UPTAKE OF PREVENTION AND CONTROL MEASURES OF PLAGUE: A POST-PLAGUE OUTBREAKS CASE-STUDY OF SINDA DISTRICT, ZAMBIA.

BY

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A Dissertation Submitted to the University of Zambia in Partial Fulfillment of the Requirements for the Degree of Master of Science in One Health Analytical Epidemiology of the University of Zambia

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DECLARATION

I, **Lottie Musenga Sinyangwe**, declare that this dissertation is a product of my own work. It is being submitted to The University of Zambia for the Degree of Master of Science in One Health Analytical Epidemiology. It has not been submitted before for any degree to this or any other University.

Signature: …………………………… Date: …………………………

CERTIFICATE OF APPROVAL

The University of Zambia approves the dissertation submitted by **Lottie Musenga Sinyangwe**, as fulfilling the partial requirements for the award of the Master of Science Degree in One Health Analytical Epidemiology by the University of Zambia.

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DEDICATION

This dissertation is dedicated to a dear brother Victor Mpazi Sinyangwe (1976 to 2012). As long as life and memory lasts, I will always remember your support toward my seemingly unending graduate project. You could have lived to see this end.

ABSTRACT

Zambia's recent plague outbreaks in 2001 and 2007 were of great public health concern because of the potential to cause devastating social, environmental and economic effects in the country. Plague is a virulent vector-borne zoonotic disease caused by *Yersinia pestis* and has potential to infect humans and cause fatalities in 50 to 100 percent of cases if left untreated. The disease is known to have had reduced the world population in the 14th century from an estimated 450 million down to near 350 million. Consequently, plague remains a global public health threat. As an active plague foci, Sinda District remains under alert for subsequent outbreaks.

Effective efforts on prevention and control of plague requires targeted approaches designed on the basis of adequate information on determinants of the uptake of plague prevention and control measures (PCM). This study, therefore, was conducted on the premise of understanding factors that determine uptake of PCM.

The study involved a cross-sectional survey design where two villages (Nyanje and Nsato) where purposively selected before the selection of 178 households using multistage sampling. From each household, a respondent (head of household or knowledgeable elderly person) was interviewed. Additionally, two key informants' interviews and one focus group discussion supplemented information. The significance of explanatory variables influencing the uptake of PCM was determined using multiple logistic regression analysis in Statistical Package for Social Sciences (SPSS) with statistical significance set at $P \leq 0.05$.

The study population comprised mainly of female (61 percent). Majority (52 percent) are indigenous to the study area. With only 43 percent having attained only primary education, most of the study participants depend on faming and trading (43 and 50 percent respectively) for their livelihoods. Multiple logistic regression showed significant associations between literacy; sources of livelihoods; knowledge and perceptions (about plague and measures); source of information about plague outbreaks and the uptake of PCM. Participants who attained at least primary level of education are 79 percent likely to take up PCM than those who have never been to school. It is further established that farming as a source of income reduces odds of taking up PCM by 1 percent compared to 84 percent likelihood of taking up PCM when trading is a source of income. The odds of taking up PCM are positive with knowledge about plague and radio as source of information about outbreaks. However, demographic characteristics are not associated with uptake of PCM.

The study has established that socio-economic factors such as education, source of livelihoods, source of information and perceptions about plague outbreaks are key determinants of the uptake of PCM. This in particular recommends design of strategies that will cogitate the significant effect of these key determinants.

ACKNOWLEDGEMENTS

Lord, great is thy faithfulness. Thank you for giving me hope in my times of despair. I submit all unto you and remain hopeful today and forever.

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To *Mzee* Johans (a brother and boss), your support in all spheres made me walk the much-needed step ahead of the finishing line towards accomplishment of my heart's desires. I remain grateful to you. I equally express my gratitude to Mr. Simasiku for the great wisdom and insights you imparted to my personal growth in my spiritual and secular spheres of life.

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LIST OF ABBREVIATIONS

CBG	Census Block Groups
CDC	Centers for Disease Control and Prevention
CFR	Case Fatality Rate
CSO	Central Statistical Office
EHT	Environmental Health Technologist
FGD	Focus Group Discussion
HBM	Health Belief Model
OR	Odds Ratio
PCM	Prevention and Control Measure
PEP	Post-Exposure Prophylaxis
PSU	Primary Sampling Unit
SSU	Secondary Sampling Unit
SPSS	Statistical Package for Social Sciences
UN	United Nations
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.0. BACKGROUND

Plague is a virulent vector-borne zoonotic disease transmitted from rodents mainly through the bites of infected fleas, most often the rat flea known as *Xenopsylla cheopsis*. The disease has potential to infect humans and cause human fatalities if left untreated (WHO, 2008; Dennis *et al.*, 1999). The disease is caused by *Yersinia pestis*, a naturally occurring bacterium found primarily in wild rodents. Other animal reservoirs of *Yersinia pestis* include rats, squirrels, mice, prairie dogs, domestic cats and gerbils (Eidson *et al.*, 1988). Having occurred recently in Zambia in 2001 and 2007, plague was also responsible for the greatest decline in the world population during the 14^{th} century from an estimate of 450 million down to 350–375 million (Byrne, 2004).

Plague maybe considered a disease of the past. Zinsser (1934) described plague as "one of the major calamities of history, not excluding wars, earthquakes, floods, barbarian invasions, the crusades, and the last war (World War I)". However, it remains a public health threat in many parts of the world, but particularly in Sub Saharan Africa (WHO, 2008) where both the number of cases and the number of countries reporting plague have increased in the recent decades (Stenseth *et al.*, 2008). Public health experts recognize plague as a re-emerging infectious disease (Schrag and Wiener, 1995) which remains the world's deadliest bacterial disease. Bubonic plague has a mortality rate which stands at 50 to 90 percent if untreated. The pneumonic and septicaemic forms tend to be fatal in most cases and mortality rate may reach 100 percent if left untreated (Tieh *et al.*, 1948; Butler, 1983; Poland and Dennis, 1999) hence there should be no delays in diagnosis and treatment. The severity of its socio-economic burden makes it to remain one of the three epidemic diseases (besides Yellow fever and Cholera) which are subject to the International Health Regulations and notifiable to the World Health Organization (WHO).

In light of the above, it is essential to understand the factors partly responsible for the long persistence and continued outbreaks of plague. Other researchers such as Schotthoefer *et al* (2012,) Ben-Ari *et al* (2011) and Kilonzo *et al* (1997) have established some factors playing an important role as determinants of plague outbreaks. In his study findings, Kilonzo (1997) revealed that socio-cultural, biological and environmental factors are at least partly, responsible for the long persistence and repeated outbreaks of plague in Lushoto district of Tanzania. The specific factors Kilonzo identified included among others the negative traditional beliefs on the cause and health seeking behaviour for treatment of plague, sleeping and food storage habits, large populations of rodents and fleas, and status of the immediate environment (Kilonzo *et al.*, 1997).

In many Sub-Saharan countries, main prevention strategies used are vector and reservoir control, epidemiological surveillance, early case management, outbreak control, public health education (community education for plague prevention) and operational research (Randriambelosoa, 2008). Prevention also includes isolation of all patients undergoing treatment for the first 48 hours after initiation. Mainly, treatment is initiated with antibiotics like streptomycin and tetracycline that have been found to be effective in treatment of all clinical forms of Plague. Sulfonamides are indicated for the treatment of bubonic plague only (Griffith, 2008). Post-exposure prophylaxis (PEP) with antibiotics such as doxycycline and ciprofloxacin are administered to asymptomatic individuals (Poland and Dennis, 1997).

In Zambia, plague outbreaks have been observed after many years of silence in three regions namely Northwestern, Eastern and Southern provinces (Worsfold, 1955; McClean, 1995; Mwase *et al.,* 1999; WHO, 2001; UN, 2008). This indication that plague can re-emerge in areas that have long remained silent (WHO, 2008) makes plague an epidemiological threat and a disease of major public health importance. Future studies should, therefore, assess associations between persistent outbreaks and possible risk factors such as socio-cultural, biological and environmental factors which have been associated with long persistence and repeated outbreaks of the disease in other endemic areas outside Zambia.

