Metro	Awudun	A fisherman, goes to the sea all the time	Tema Metro	19/7/14	could not remember
8	Ga East	Ashongman	Sells at Kwame Nkrumah circle	Accra Metro	21/7/14	Bought food from circle
9	La Nkwantanan	Agbogba	Mother didn't know where he went to	Ga East	23/7/14	mother could not tell
10	Ga Central	Santa Maria	Child attends school in Lapaz	Accra Metro	23/7/14	Bought food from school
11	Ga South	Anyaa	Trader at Lapaz	Accra Metro	23/7/15	Ate and drinks in Lapaz
12	Shai Osu Doku	Dodowa	Went to Accra to buy something a day before onset	Accra Metro	30/7/14	Ate in Accra
13	Kpone Katamanso	KponeApolo	A caterer, goes to tema to buy food stuff	Tema Metro	3/8/14	Could not remember
14	Ada East	Korlekope	came from Chorkor to visit a relative on Aug 4	Accra Metro	5/8/14	Ate home prepared food
15	Ningo Prampram	Darkuman	Lives in Darkuman, had his service in Ningo Prampram	Accra Metro	12/8/14	Patronize food vendors

Results from the interview reveals that 80% (20) had traveled or visited the Accra metropolitan areas. There were various communities in the Accra Metro where index cases visited, these places included; Darkuman, Dansoman, Chorkor (Ablekuma sub-metro), Lapaz, Achimota (Okaikoi sub-metro), Kwame Nkrumah circle (Osu Clottey sub-metro) and Accra central (Ashiedu Keteke sub-metro).

Figure 5a: Spot map of 2014 cholera index cases by districts with time of onset



4.3.1 DESCRIPTION OF HOW INDEX CASE FROM THE VARIOUS DISTRICTS WERE LINKED

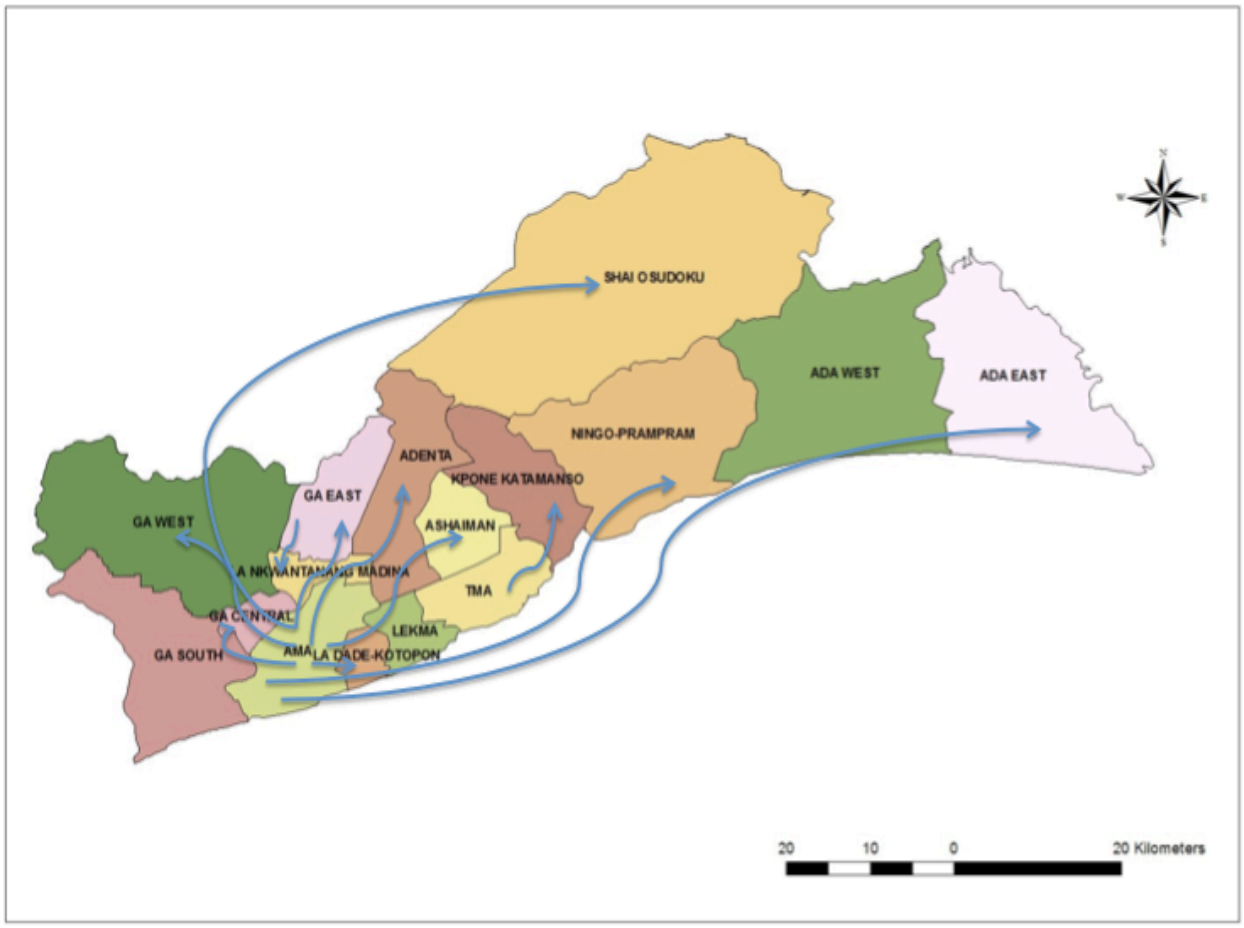
Greater Accra region experience of the 2014 cholera outbreak started during the epidemiological week 24 when a 10-year-old girl reported to the Ussher Polyclinic, a facility in the Accra Metropolis. She reported on 10th June, 2014 with onset of the disease from the previous day. Stool specimen from her proved positive to *Vibrio cholerae* 01 of the Ogawa sub type. The laboratory confirmation came in after she had

been discharged. Follow up investigation revealed that the evening prior to the onset of diarrhoea she ate rice and fried turkey tail (locally called Tsofi) from a street food vendor at Agbado, a suburb of Accra Metropolis. Another case was confirmed in Maamobi polyclinic, another facility in the Accra Metropolis within the same week. After the second confirmed case, the Accra Metro began to experience an upsurge in the number of cholera cases reporting.

By the 29th week the cases had spread to the other districts. The next affected district after Accra metropolis was Adantan municipal whose first case reported on 1st July 2014. This was a woman who trades at the Makola market, believed to have gotten the infection whiles there and exported the disease to her district. Ashiaman recorded their first case on 4th July 2014. The case was a 24yrs old male who came on vacation from school and usually visits his friends who runs an internet café in Accra. He spends most of his with them and eats from there.

All the other districts had a contact in the Accra metropolis with the exception of Tema and KponeKatamanso. KponeKatamanso district index case can be traced to Tema where a caterer visits Tema on commercial purposes during which there was an ongoing cholera transmission. She gets herself infected and exports the infection to her community, Apolo in Kpone. Tema's index case was a fisherman who is always on the sea fishing. He started experiencing signs and symptoms of the disease on 19th July 2014 when by then there were existing outbreaks in six districts. Tema is surrounded by four out of the six districts, ie. Adentan, Ashiaman, La Dadekotopon and LedzokukuKrowor. However, there is a link between Tema and Accra metro by the sea. Figure 5b below describes how the index cases moved within the various districts in GAR.

Figure 5b: Movement of the index cases in the 2014 cholera outbreak in GAR



4.4 EPIDEMIC CURVE OF THE 2014 CHOLERA OUTBREAK IN G.A.R

Data review was carried out on the outbreak with the use of the line list. Results from the data revealed that even though there were some cases that were suspected at the initial stages of the year (5th week) that turned to be negative, the actual onset of the epidemic occurred on 9th June 2014 (24th week). Since the epidemic curve can be described as a common source, it rapidly increased and achieved its peak at the 35th week.