Furthermore, it is assumed that people's levels of knowledge, beliefs, perceptions and attitudes influence their health behaviors, which ultimately determine their response to use or not to use preventive services offered by public health departments to prevent plague in their communities. Understanding of factors influencing people's responses toward plague management interventions administered in their communities sets the beginning for targeted approaches to prevention and control of plague in a target area.

1.1. PROBLEM STATEMENT

Plague outbreaks have been observed to emerge and re-emerge in poor communities of Sub-Saharan countries (Tikhomirov, 1999) that include Democratic Republic of the Congo, Madagascar, Tanzania, Uganda, Angola, Zambia, Mozambique, Zimbabwe, Malawi, South Africa, Lesotho, Botswana, Kenya, and Namibia . Moreover, Zambia has not been spared from plague outbreaks as observed in the study areas (villages of Nyanje and Nsato) in Sinda district) where outbreaks have been reported to re-emerge a decade after initial outbreak (UN, 2008). The study sites have further been confirmed as active foci and plague endemic sites by clinical investigations conducted almost a decade after the last outbreak (Nyirenda, personal communication).

This study targeted an area in Eastern Province where plague outbreaks occurred more than once in a decade. In March 2001, the first outbreak recorded a total of 436 suspected cases of bubonic plague in humans (including 11 deaths) (WHO, 2004). Despite the health education messages on the prevention of the disease implemented after the first outbreak, the United Nations reported 32 cases of plague in 2007 (UN, 2008). In other parts of Zambia, outbreaks have occurred, including the deadly outbreaks of the period December 1996 and February 1997 reported in Namwala district which resulted in 267 human cases and 26 deaths (Mwase *et al.*, 1999). However, another outbreak a decade later (2007) led to 4 deaths within the same district of Namwala (Daily nation, 2007).

It is apparent from previous reports that plague can re-emerge in areas that have remained silent. Plague consequently remains an epidemiological threat and a disease of major public health importance. Lack of information about effectiveness of control and prevention measures of plague implies that even the responses initiated during outbreaks are not likely to be targeted by design because of the failure to incorporate factors significant in the uptake of such measures. There is need, therefore, to quickly and accurately identify those factors that will make prevention and control measures more effective and efficient. Such information is not available in the Zambian context. Despite being an exceptionally virulent disease, no studies so far were found to have systematically documented the factors influencing uptake of prevention or control interventions in Zambia.

1.2. JUSTIFICATION OF THE STUDY

For Sinda district, this study was prompted by the reported major outbreaks of 2001 and 2007 and the aim was to generate information necessary to guide policy making and health promotion effectively. This study is important because it has established some factors associated with the uptake of prevention and control measures (PCM) of plague. Information on the factors associated with uptake of PCM is not available in Zambia because no study has been conducted to the magnitude and with specific focus as this study. Ultimately, clinical, medical and environmental management staff will be guided in designing of appropriate interventions in which the community will promptly and fully participate in adoption of effective PCM against plague. This has inherent benefits, including creating efficiencies because resources will be dedicated on those that are most at risk and taking into consideration factors making the adoption of interventions more desirable.

In Zambia, this study was the first to investigate in-depth the factors significant in the uptake of PCM of plague. This study provided partial understanding of why plague outbreaks are persistent despite introduction of preventive and control measures. Results of this study will be shared with health personnel directly involved in the design and implementation of PCM so that uptake levels for similar interventions are enhanced.

1.3. RESEARCH QUESTION

What factors determine or predict the likelihood of taking up recommended prevention and control measures of plague?

1.4. OBJECTIVES

1.4.1. General Objective

To determine factors associated with uptake of prevention and control measures of plague in Sinda district of Zambia.

1.4.2. Specific Objectives

1.4.2.1. To determine factors associated with uptake of prevention and control measures among people of Sinda district.

1.4.2.2. To assess the prevention and control measures used by people of Sinda district during the plague outbreaks.

CHAPTER TWO

LITERATURE REVIEW

2.0. GENERAL OVERVIEW OF PLAGUE

This section examined the detailed epidemiology of plague through plague characteristics (aetiology, transmission, diagnosis), distribution and occurrence, prevention and control measures (PCM), the factors associated with uptake of PCM and the historical impact of plague.

2.1 CHARACTERISTICS OF PLAGUE

Sometimes referred to as the "black death", Plague is one of the serious infectious diseases cause by a zoonotic bacterium called *Yersinia Pestis*. The bacteria are naturally found in small animals and their fleas. Its transmission between animals and humans occurs by the bite of infected fleas, either via direct contact or inhalation. However, transmission may rarely take place through ingestion of infective materials. Plague usually persists in areas that are overcrowded, with poor sanitation and where the population of rodents may be large (WHO, 2016).

Chamberlain (2003) noted that plague assumes three major clinical forms in humans: bubonic, pneumonic, and septicemic. He further reported that flea bites usually cause bubonic plague or 'Black Death' and that bubonic plague is the most common form of naturally occurring plague and is characterized primarily by swollen, tender lymph nodes (called buboes). Pneumonic plague is the result of *Yersinia pestis* infection of the lungs. It results from inhalation of *Yersinia pestis* bacteria and maybe expected following an aerosol attack with *Yersinia pestis* (Wang et al., 2011). Pneumonic plague is the most feared form because it can readily be transmitted from person-to-person via inhalation of contaminated airborne droplets (Sebbane, 2006). The case fatality rate is close to 100 percent if no antibiotic treatment is given within the first 48 hours following symptoms onset of Pneumonic plague (Koirala, 2006). Furthermore, Chamberlain described septicemic plague as resulting from the multiplication of plague bacteria in the blood and disseminating throughout the body. It usually occurs as a result of untreated bubonic or pneumonic plague.

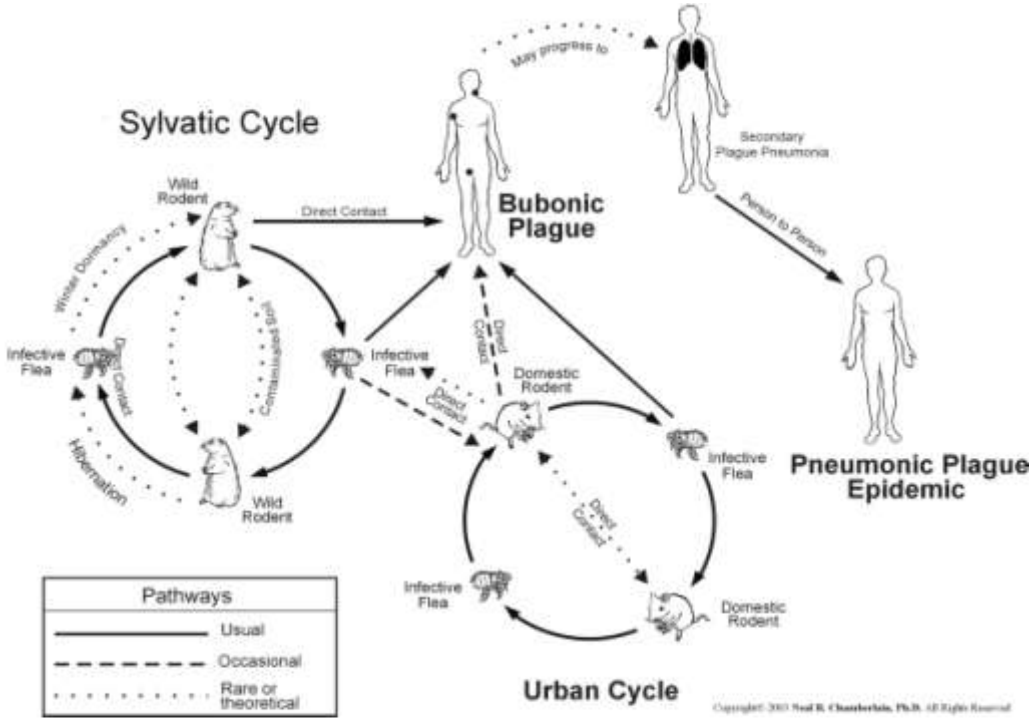


Figure: 1.0. Plague cycle. Source: Neal R. Chamberlain (2003).

In Table 1.0., Chamberlain (2003) describes the maintenance of *Y. pestis* in rural and urban populations where the bacteria are known to move from flea to rodent and vice-versa. However, transmission of plague to human occasionally occurs when there is contact with infective animals (Perry and Fetherston, 1997; Chamberlain, 2003). Human to human transmission occurs in pneumonic plague which is highly infectious and rapidly fatal (Wren, 2003). This is where the spread occurs via the respiratory droplets between humans. However, this type of epidemic is currently uncommon due to the advent of effective antibiotics and modern public health measures. The other mode of transmission is by inhaling droplets expelled by the coughing of a plague-infected animal like house cats (Doll *et al*., 1994). This can result in plague of the lungs (plague pneumonia).

Plague can persist in the environment without living rodents (Casman and Fischhoff, 2008). Even at near- freezing temperatures, plague can live for years making it possible for animals to become infected and initiate new enzootic cycles when they dig through contaminated soil (Butler *et al*., 1982; Drancourt *et al*., 2006). The hoofed animals are rarely infected thereby posing little threat to humans. Despite being resistance to plague, birds are capable of transporting infected fleas between susceptible hosts. House mice can be infected with *Yersinia pestis* but they have not been implicated in human plague (Zhao, 2001; Mittal *et al*., 2004).

Since plague is not a common disease as malaria in many parts of Sub Saharan Africa, the early signs of the disease are sometimes mistaken for flue and other illnesses such as chills, body weakness, and fever. This affects the efficacy of treatment because successful treatment depends on the use of appropriate antibiotics to be administered within a narrow time frame (Blue, 2001). Plague cases must be accurately defined to guide public health interventions. Cases are defined under three broad categories. Suspected cases are those cases lacking laboratory confirmation but symptoms are consistent with plague. However, when *Yersinia pestis* has been isolated and identified by cultural characteristics, biochemical characterization and specific bacteriophage typing, or when there is a four-fold rise in antibody titres against *Yersinia pestis* for paired acute phase and convalescent phase serum samples, such cases must be classified as confirmed (Gage, 1997).

2.3. DISTRIBUTION AND OCCURRENCE OF PLAGUE

In the history of plague, three great world pandemics have been recorded (Frith, 2012). The first pandemic being the Justinian Plague of 541 AD which started in Central Africa and spread to Egypt and the Mediterranean. The second great plague is recorded as the Black Death of 1347 and believed to have originated in Asia and spread to the Crimea then Europe and Russia. Finally, the third pandemic was that of 1894 which was documented as having originated in Yunnan, China, and spread to Hong Kong and India, subsequently to the rest of the world. (Chtman *et al.*, 1999). All the three great plague pandemics had different geographic origins and paths of spread.

2.3.1. Global Distribution and Occurrence of Plague

Worldwide, plague pandemic is active in the modern days, although many still classify plague as a disease of the past. The natural foci of plague occur on all inhabited continents, except Australia, in areas where populations of suitable rodent reservoirs and flea vectors are found.
The disease has not been completely eradicated as evidenced from active plague-endemic foci persistent in Africa (the most affected continent), Asia, South America, and North America (WHO, 2009). The worldwide plague incidence is alarming and has reached approximately 2,000 to 3,000 reported cases each year (Figure 2.0) South America, and North America (WHO, 2009). Currently around 2000 cases occur annually, mostly in Africa, Asia and South America, with a global case fatality rate of 5 to 15 percent (WHO, 2012).

For instance, the WHO reported that the worldwide incidence in 2002 and 2003 was 1925 cases (with 177 deaths) and 2,118 cases (with 182 deaths) respectively (WHO, 2005). In the period 1992 to 2001, WHO reported 28, 956 cases with 2064 deaths from 22 countries of which 80.3 percent of cases and 84.5 percent of deaths were from Africa. However, global case fatality rates (CFRs) were seen to have increased from an average of 7.1 percent per year in the period 1992–2001 to averages of 9.2 percent and 8.6 percent in 2002 and 2003 respectively. This increase in the number of cases (Figure 2.1) has aroused interest in plague as an emerging infectious disease.

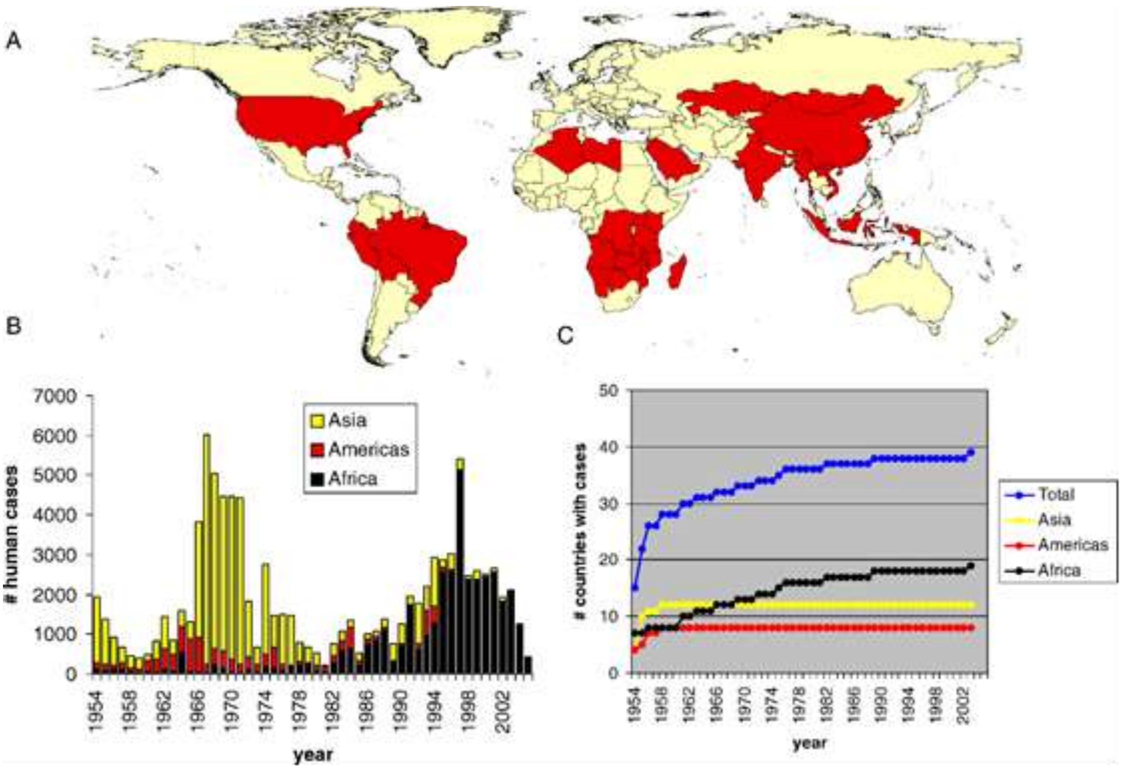


Figure 2.0. The Global Distribution of plague from 1954-2002. (A) Map showing countries with known presence of plague in wild reservoir species (red) (WHO, 2005). (B) Annual number of human plague cases over different continents, reported to WHO in the period 1954–2005. (C) Cumulative number of countries that reported plague to WHO since 1954. Source: Stenseth *et al* (2008)