Figure 6 below describes the epidemic curve of the 2014 cholera outbreak in Greater Accra

Figure 6a: Combined Epicurve of the 2014 Cholera outbreak in Greater Accra

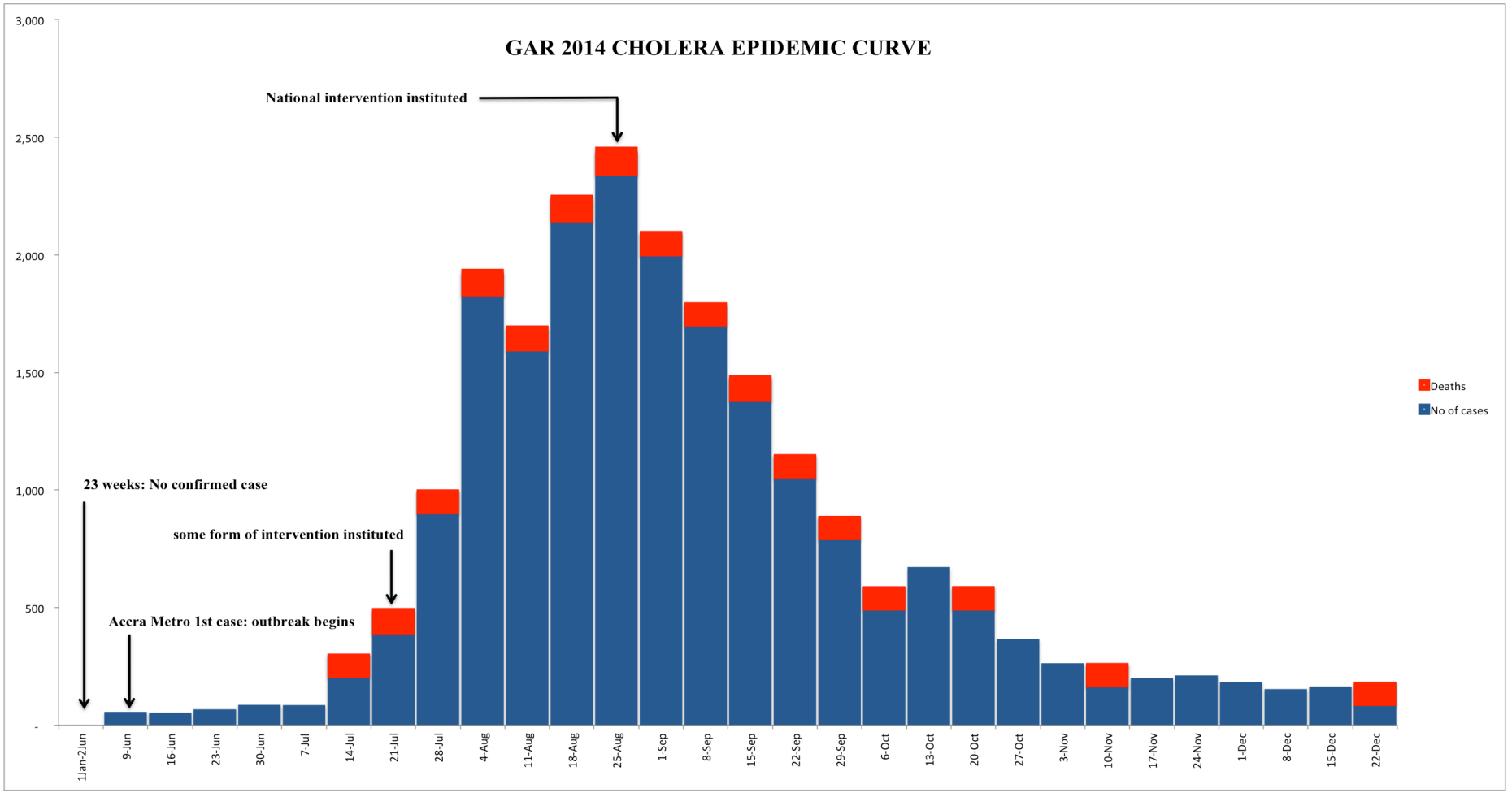
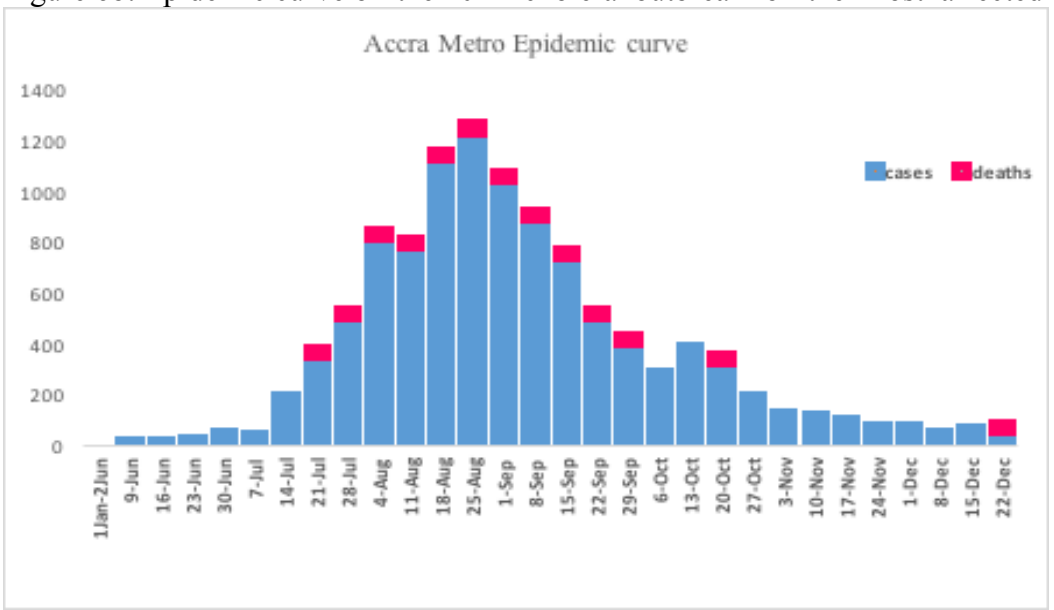
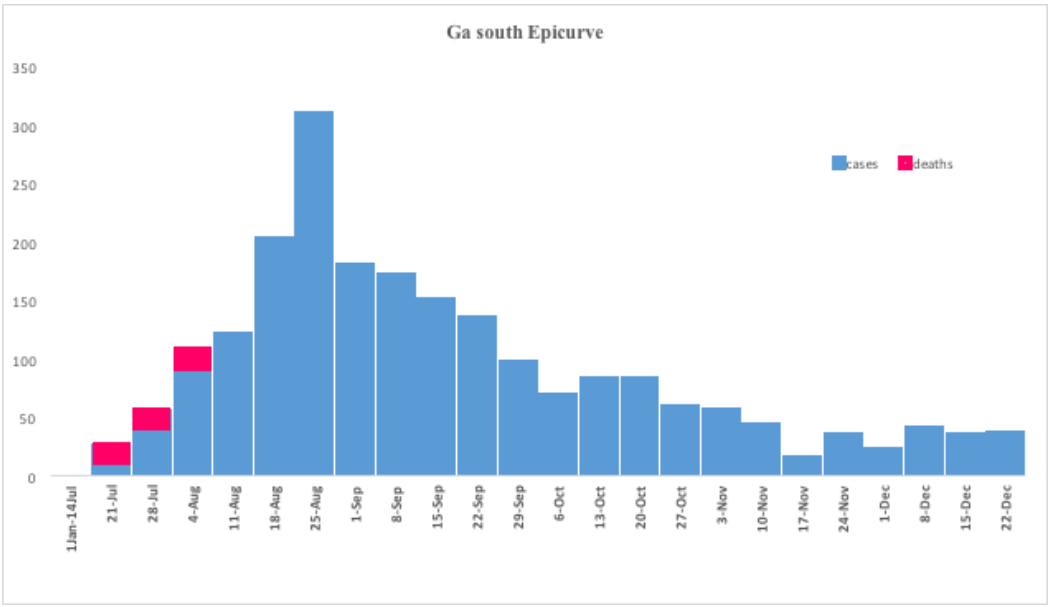
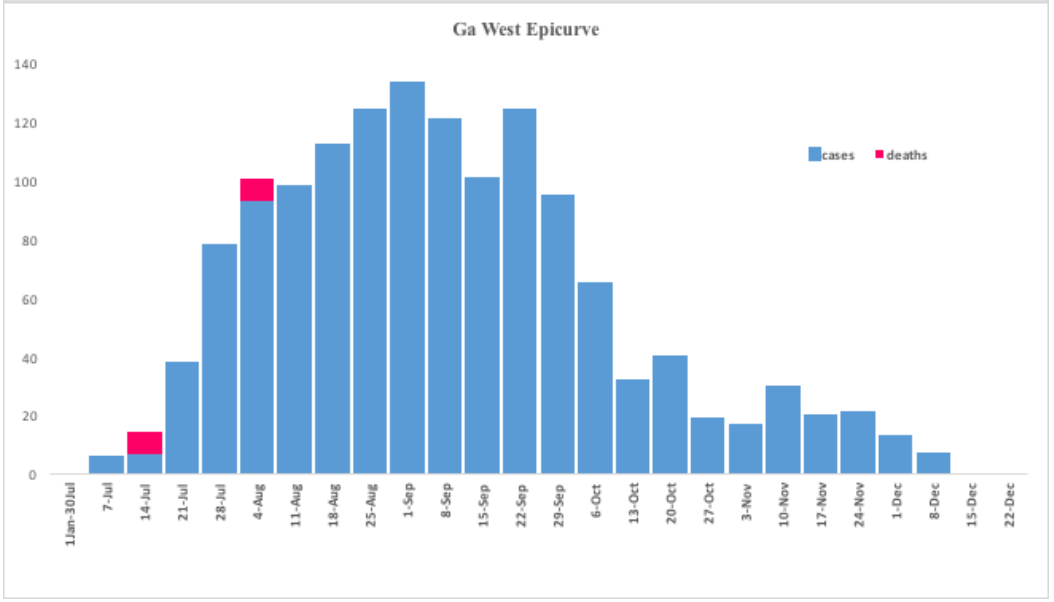
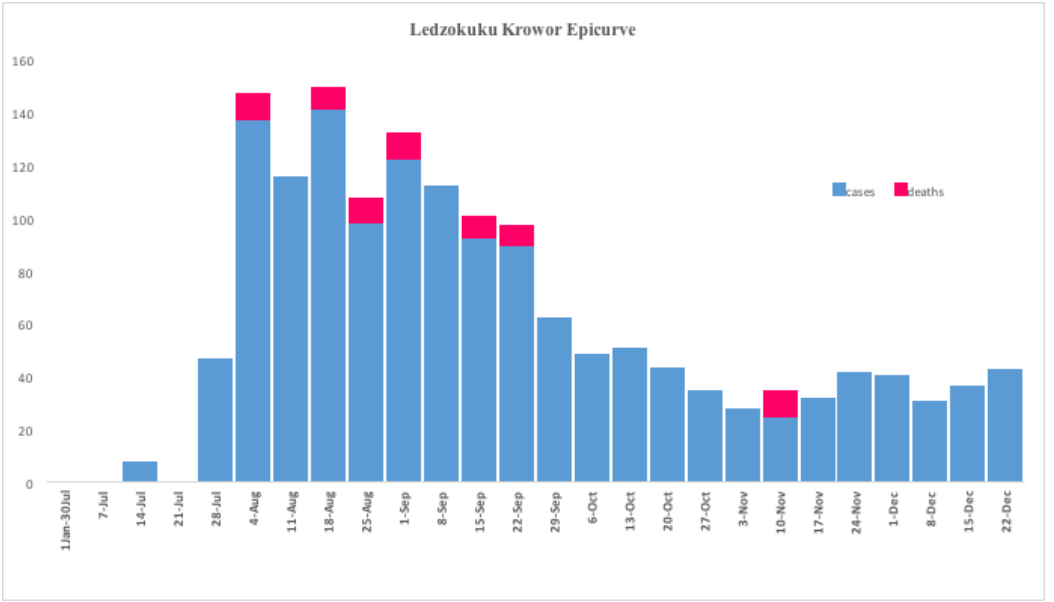