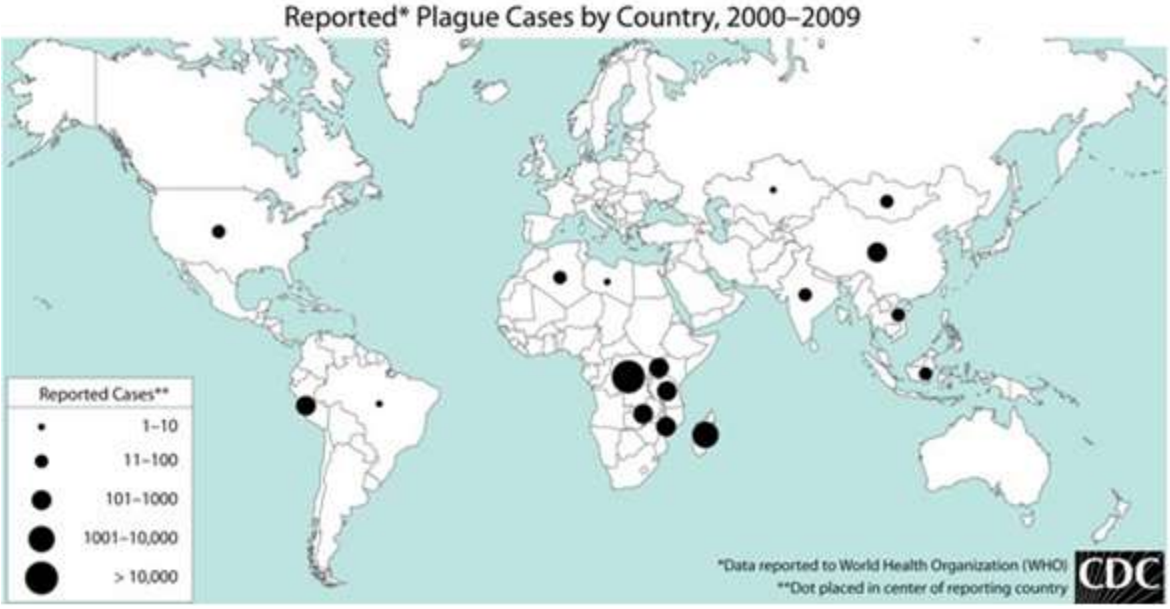


Figure 2.1. The Global Distribution of Plague 2000-2009. Source: CDC (2013).

2.3.2. Plague Distribution and Occurrence in Africa

Today, most human cases of the plague occur in Africa (WHO, 2016). According to the World Health Organization's Global Alert Response (2015), four (4) countries (Madagascar, Democratic Republic of Congo, Uganda and United republic of Tanzania) regularly report cases and have recorded 3,124 cases with 519 deaths in the period 2010-2015. Madagascar is one plague endemic island where outbreaks have resurfaced nearly every year since 1980. Currently, 263 cases, including 71 deaths have been recorded, making Madagascar the country most severely affected by plague worldwide over the past 3 years (WHO, 2015).

In the specific period of 2002-2003, six countries in the Sub-Saharan region (Democratic Republic of the Congo, Madagascar, Malawi, Mozambique, Uganda and the United Republic of Tanzania) reported a total of 1,822 cases (with 171 deaths), representing 94.6 percent (with 96.6 percent) of the corresponding world totals. In 2003, 5 countries (Algeria, Democratic Republic of the Congo, Madagascar, Mozambique and Uganda) reported 2,091 cases with 180 deaths. These figures represent 98.7 percent and 98.9 percent of the corresponding world totals (WHO, 2004). Except for Algeria, all the other countries in which human plague is active are located in the southern and eastern regions of which the most heavily affected African countries share boarders with Zambia (Democratic Republic of the Congo, Mozambique, and the United Republic of Tanzania except for Madagascar and Uganda). Zambia, therefore, remains at high risk of experiencing future plague outbreaks if effective measures are not instilled.

2.3.3. Plague Distribution and Occurrence in Zambia

According to Mwase *et al* (1999), Zambia observed its first confirmed major outbreak of plague between December 1996 and February 1997 (when 267 human cases resulted in 26 deaths) (Mwase *et al.*, 1999). However, McClean (1995) had earlier documented 3 cases of plague, all with pneumonic involvement in a small village in Zambezi district (Figure 3.0) in December 1993. McClean (1995) argued that the 1993 outbreak represented the third recognized outbreak of plague following the first and second outbreaks of January 1936 and December 1954 (Worsfold, 1955). McClean (1995) reported that no written records of the 1936 outbreak have survived but it is believed the outbreak was successfully terminated by burning involved villages and relocating the villagers. Furthermore, the outbreak of 1954 was characterized by bubonic plague (7 cases) and septicemic plague (2 cases). The 1954 outbreak was fatal with 5 deaths out of 9 cases (Worsfold, 1955).

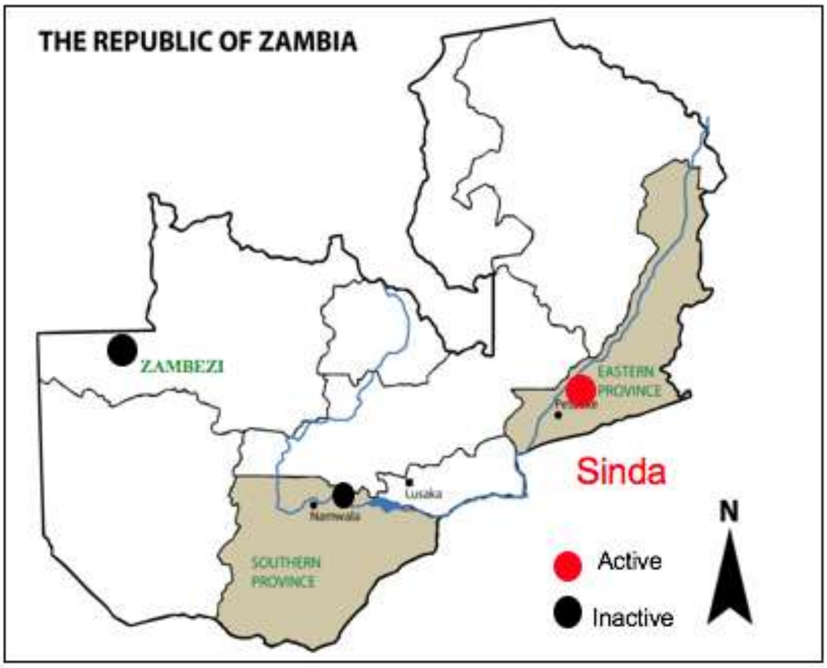


Figure 3.0. Plague foci in Zambia. Source: Hang'ombe et al (2012).

All the countries sharing boarders with Zambia (except Angola) reported confirmed cases of plague between 1989 and 2003 (WHO, 2004). During the same period, Zambia reported 319 confirmed cases of human plague with 26 deaths in 1997 and 850 cases with 3 deaths in 2001. However, 436 cases of bubonic plague in humans (with 11 deaths) were suspected in Nyanje area of Sinda district in early 2001 (WHO, 2001). Despite implementation of interventions on prevention and control of plague after the 2001 suspected outbreak, another outbreak involving 213 reported cases and 2 confirmed deaths was rcorded in the same area of Sinda district in 2007 (United Nations, 2008; Neerinckx et al., 2010). In the same year of 2007, a suspected outbreak of plague was recorded in Namwala district. The Namwala district outbreak involved 60 reported cases and led to 4 deaths (Hang'ombe et al (2012). Currently, there exist active foci, mainly in the Eastern Province. The latest suspected outbreak had affected 13 people in Kavyeni village of Nyimba district and led to 3 deaths in 2015 (Herriman, 2015). Furthermore, active foci have been confirmed via clinical investigations (Nyirenda et al, 2016) suggesting that plague outbreaks may easily occur in Zambia.

2.2. PREVENTION AND CONTROL OF PLAGUE

In many sub Saharan countries, such as Madagascar, the main prevention strategies used are vector and reservoir control, epidemiological surveillance, early case management, outbreak control, public health education (community education for plague prevention) and operational research (Randriambelosoa, 2008). Prevention should also be done by isolation of all patients undergoing treatment for the first 48 hours after initiation. According to Burmeister and others (*1*962), pneumonic plague requires strict, rigidly enforced respiratory isolation procedures, including the use of gowns, gloves, and eye protection due to its virulence. They furthermore advise that patients with pneumonia must be in isolation until completion of at least 48 hours of antibiotic therapy and with shown favorable clinical response. However, those patients who have not exhibited any pneumonia or draining lesions at 48 hours may be taken out of strict isolation. In all this, care must also be observed when handling blood and other discharge like bubo aspirates.

Plague control measures must include insecticide use on rodents (which is effective because constant preening distribute the insecticides over their bodies after picking up dust and carrying it to their nests (Cavanaugh *et al.*, 1982) in addition to environmental sanitation (to reduce sources of food and shelter for rodents) and periodic rat capture for laboratory analysis. Reduction of rodent populations may include periodic bush clearing, removal of potential rat habitats in houses, promotion of rat-proofing devices and use of chemicals such as cholecalciferol (Cavanaugh *et al.*, 1982; Butler, 1989). However, killing of rodents releases substantial amounts of infected fleas hence fleas must always be targeted before rodents (Dennis *et al.*, 2005). The fleas (vector) which carry *Yersinia pestis* live on wild rodents (the reservoir such as rats, mice etc.) and when rodents' die-off, the fleas are driven off. The Centers for Disease Control and Prevention (CDC) (2015) reports that when fleas are driven off the dead rodents, the hungry fleas would seek other sources of blood. However, the released infected fleas may end up biting humans and infecting them with the disease. This is the reason why fleas must first be killed before the rodents. It is therefore, not recommended for people to visit places where rodents have recently died from plague because they are at risk of being infected from flea bites driven off the dead reservoirs (CDC, 2015).

There are effective ways of controlling plague. The concept of "one health" is one of those effective approaches involving the coming together of human, animal and environmental health. The veterinarians dealing with livestock and wild animal populations, the environmental health technicians examining biodiversity and the public health experts work together in disease surveillance, management, and eradication. When this happens, there are more rapid resolution to disease outbreaks.

In the control of plague, the health of livestock and wild animals is very important. Veterinarians ensure that livestock and animals are safe from blood sucking fleas through the use of insecticides. This prevents infected fleas from reaching humans who are in contact with livestock and animals. It is also important to ensure that soil and water recourses are never contaminated with manure which contains a great variety of zoonotic bacteria (Flynn, 1999). This is achieved with appropriate livestock and animal management. Ecologists are thus important in promotion of environmental safety so that contamination with zoonotic bacteria is contained. Public health experts play a critical role in preventing the ingestion of *Yersinia pestis* or simply *Y. pestis* by ensuring that food contamination is avoided. All efforts by veterinarians, ecologists and public health experts are targeted at preventing the transmission of *Y. pestis* from animals or the environment to humans.

The interface between humans and animals has become narrower today. For instance, in the tropical climate where biodiversity is high, a danger of new diseases is prominent as result of opening up these areas due to human practices (such as deforestation) and population growth (Wolfe, 2007). In this regard, management of biodiversity becomes key in the control of plague and other zoonotic bacteria by reducing probability of human exposure to *Y. pestis* transmission from wildlife, such as wild rodents. The only way of controlling plague is thus to avoid contact with rodents and any associated animals as shown in Figure 1.0.

2.4. FACTORS ASSOCIATED WITH UPTAKE OF PREVENTION AND CONTROL INTERVENTIONS

The uptake of prevention and control interventions maybe determined by a complexity of factors which are associated to the long persistence and repeated outbreaks of human plague in most identified endemic plague foci where it has been characterized by decades of silence (WHO, 2008). Kilonzo *et al* (1997) highlights socio-cultural, socio-economical, environmental and biological factors as some of these factors and recommends that information from in-depth ethnographical studies be used in designing appropriate and effective interventions. The social factors may include such things as behavioral activities like increased trade and travel, patterns of food consumption and mass migrations of people. "Appropriate intervention should include a carefully designed programme of health education that is socially and culturally acceptable to the villagers and their leaders. As such, the communities can, in the long run, willingly change their attitudes about causation and treatment of plague and hence be prepared to report cases promptly and fully participate in carrying out effective control and preventive measures against the disease" (Kilonzo *et al.*, 1997).

2.4.1. Geographic Factors

Stenseth *et al* (2008) in one of their studies documented that "Plague cannot be eradicated, since it is widespread in wildlife rodent reservoirs. Hence, there is a critical need to understand how human risks are affected by the dynamics of these wildlife reservoirs". It is during epizootic periods when Humans and other susceptible mammals have been observed to experience their greatest exposure risk. It is henceforth, imperative to understand the factors leading to epizootics (Gage and Kosoy, 2005). According to Parmenter *et al* (1999)'s trophic cascade hypothesis, the supply of food for rodents is enhanced by increased precipitation which leads to greater plant growth. With the increase in host populations (rodents), there is a greater likelihood of epizootics and human cases of *Yersinia pestis* (Parmenter *et al.*, 1999 in Gage and Kosoy, 2005). Based on the above, climate may play a significant role in the epizootics and should be considered when planning for control programmes.

However, human behavior and activities in plague-infected areas are not to be neglected but considered as determinants of plague transmission to humans (Gubler *et al.*, 2001). Human behaviors are driven by the outcomes of climate (e.g. drought and famine). Macchiavello

(1946) found that plague transmission reportedly occurred during the harvesting season in Argentina. In Peru, climate fluctuations associated with El Nino were related to a bubonic plague outbreak in 1999 (Stapp *et al.*, 2004).

It is noted from above that the increased supply of food during increased precipitation (Parmenter *et al* (1999)) and harvesting season (Macchiavello (1946)) is associated with increased outbreaks of plague due to increased exposure of humans to infected flea bites. However, agricultural activities involving production or processing of crops such as harvesting and storage may not easily be abandoned during the outbreaks making it difficult for targeted community members to adhere to prescribed PCM such as those involving clearing, burning and staying away from fields. This even makes it difficult for adoption of such PCM where livelihoods are dependent on agriculture.

2.4.2. Socio-Economic and Cultural Factors

A study conducted in Nyanje area of Sinda district of Zambia documented the knowledge, attitudes and the public health response of the community and health workers towards plague (Ngulube *et al.*, 2006). This study took place after the outbreak and control of bubonic plague in 2001. Ngulube *et al* (2006) used interviews and questionnaires to capture both qualitative and quantitative data and analyzed it based on thematic areas. Ngulube reported that the lack of basic knowledge on the aetiology of plague in Nyanje area was found to be 43.4 percent among all the surveyed respondents. Failure to understand the cause of illness is barrier to institution of correct disease control measures. He furthermore reported that witchcraft was believed to be the major cause of plague among the locals.

Additionally, other studies have also alluded to witchcraft as the cause of illness and disability (Obiechina *et al.*, 2002; Aujoulat *et al.*, 2003; Stadler, 2003; Byford and Veenstra, 2004). Ngulube *et al* (2006) noted that lack of appropriate formal education is one of the many possible reasons for the perpetuation of the witchcraft beliefs. The witchcraft beliefs should, therefore, be tested to ascertain its influence on the uptake of modern public health interventions. Another limitation of the study could be the failure to determine the relationship between formal education and uptake of public health information and measures (Ngulube *et al.*, 2006)). However, Kilonzo *et al* (1997) had reported that "personal characteristics" may negatively influence the uptake of appropriate interventions and "potentially influence the persistence and recurrence of human plague in the area" (Kilonzo *et* *al.*, 1997). Low basic education was one of the personal characteristics assumed to have a negative impact on the level of understanding of health education by villagers. Ngulube *et al* (2006) also revealed the misconception about the use of rodenticides as the communities feared it was aimed at poisoning people.