Figure 6b: Epidemic curve of the 2014 cholera outbreak for the most affected districts



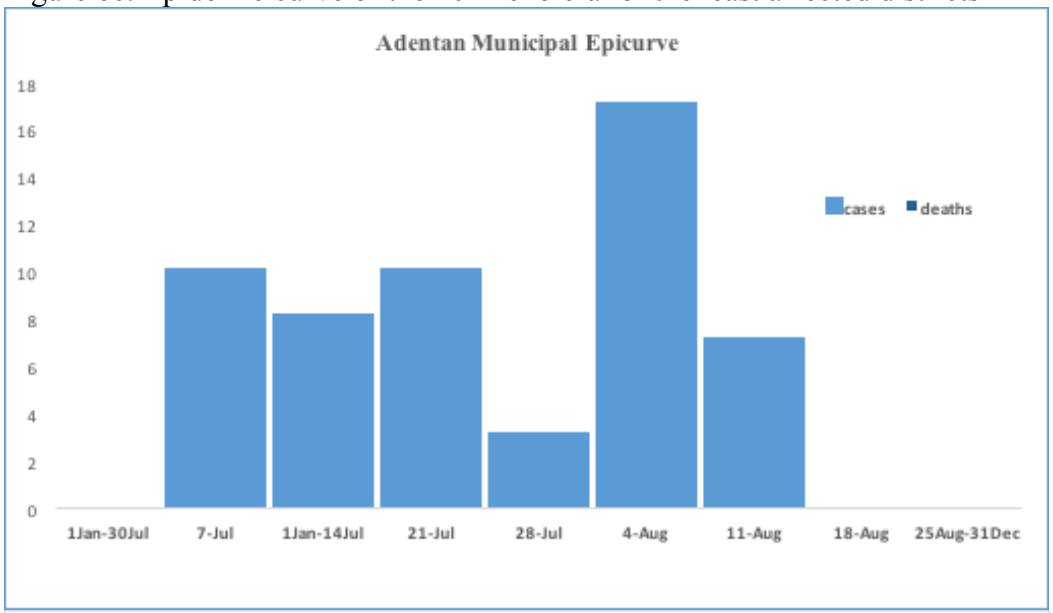


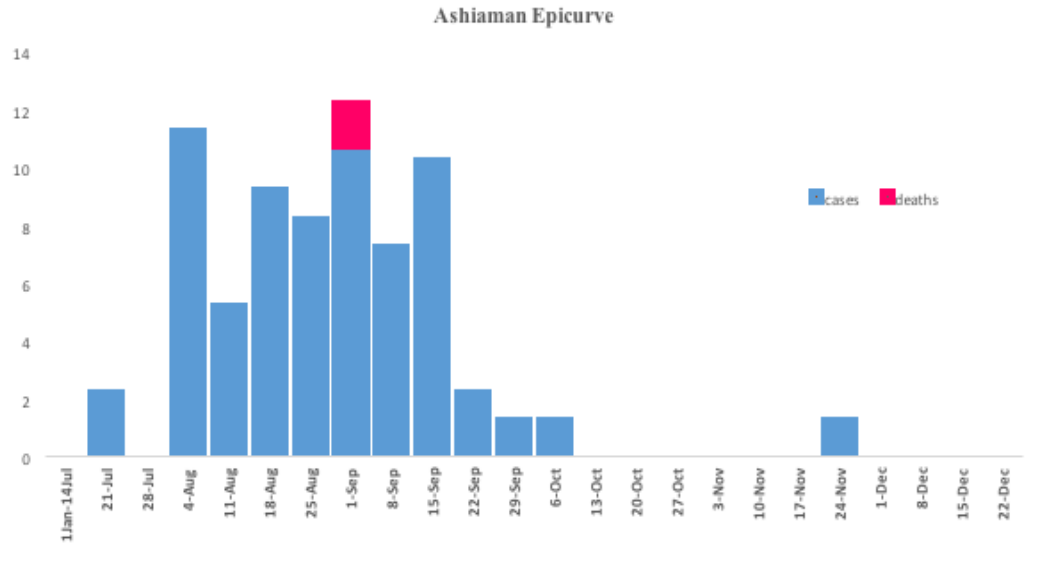


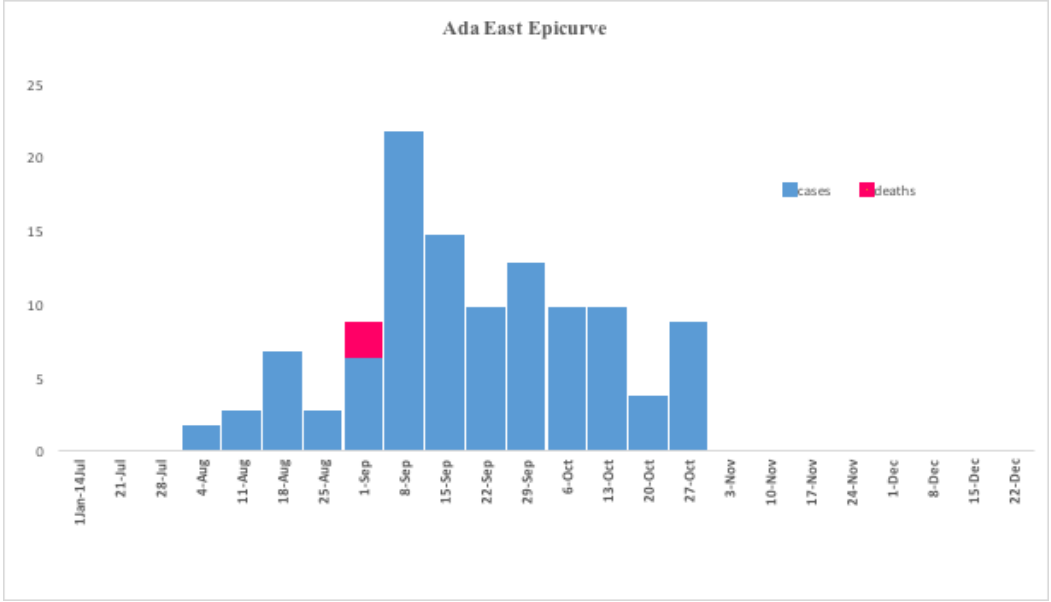


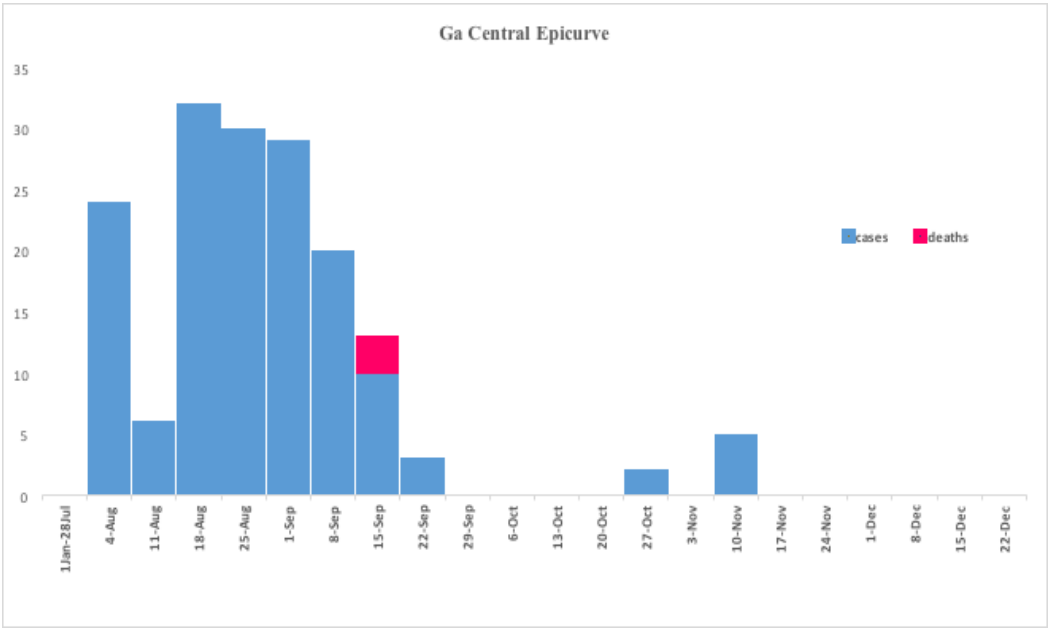
The outbreak in Accra Metro reveals a point source epidemic. Similar situation is seen in Ada East, Ga south and Ledzokuku Krowor districts.

Figure 6c: Epidemic curve of the 2014 cholera for the least affected districts



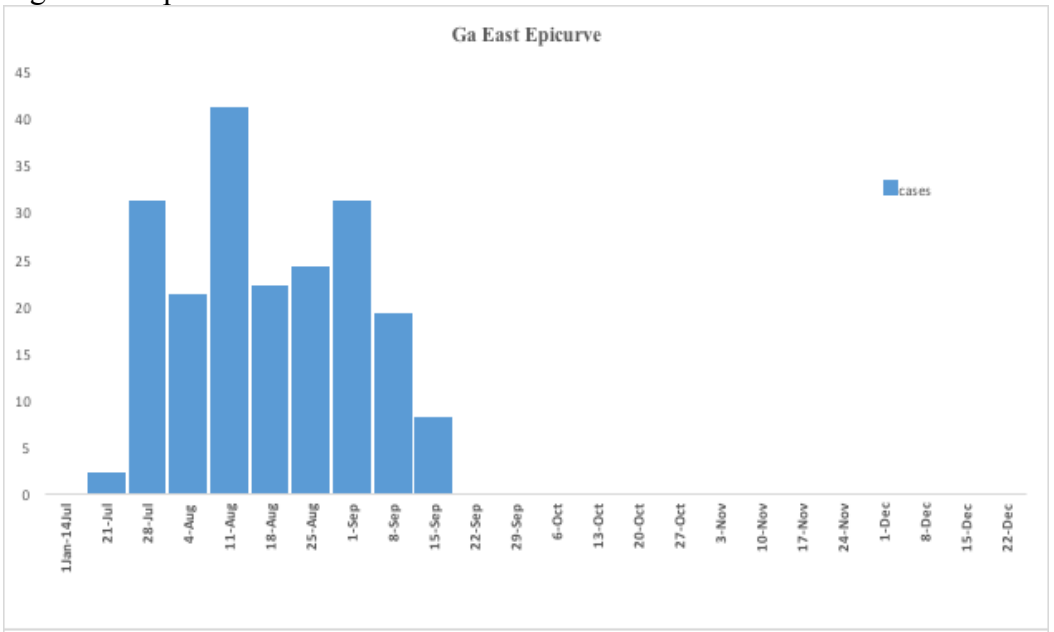


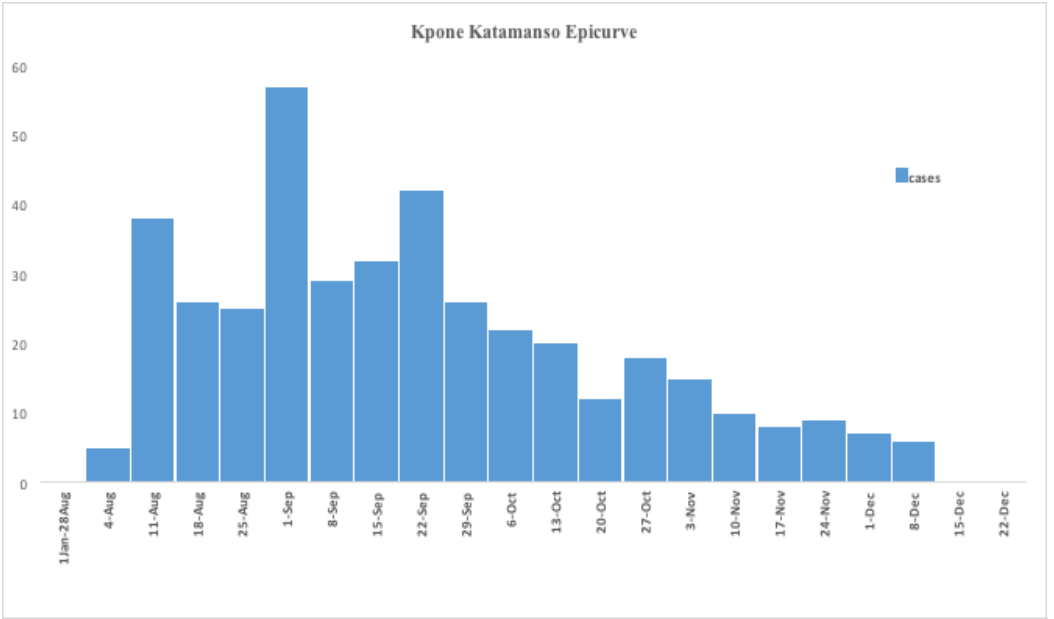


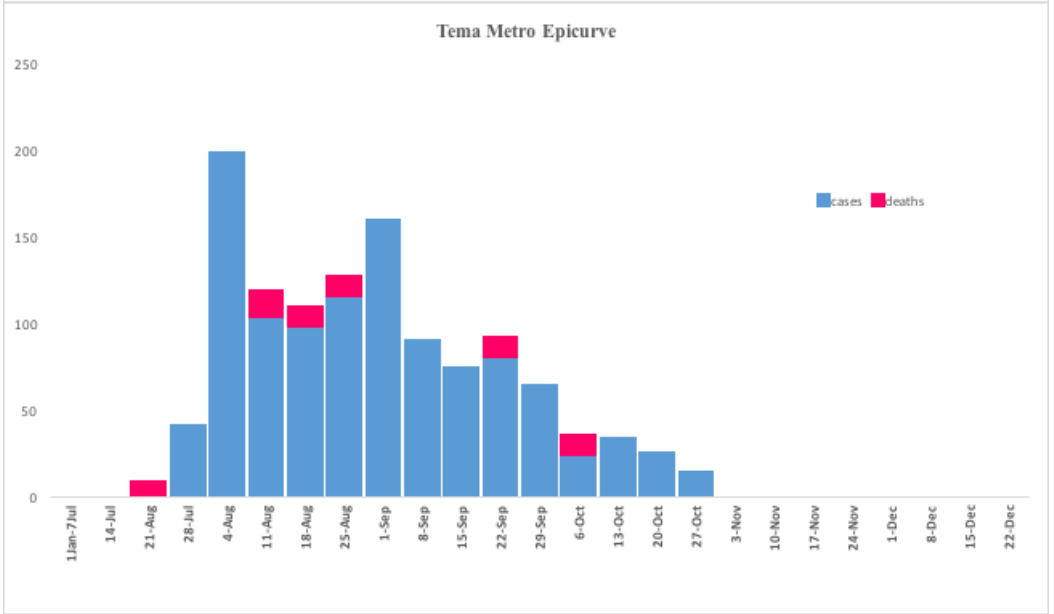


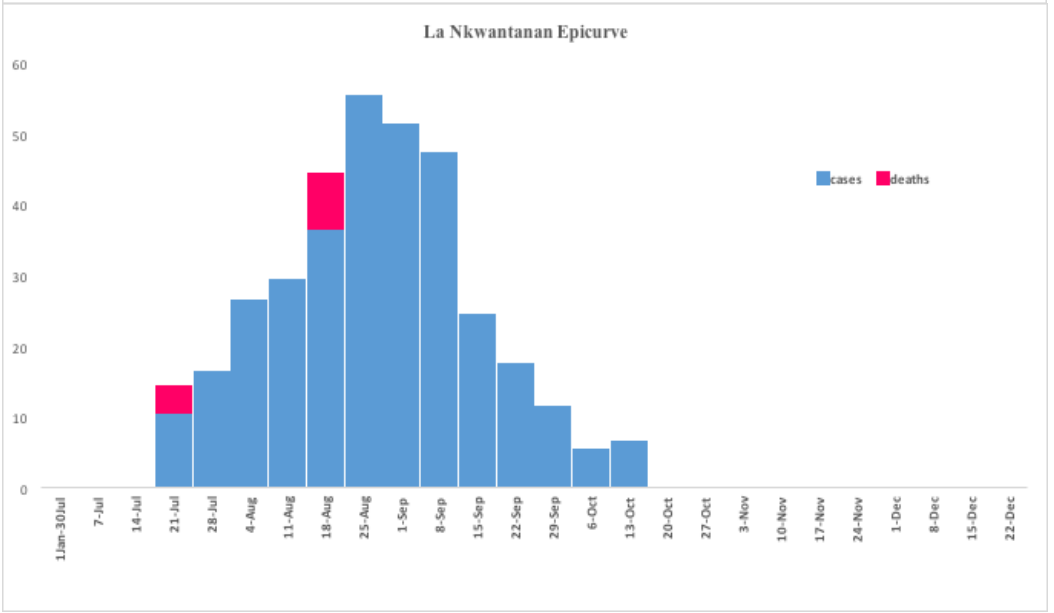
Ashiaman, Ada East and Ga central districts seem to have a point source epidemic as the most affected districts. Adentan on the other hand shows a common source epidemic curve