Adoption of an intervention is a matter of choice, guided by some factors. One of such factors is education, which is able to influence the decisions people make by widening not only the resource base but also their choices. In particular, attainment of a certain level of education enhances someone's knowledge about health issues and increases their power in making positive and proactive decisions about the use of healthcare services more effective. Most educated people are less likely to be exposed to negative traditional norms (Adeladza, 2009). The choice of treatment or specifically the power to decide whether or not to adopt an intervention is significantly associated with education. This was observed in a study on home management of diarrhea in Nigeria among the Yaruba women where it was established that mothers with some education are more likely to take up a combination of treatments, with fewer mothers inclined to use of modern treatment alone (Brieger *et al.*, 1990).

Temporal changes in socio-economic factors have been associated with location of human plague cases (Schotthoefer *et al.*, 2012). For instance, the plague of 1980s tended to occur in census block groups (CBGs) with poor housing conditions (e.g. old homes with incomplete plumbing) and high proportions of the population living near or below the poverty line (Odds Ratios (ORs) of 6.68, 1.97 and 1.23 for the time frames 1976-1985, 1986-1995 and 1996-2007 respectively). Furthermore, the homes using wood fuel were consistently associated with plague cases as suggested by results from previous studies (that availability of harborage for rodents like wood pile may increase human plague risk (Kartman, 1970; Mann *et al.*, 1979; Barnes *et al.*, 1981; Eisen *et al.*, 2007).

In above literature, Schotthoefer and others *(*2012) have shown that housing condition and source of energy are risk factors and effective prevention measures must be designed to address these risk factors. Prevention measures must not be seen to be an economic burden on the targeted households. The financial capacity for households to transform the state of housing conditions and energy sources will determine the adoption of preventive interventions demanding improvements in home values and also the use of cleaner energy sources other than firewood for cooking.

Populations that depend on wildlife as source of food are at risk of being exposed to plague especially if wild rodents or animal reservoirs are involved. This even makes it difficult especially in settings where certain species, such as wild rodents, are captured for food because they are reservoirs to the organism that causes plague. Furthermore, other settings keep domestic animals that equally harbor *Yersinia pestis*. Studies have shown that Feline (domestic animals) plague infection is an important risk factor for human plague infection. Eidson *et al* (1988) reviewed epidemiological features of 60 cases of feline (referring to domestic cats in this context) plague from 1977-1985 in New Mexico and found that sixty-five (65) per cent (39/60) of feline case was associated with a case of bubonic plague in a child bitten and scratched by the cat. The root for transmission was thought to have been directly from the cats to their human contacts (through bites, discharge etc.) and mechanically (transmission of *Yersinia pestis* organism by fleas from infected cats or rodents). The cats regularly roam and hunt thereby getting exposed to the naturally occurring *Yersinia pestis* organisms in the environment. It may be difficult for some households to avoid contact with domestic animals known to harbor plague during an outbreak.

2.5. THEORETICAL FRAMEWORKS GUIDING UPTAKE OF INTERVENTIONS

In order to understand factors influencing the uptake of disease control measures, and subsequent effectiveness, it is essential to analyze some theories and models influencing the uptake of health interventions which is dependent on multiple determinants of health and health behavior. There are several theoretical frameworks one can draw upon to study the uptake of prevention and control measures of diseases. The Health Belief Model (HBM) and Theory of Reasoned Action (TRA) are of particular interest and therefore this study is anchored on both of them.

2.5.1. Health Belief Model

Developed in the 1950s, the health belief model (HBM) as illustrated in Figure 4.0. has been used in understanding health behaviors (Hochbaum, 1958). Its development was aimed at explaining why people did or did not use preventive services offered by public health departments to prevent or identify disease early. The HBM theorizes that people's beliefs about whether or not they are at risk for a disease or health problem, and their perceptions of the benefits of taking action to avoid it, influence their readiness to take action. The model further holds that perceptions about a disease and strategies available to decrease its occurrence determine health behavior (Hochbaum, 1958). According to the HBM, the uptake or adoption of positive preventive behaviors tend to be low when people believe that they are not at risk (Belcher, 2005). The resulting action undertaken depends on perceived benefits (an individual's opinion about the value of a new behavior in decreasing the risk of contracting an infection (Mutulei, 2013)).

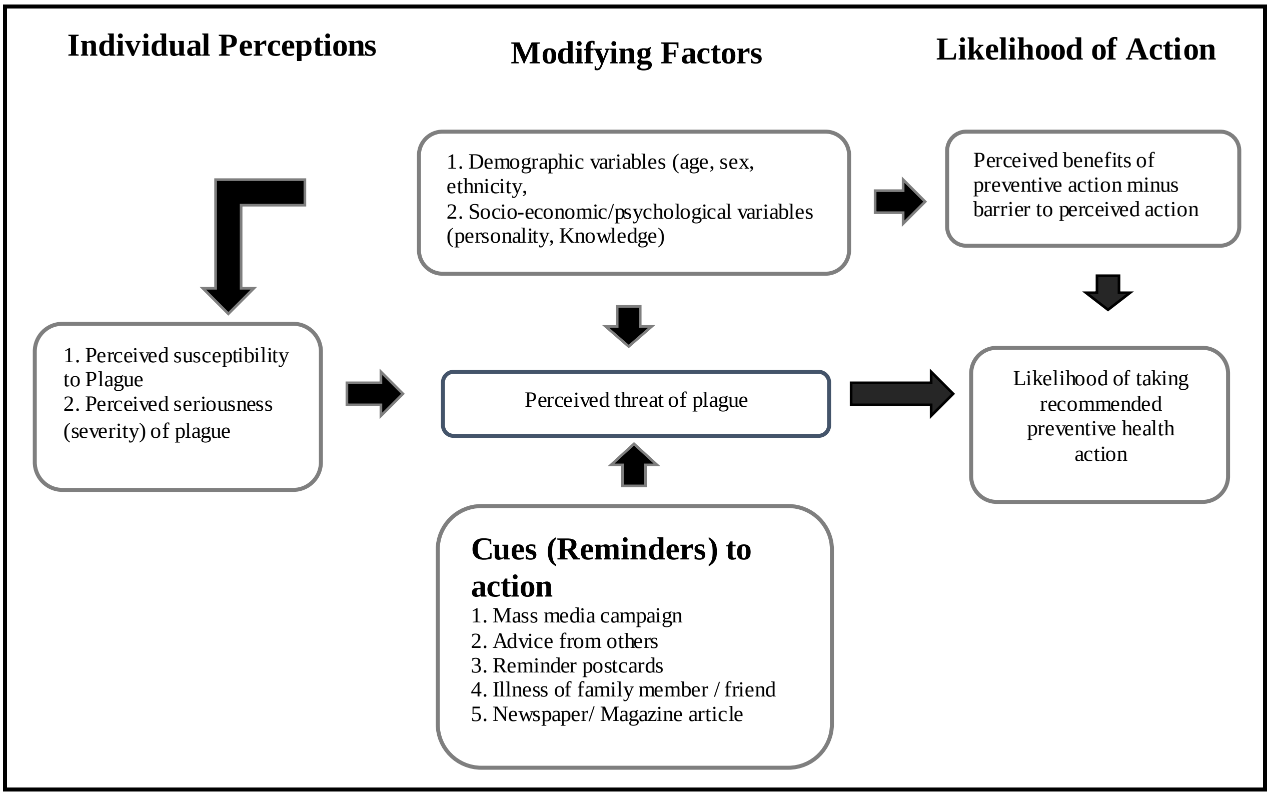


Figure 4.0. The Health Belief Model. Source: (Stretcher and Rosenstock, 1997).