Figure 6d: Epidemic curve of the 2014 cholera for the other affected districts



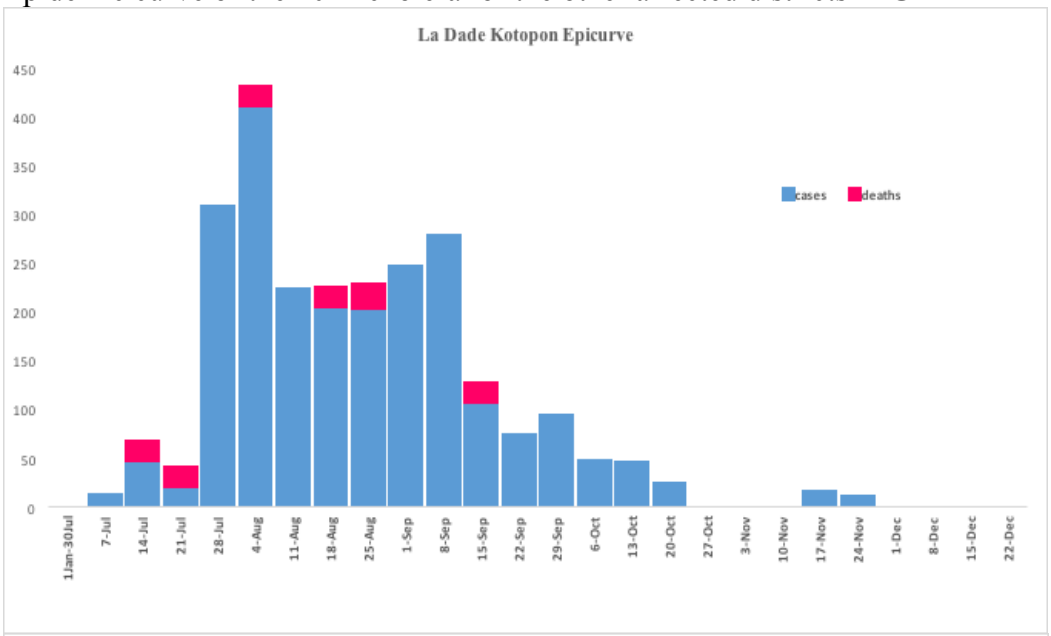


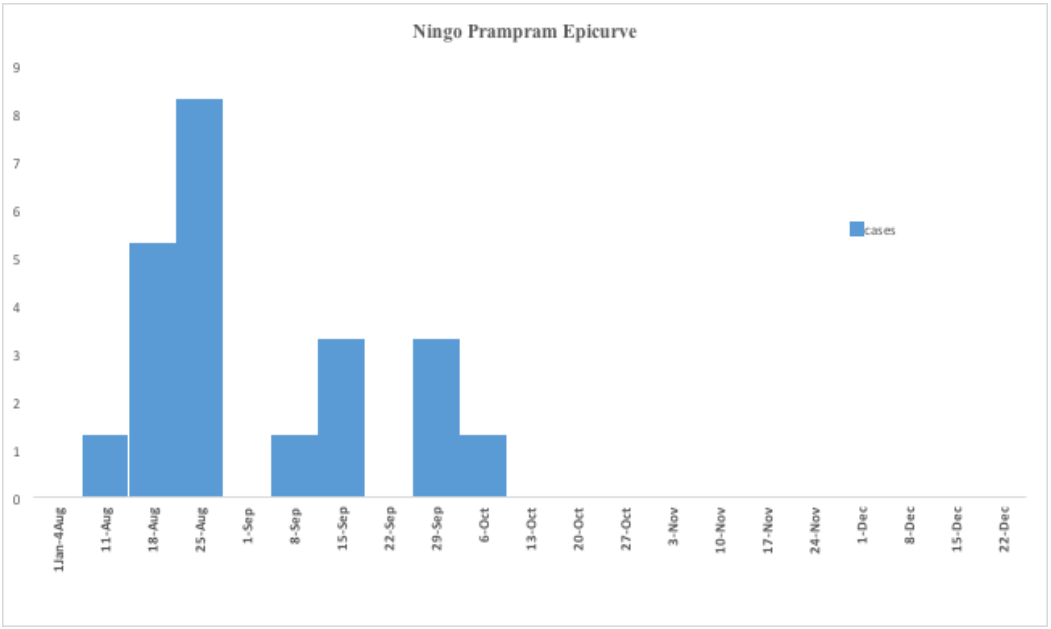


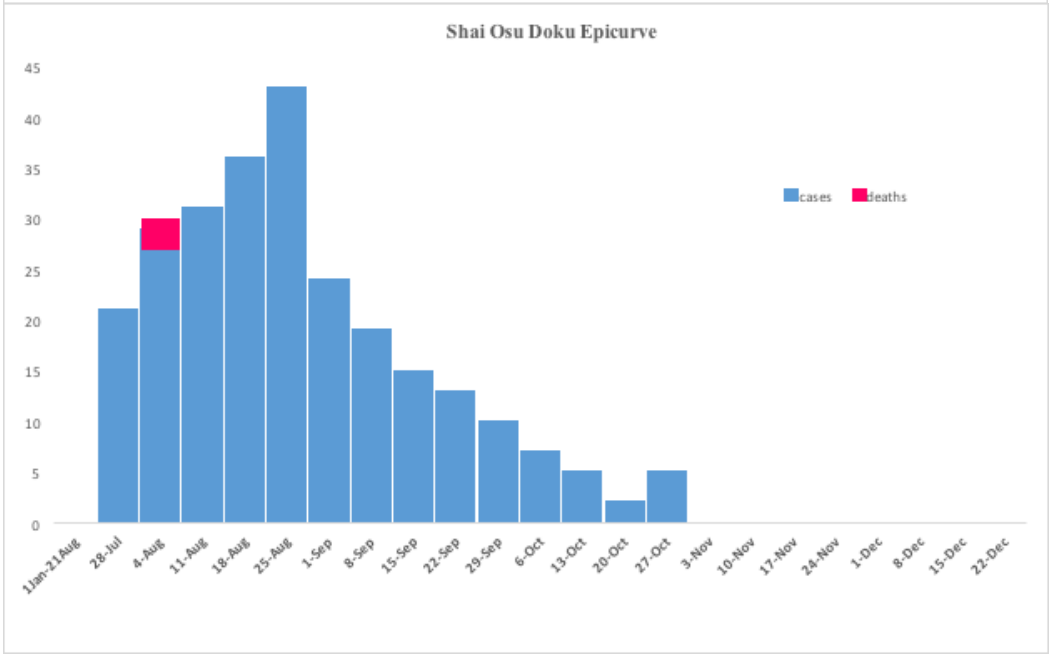


The other affected districts also show a point source epidemic curve

Epidemic curve of the 2014 cholera for the other affected districts in GAR







There were no confirmed cases recorded within the first 23 weeks in the Greater Accra region, even though there were few suspected cases at the initial stages of the year. The first positive case was confirmed at week 24. Five more districts confirmed between week 27 and 29. There were some interventions by the various districts such as the activation of the rapid response team, emergency preparedness plans, community education and alert, etc. By the 33rd week all the districts had reported cholera cases with the exception of Ada West. The epidemic reached its peak during the 35th week. This was when major interventions were put in place as a nation. Cholera was then seen as a big problem and required attention. All stakeholders including the district assemblies, Ghana water company, local government, ministry of health and Ghana Health Service, etc were brought on board to help tackle the outbreak. The magnitude of outbreak steadily reduced after 6 weeks of intervention implementation.

4.5 ENVIRONMENTAL ASSESSMENT

Environmental conditions of the communities within which index cases for the various districts lived were assessed. Pictures of the environment were taken to be able to well describe it.

The various environmental conditions within which index cases were found can be described as unhygienic and unclean. There were generally poor environment sanitation. There was crude dumping in most of the places visited. There was open defecation in some of the places. This was because most of the households did not

have a place of convenience attached to them. Inhabitants patronize the public latrines. The cesspit emptier that empties these liquid wastes end up emptying its content into the sea. There were inadequate drainage and sewage systems. Inhabitants resort to dumping at sea and in gutters when it rains. Continuous water supply was another major problem in these areas. They mostly depend on the sachet water as the safest source of drinking water.

Figure 7a: Environmental conditions where index cases resides in GAR

Insanitary environment around index cases

poor sewage system

Figure 7b: Environmental conditions where index cases resides in GAR

Insanitary environment in GAR

crude dumping in Accra metropolis

CHAPTER FIVE

DISCUSSION

This study has proven that the 2014 cholera outbreak is the highest outbreak Ghana has ever recorded in a single year over the past three decade. Until 2014, the highest outbreak the country has ever recorded was in 1982 with 15,032 cases (Gershon et al.). The 2014 outbreak affected over 28,922 individuals with 243 deaths (Weekly epidemiological bulletin, Ghana Health Service, 2015). Greater Accra's share of the 2014 cholera outbreak has also been the highest in the history of the region. It forms about three quarter of the country's total cases affected. Greater Accra region recorded a total of 20,199 cases with 121 deaths. The region recorded an attack rate of 445 per 100,000 population with a Case Fatality Rate (CFR) of 0.6%. The CFR can be said to be acceptable according to WHO (CFR should not exceed 1% if prompt and adequate care is provided) (WHO, 2013).

More than half of the total cases came from the Accra Metropolitan areas. The least number of cases were seen in Ningo Prampram district. This proportion is in line with the findings from an outbreak investigation study by Gershon et al. in 2014. They found that Accra metropolis formed 59.4% of Greater Accra total cases. This is probably due to the high population density in the metropolis.

The mean age of the cases was 29 years with a standard deviation of 6.87. About 60% (12,255/20,199) of the total cases were between the age group 20-40yrs. The same age group also recorded the highest number of the deaths with 53% (64/121). Males form 58% (11,694/20,199) of the total cases. This current findings support different

studies conducted in different parts of the world. Opare et al. in an outbreak investigation in East Akim in Ghana in 2010 recorded a similar proportion for the age group and sex distribution. They found that the most affected age group was 20 – 29 years whiles males form 56.6% of the total cases. In 2013, Wahed et al.'s cross sectional study in Bangladesh on the knowledge, attitude and preventive practices on cholera revealed that the most affected age group was 24 to 30 years and males form about 59.4% among those affected. Similar findings were seen from Dubois et al.'s study in 2006 in Zambia showed that the median age of those affected was 28 years (ranges from 5 – 75 years). They also recorded 58% of the total cases as males. All the studies reviewed show a particular trend of the most affected age group and the mean age. They happen to affect the most active and productive age group. This may be because this age group may choose to patronize street food vendors than home prepare food due to the nature of work and activities they do (schooling, working, etc) so they spend most of their times outside the home, whereas the very young and old ones will usually be home to enjoy the family food.

The trend of the epidemic has shown that the epidemic started after the rains had began (usually from April). The year started with no confirmed cases recorded for the first 23 weeks in the Greater Accra region, even though there were few suspected cases at the initial stages of the year. The first positive case was confirmed at week 24. Five more districts confirmed between week 27 and 29. At the 33rd week, all the districts in the region had reported cholera cases with the exception of Ada West. The epidemic reached its peak during the 35th week when the national interventions were initiated before the cases drastically reduced. If early national interventions were instituted after the first few cases were confirmed, a whole lot of individuals could

have been saved from getting the disease. Studies have shown that early intervention on a public health problem goes a long way to protect and preserve the lives of the people. A study such as that of Wang et al. in China in 2011 during the H1N1 pandemic, they realized that early intervention by the government through the closure of some schools and workplaces resulted in a drastic decrease in the transmission rate. (Wang et al., 2011).