Furthermore, people are thought to weigh an action's effectiveness in reducing a health threat against possible negative outcomes associated with that action. However, the HBM is not without limitations (Janz and Becker, 1984; Rimer, 1990;). The fact that the HBM does not imply a strategy for change and is more descriptive than explanatory (Rosenstock and Kirscht, 1974), other variables (such as self-efficacy) and models should be integrated to enhance its predictive value and applicability to behavior change. Nevertheless, HBM is applauded for considering the effect of personal attributes like demographic and socio-economic factors (Glanz *et al.*, 2002).

2.5.2. Theory of Reasoned Action

The theory of reasoned action (TRA) has been described as a model that addresses psychological (internal) determinants of people's actions across a wide range of situations (physical and social) (Parminter and Wilson, 2003) which have not been addressed in the HBM. People's attitudes are formed when they act upon the information that they have about the behavior being considered (Fazio, 1990). For instance, the misconception that the use of rodenticides was aimed at poisoning people during the plague outbreak (Ngulube *et al.*, 2006) may have instilled fears in the local communities and compelled them not to support the intervention. There is a significant association between an individual's expectation of good consequences from a particular behavior and the development of positive attitude towards that behavior. According to Parminter and Wilson (2003), the attitudes of people (and subjective norms) influence their behavior through the formation of intentions to behave in certain ways as illustrated in Figure 5.0 below.

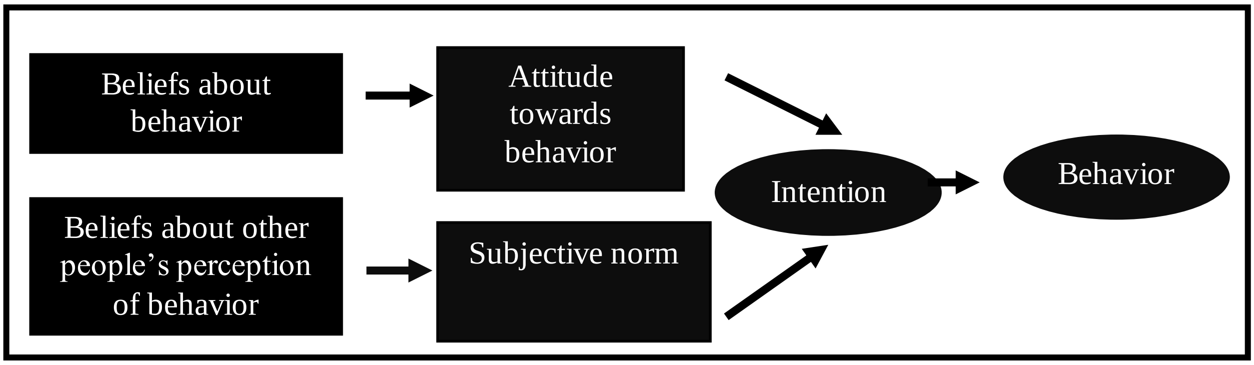


Figure 5.0. Theory of Reasoned Action (Adapted from Parminter and Wilson, 2003).

As illustrated in Figure 5.0, intention maybe associated with positive behaviors that are consistent with prevention and control of plague. For example, this may imply that an individual intends to behave in ways that ensures the *Yersinia pestis* does not find its way into human dwellings. The behaviors here may include implementing the new measures prescribed by public health specialists or authority. Internal to the individual are beliefs, attitudes and subjective norm (Botha and Atkins, 2005). According to Kippax and Crawford (1993), the TRA neglects the role played by environmental and structural issues and the linearity of the components of the theory. However, individuals may first change their behaviors before their beliefs or attitudes, which is a contradiction to the TRA predictions.

2.3. HISTORICAL IMPACT OF PLAGUE OUTBREAKS

Plague has had both devastating (such as deaths, economic losses and religious breakdown) and beneficial (such as advancement in medicine, increased wages and better conditions of employment) consequences upon the populations to which it had spread globally (Campbell and Hughes, 1995; Herlihy, 1997; Zapotoczny, 2006). However, recent devastations have been felt in Africa, with over 80 percent of deaths being recorded in Africa (WHO, 2003).

The several consequences observed were socio-economic in nature. On a positive note, plague had set the stage for what is now known as modern medicine and also led to advancements in public health. Ordinarily, diagnoses of black death revolved around astrology and superstition. However, this changed with the discovery of clinical medicine to inclusion of other public interventions like enforcement of sanitation procedures (Herlihy, 1997).

The World Health organization (WHO) observed that Plague has remained an epidemiological threat and a disease of major public health importance in Africa. In this regard, a number of efforts have been initiated to look at the nature of impact from plague as well as interventions that can reduce impact. Therefore, an interregional meeting on prevention and control of plague was held in April 2006 under the auspices of the WHO (WHO, 2008).

Failure to understand factors influencing uptake of prevention and control measures may lead to design of ineffective interventions against plague outbreaks. Ultimately, plague may persist in communities thereby causing adverse public health effects. Human plague caused by *Yersinia pestis* remains a public health threat in endemic countries, because the disease is associated with increased risk of mortality and severe economic and social consequences (Pham *et al.*, 2009). Despite the relatively low number of human cases, plague should not be overlooked because of its inherent communicability, rapid spread, rapid clinical course, and the high mortality usually resulting from untreated cases. The severity of its socio-economic burden makes plague to remain one of the three epidemic diseases other than Yellow fever and Cholera which are subject to the International Health Regulations and notifiable to the World Health Organization. However, some countries are unwilling to notify WHO because of the fear of economic and political consequences, such as the loss of tourism and trade, and the imposition of travel restrictions (WHO, 1997). In many instances, this causes underreporting and reporting delays.

For instance, during the 14th century, plague outbreak (known as Black Death) resulted in great devastation in Europe causing a series of religious, social and economic upheavals, which had profound effects on the course of the European history (Alchon, 2003). Alchon further reports that plague has remained one of the most devastating pandemics in human history which is estimated to have killed between 30 to 60 percent of Europe's population between 1347 and 1350. This had led to the reduction in the world population from an estimated 450 million to between 350 and 375 million largely due to plague outbreaks. During the aforementioned devastating period, Black Death led to unintended migrations that resulted in depopulation of many rural villages, mostly the smaller communities of Europe as the survivors fled to larger towns and cities (Byrne, 2004). For areas with low and isolated populations, the impact from the plague was less (Zapotoczny, 2006).

It is apparent that consequences of Zoonotic diseases such as plague can be devastating, more especially in economic terms and may not spare any sectors including agriculture, trade and commerce. Many other industries such as retail, wholesale, consumer packed goods, hospitality, aviation, sports, financial institutions, transportation, and logistics may indirectly suffer severe economic losses due to a decrease in public gatherings (like symposiums or conventions), travel, and tourism. The loss of access to regional and international markets tends to have much more important economic implications than local production losses alone. One typical experience of such economic impact was felt by India in 1994 when plague outbreak in Surat resulted in panic which brought about a sudden exodus of 0.5 million people from the region and led to abrupt shutdowns of entire industries, including aviation and tourism. During this outbreak, several countries froze trade, banned travel from India, and sent some Indian migrants home. For instance, the World Health Organization estimated the outbreak cost India a total of some $2 billion (Campbell and Hughes, 1995; WHO-SEARO, 2002).

In the agriculture sector, the impact of the plague was very significant economically especially for the aristocracy (upper classes) whose wealth and dominance were based on land. The agricultural prices had dropped swiftly and at the same time, the declined population led to shortage of labour and consequent dramatic increases in the wages, making the labours better-off as their conditions of employment improved (Zapotoczny, 2006).

CHAPTER THREE

MATERIALS AND METHODS

3.0. STUDY AREA

The study on uptake of prevention and control measures of plague was conducted in Nyanje and Nthope villages of Sinda district which is located in Eastern Province of Zambia (Figure 6.0) at 14^{o}14'53.32"S, 31^{o}38'10.88"E. Sinda is situated on a plateau area an an altitude of 1129 meters above sea level.