Eighty percent (12/15) of the index cases interviewed had traveled or visited the Accra metropolitan areas. Communities in the Accra Metro areas where index cases visited included; Darkuman, Dansoman, Chorkor (Ablekuma sub-metro), Lapaz, Achimota (Okaikoi sub-metro), Kwame Nkrumah circle (Osu Clottey sub-metro) and Accra central (Ashiedu Keteke sub-metro). Based on the history of the index and first cases, the 2014 cholera outbreak in Greater Accra region can be linked to one point source; Accra Metro (a 10 year old girl from Agbado). Kpone Katamanso district is believed to have acquired the cholera transmission from Tema. Cholera transmission in Tema began on 19th July 2014 by which there were ongoing transmission in Accra metro, Adentan, Ashiaman, Ga west, La dadekotopon and Ledzokuku Krowor districts. Since Tema's index case was a fisherman who will usually travel along and over the sea, there is a high probability that his infection was from Accra Metro than the other districts since Accra metro also have fishing communities which surrounds the sea.

This study utilizes the advancement of the Geographic Information System especially with spatial disease mapping where the index cases were located and shows how the disease travelled within districts in the Greater Accra region. Visual observation of the map reveals heavy cholera transmission in the Accra Metropolis (as seen in figure

2), which forms the central part of the region. The transmission at the other districts can be attributed to the transmission occurring at the metropolis.

Accra metro is the most urbanized and highly commercialized district in the region. This results in high daily influx of traders, travelers, private personnel and civil workers from neighboring districts and other regions all over Ghana. Such high commercial activity of the metropolis results in straining of existing sanitation and social amenities thereby putting people at an increased risk of cholera transmission. Since the major road network linking the various sectors of Ghana pass through Accra metropolis there is a higher probability of stoppage and transit by travelers resulting in high daily population increase and overcrowding in the metropolis.

Again, people from the rural areas of Ghana especially from the three Northern regions migrate to the metropolis to seek greener pastures and with the hope of living a better life but due to high cost of living like housing they result in living in slum or squatter areas where environmental conditions are poor. Since majority of the index cases (80%) had traveled to the metropolis, this suggests that Accra metropolis (presumably Accra central) served as the point source for the 2014 cholera outbreak in Greater Accra region. This findings is similar to the results of a study conducted by Opare et al in 2010 and another by Gershon et al. in 2014 all in Ghana. They realized that high urbanization and overcrowding was a high predictor of occurrence of cholera.

Although cholera is known to be transmitted mainly through contaminated water and food, high urbanization and overcrowding which results in poor sanitary conditions in the environment is a high predictor of cholera. This is because *vibrio cholerae*

survives and multiple outside the human body and spreads rapidly in overcrowded and insanitary conditions and where there is unsafe disposal of solid and liquid waste. Such inadequate sanitary facilities coupled with intermittent supply of pipe borne water in the urban areas put the population at risk of cholera. Seawater pollution is seen to be worse in the metropolis where the commonest contamination is from human excreta and sewage. Defecating and dumping in and at the banks of the sea and has become a common practice in the metropolis and unfortunately some urban inhibitors resort to such polluted water sources for various household activities for cooking and washing during periods of water shortage. There are usually inadequate and inconsistent water supplies from the Ghana water company and so people will normally fetch water in buckets and gallons and store them for future use, which gets contaminated during the process of handling. This current findings confirms studies conducted by Emch in 2008 in a cholera outbreak in Bangladesh and another by Schaetti et al. on Tanzania's cholera outbreak in 2009, where their identified risk factors included inadequate water supply, poor sanitation and unsafe disposal of solid and liquid waste.

With the slum settlements in the metropolis such as Kokomba and Agbogbloshie, inhabitants are generally poor and face problems including access to potable water and sanitation. They are worse off than their rural counterpart in terms of access and affordability to safe drinking water and sanitation. Utility providers fail to serve the urban slum areas due to factors regarding land tenure systems, service regulation and city development plans. Such slum settlements are mostly located at areas with unfavorable topography, soil and other conditions that make it difficult to achieve and maintain high sanitation standards. This current study has proven the study by Opare

et al. in 2010 that demographic risk factors of cholera in Ghana may be the same in any similar geographic area in the country.

Although results of this study reaffirm the already known hypothesis about cholera (risk factors), what it failed to do was to look at the tendencies of the virulence of the vibro cholerae changing which could have also accounted for the large number of people affected in this outbreak. There were some limitations to this study. Records on cases reviewed at the various level may just be a fraction of cases that actually occurred since possibly there may be some unreported cases in the communities. There were difficulties in locating the homes of the index cases due to the poor addressing system in the region. There is a high tendency of recall bias occurring among index cases interviewed. This is because the interval between the time of incident (unset of cholera) and time of interview was far apart, which may result in inaccurate responses from the respondents.

In summary, the 2014 cholera outbreak in Greater Accra region affected over 20,199 individuals and claimed 121 lives. The transmission that existed at the various districts in the region can be linked to a point source in the Accra metropolis. High urbanization and overcrowding in the region that results in insanitary conditions in the environment can be attributed to the cause of the outbreak.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The results from this study can possibly be considered as one of the first studies that have successfully linked the index cases of the 2014 cholera outbreak in Greater Accra. The study has shown that the outbreak was a point source epidemic that can be linked to Accra metropolis.

The study employed records review of the line list and interview with the index cases for each district in the region and described the demographic characteristics of the cases and outbreak transmission pattern in terms person, place and time. The study revealed that over 20,199 individuals were affected by the outbreak with a case fatality rate of 0.6%. More than half of the total cases reside in the Accra metropolitan areas. The study further showed that the productive age group (20-40years) was the most highly affected. The outbreak started during the 24th week of the year and reached its peak by the 35th week when national interventions were instituted.

The study also affirms that urbanization and overcrowding resulting in insanitary conditions coupled with heavy rainfall and potable water shortage is a predictor of cholera outbreak in Ghana.

This study contributes to existing knowledge about the risk factors of the disease and the importance of early interventions. It has provided a framework that can be used for future epidemiological research on infectious and environmentally related disease.

6.2 RECOMMENDATIONS

This study has been worth the effort and investment in financial, time and material resources. The recommendations outlined below if carefully considered and implemented will go a long way to prevent future outbreak, reduce the magnitude of the outbreak and prevent lives if they occur.

National Level

1. Interventions to be employed at the early stages of an epidemic.
2. The Government of Ghana and the Accra Metropolitan Assembly should ensure provision of basic social amenities and good sanitation.

Regional / District Level

1. The regional and metropolitan/districts to ensure that interventions are employed promptly.
2. The metropolitan/districts assemblies to advocate for the provision of basic social amenities and good sanitation.
3. Continuous mass community education and promotion on cholera prevention at all levels by community health promotion officers.

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APPENDICES

APPENDIX 1: INFORMED CONSENT FOR PARTICIPATION

Research Title: Epidemiological link of the 2014 cholera outbreak in Greater Accra region.

Principal Investigator: Kennedy Ohene-Adjei.

Introduction

My name is Kennedy Ohene-Adjei, a student from the School of Public Health, College of Health Sciences, University of Ghana, Legon. I am carrying out a study to describe the epidemiological link of the 2014 cholera outbreak in the Greater Accra region.

Description of Procedures

You are being invited to participate in this study because you are one of the first individuals in Greater Accra to be attacked by cholera. The study will involve answering few self-constructed questions about your experiences before during and after you were diagnosed with cholera. Participation in the study is absolutely voluntary and no coercion will be used to obtain responses from participants. It will be much appreciated if you could participate in this study.

The study is purely academic and forms part of the requirements for the award of a Master degree in Public Health. Findings from this study will also inform decision-making about the appropriate interventions to be instituted to prevent subsequent outbreaks in the country and also provide Ghanaians with information about how the disease moves from one area to another.

Risks and Benefits

This research poses no potential risk to either to you participating or to the society. There would be a slight discomfort when the field staff visit you at home and engage you in the short interview followed by the taking of GPS coordinates and pictures of

your surroundings. However, well-trained field assistants will carry the procedure out in order to minimize time spent or any other discomfort.

There is no direct benefit to you for participation or monetary gain. However, the study is envisaged to be beneficial to both the study population and the society in many ways. To begin with, the study will provide the study population knowledge about how cholera transmission occurs from one person to another. Secondly, it will inform Ghanaians how cholera can move from one community to another. Finally, it will provide useful information for the government to institute effective measure to prevent further cholera outbreak.

Voluntary Participation

Participation in this study is voluntary and you can choose not to answer any individual question or all the questions. You are free to withdraw from the study at any time. However, you are kindly requested to fully participate in the study since your responses will help us understand the dynamics of cholera transmission.

Anonymity and Confidentiality

Participants would be given unique codes for identification. These codes will be written on the questionnaires and used during data entry analysis. Records identifying participants will be kept confidential to the extent permitted by laws and regulations and would not be made publicly available. You are therefore assured that all information provided will be kept confidential, privacy and would not be shared with anybody who is not part of the study team.

Dissemination of Results

A written report will be sent to the National surveillance unit, regional disease control unit and the district health service administration.

Before taking Consent

Do you have any questions you wish to ask about the study? Yes ( ) No ( )

If yes please indicate the questions below:

……

……

……

In case you have any questions later please, do not hesitate to contact Kennedy Ohene-Adjei (Tel: 0208956587) Or Ethical Review Committee (ERC) administrator, Hannah Frimpong on 0243235225 / 0507041223

Voluntary Consent

I have read the information provided above, or the information above has been read to me and I understand. I have been given the opportunity to ask questions regarding this study; questions have been answered to my satisfaction. I now voluntarily agree, and also voluntarily agree for my relative to participate in this study knowing that I have the right to opt out and also withdraw my relative from this study at any time without affecting future health care services.

…… ……. ……

Name of participant Signature/Thumbprint Date

…… ……. ……

Name of witness Signature/Thumbprint Date

…… ……. ……

Name of researcher Signature/Thumbprint Date

Interviewer's Statement

I, the undersigned, have explained this consent to the subject in English language/Ga/Twi, and that she/he understands the purpose of the study, procedures to be followed, as well as the risks and benefits of the study.

The participant has fully agreed to participate in the study.

Signature of Interviewer ……..

Date:…….

Address……

…….

APPENDIX 2: QUESTIONNAIRE

Location Information

Name of District: …….

Name of Community: ……

Location of index case……

GPS coordinate of location: longitude:……latitude:…….

Clients Information

Name of Index case: ……

Date of Onset of cholera: ……..

Date of Admission:…….

Date of Discharge from Hospital:……..

Please can you tell me places where you visited or travelled to within 3 to 5 days prior to the onset of the disease?

……

……

……

…….

Can you tell me if you were in contact with anyone prior to your illness. Where does the person live.

……

……

……

……

Can you explain how you got the disease (food you ate, water, etc)

……

……

……

……

Can you describe the feelings (signs and symptoms) you had when you got the disease.

……

……

……

……

Please can you tell me how you think you can prevent the disease from spreading?

……

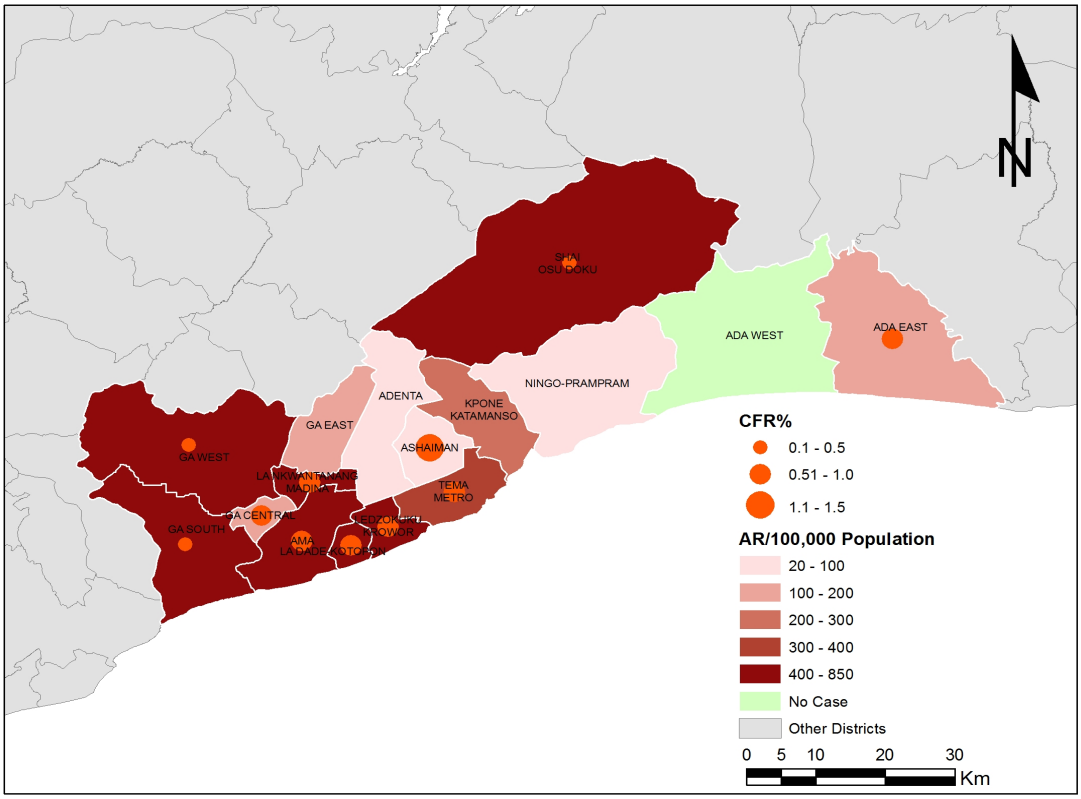
……

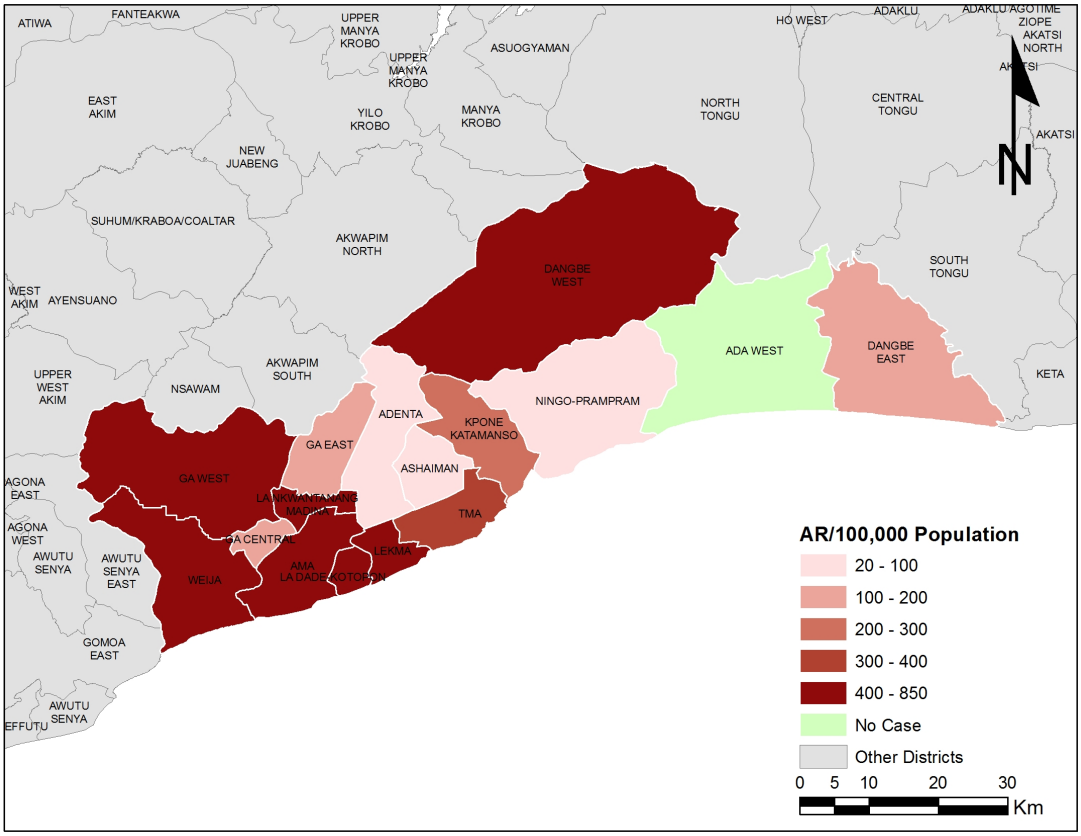
……

……

APPENDIX 3: FIGURES AND CHARTS

Attack Rate and Case Fatality Rates by districts





GIS location of index cases (Google map)

Demographic characteristics of cholera cases in GAR