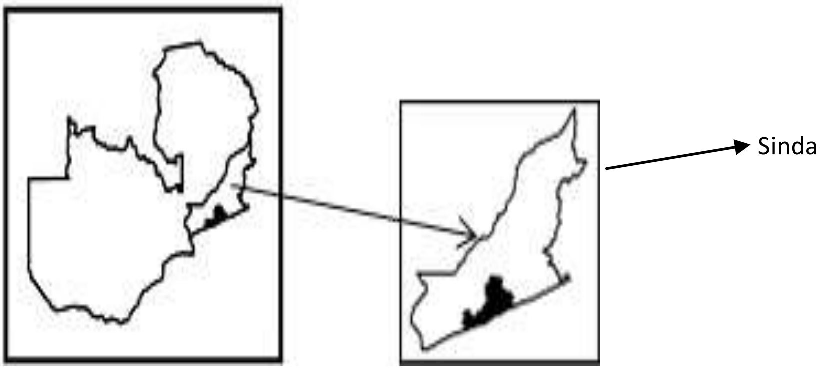


Figure 6.0. Location of Sinda district in Zambia.

The 2010 Census of Population and Housing preliminary report (CSO, 2011) projected that the population of Sinda will be around 80,867 people, out of whom 35,787 were aged 18 years and over. The population of Sinda is concentrated in Nyanje, where there are a lot of grinding mills, location of the main referral health institution (Nyanje Mission Hospital) and a lot of cross-border trading between Mozambicans and Zambians. The villages of Nyanje and Nthope are located in Ching'ombe ward of Kapoche constituency (Sinda). The population of Ching'ombe is estimated around 15,939 (CSO, 2011).

Sinda was declared a district in 2012 but before that, one half belonged to Katete and the other to Petauke. Mozambique boarders with Sinda through Nyanje village and thus there is a lot of cross-border trading. The border between Mozambique and Zambia is porous and as such, there is no control in terms of the movement people across borders. Mozambicans living in the villages around the border access health services in Sinda district because there are no health facilities on its side. The economy of Sinda is dependent on agriculture, timber production, with some of the population engaged in fisheries and poultry. This area was selected for the study because of the reported outbreaks of plague in 2001 and 2007 (WHO, 2004; Ngulube *et al.*, 2006; UN, 2008; Mwendabai, 2016).

3.1. STUDY DESIGN

A cross-sectional study was used to identify factors associated with uptake of prevention and control measures (PCM) of plague among members of Nyanje and Nthope villages. Similar study designs have been used in the study of practices and behaviors towards utilization of health interventions (Scrimshaw and Hurtado, 1987; Mutulei, 2013). Only individuals aged at least 20 years were selected from the sampled households. These were individuals who had lived in any of the villages during one or both of the 2001 and 2007 outbreaks. The cross-sectional study design utilized both quantitative and qualitative data collection methods. Although some qualitative data was collected, the data was only used to validate the patterns observed in the quantitative data and not to make statistical inference. Thus, the findings of the study are purely based on the quantitative data collected via guided interviews using questionnaires.

3.2. SAMPLING PROCEDURES

A multistage sampling was employed in the selection of respondents. The process began with the development of a list of clusters (villages within Sinda) in which plague prevention or control interventions were implemented. At the first stage, 2 villages (or primary sampling unit (PSU)) were selected randomly from among seven (7) villages. At the second stage, a proportionate number of households (secondary sampling unit (SSU)) within each of the 2 villages were obtained randomly to avoid sampling every household. In total, 178 households were sampled. In each selected household, a suitable subject (preferably the head of household or any knowledgeable elderly person) was sampled purposefully and included in the study. Where a suitable subject in a selected household was not available, the closest household was selected. Furthermore, 2 key informants (from the health department and community) were interviewed. One focus group discussion (FGD) with 10 participants from the selected clusters provided additional data used in validation of the patterns in the data collected.

3.3. SAMPLE SIZE

Fisher's formula (below) was used to determine sample size under multistage sampling because of stages involved in sampling (Mutulei, 2013). The effective sample size to be selected for the study was 380 respondents. However, the actual number of respondents selected was 178, due to budget constraints.

$$n_i = \left\{ \frac{\delta(1-\delta)}{\left(\frac{\alpha}{z}\right)^2 + \delta(1-\delta)/N_i} \right\} * \mu_i$$

Where, n_i = effective sample size (380 when rounded off to nearest whole number)

N_i = population size (35,787)

δ = estimated population variance (0.5)

α = desired level of precision (0.05)

μ_i = design effect (1.0 because it is random sampling)

Z = confidence level: 1.96 for 95% on the Normal distribution curve

3.4. DATA COLLECTION INSTRUMENTS

A mixed method approach involving a structured questionnaire and focus group discussion (FGD) was used as the instruments for data collection. A questionnaire was administered to gather quantitative information such as socio-demographic, socio-economic and socio-cultural correlates of behaviors on uptake of prevention or treatment interventions. The questionnaire yielded information on both past and future events (i.e. past experiences in using prescribed interventions or perceptions on using such an intervention in future). Structured interview guides for key informants and discussion guides for focus group discussion (FGD) were also developed. Final pre-test of the instrument took place in Sinda district before finalization and prior to commencement of data collection.

3.4.1. Operationalization of Variables

3.4.1.1. Dependent Variables

At the time of designing data collection instruments, a dependent variable was constructed, as a discrete binary variable coded as one (1) if the respondent had chosen to take-up (use) prescribed control and preventive measures during the outbreak and zero (0) if the respondent chose not to take-up (use) prescribed measures during the outbreak.

3.4.1.2 Independent Variables

The independent variables are classified into five broad categories namely; socio-economic, demographic and knowledge about plague, perceptions about plague and measures, access to information through media, and cultural and psychological factors. The specific variables under each of the broad categories are shown below in the Tables 1.0 to 1.4.

Table 1.0. Socio-economic and Demographic

ID	Variable	Response-Coding
01	Sex of respondent	Male (1), Female (2)
02	Age of respondent	20-24 (1), 25-29 (2), 30-34 (3), 35-39 (4), 40-44 (5), 45+ (6)
03	Level of education	Primary (1), Secondary (2), College/University (3), Never been to school (0)
04	Employment status	Employed (1), Un-employed (2), Self-employed (3), Student (4)
05	Source of income	Farming (1), Charcoal Production (2), Carpentry (3), Trading at market/shop (4), None (0)
06	Tribe (Ethnicity)	Chewa (1), Nsenga (2), Ngoni (3), Tumbuka (4), Bemba (5), Lozi (6), Tonga (7), Other-specify) (8)
07	Place of residence (Living in Sinda during any of outbreaks)	2001 outbreak (1), 2007 outbreak (2), Both outbreaks (3) None of above (4)

Table 1.1. Knowledge about plague

ID	Variable	Response-Coding
01	Know what plague is	Yes (1), No (0)
02	Know the symptoms of plague	Yes (1), No (0)
03	Know causes of plague	Yes (1), No (0)

Table 1.2. Perceptions about plague and measures

ID	Variable	Response-Coding
01	Plague preventability	Yes (1), No (0)
02	Involvement of health	Very involved (1), Somewhat involved (2), Not

	professionals	involved (3), None of above (0)
03	Effectiveness of measures	Effective (1), Not effective (0)
04	Safety of measures	All harmful (1), Some harmful (2), All safe (3), Some safe (4), Didn't know (0)
05	Perceived benefits	There are Benefits (1), There are no benefits (0)

Table 1.3. Access to Information through media and others

ID	Variable	Response-Coding
01	Listened to Radio announcements	Yes (1), No (0)
02	Read newspaper publications	Yes (1), No (0)
03	Community education	Yes (1), No (0)

Table 1.4. Cultural and Psychological

ID	Variable	Response-Coding
01	Cultural beliefs about measures	Yes (1), No (0)
02	Experience of initial outbreak	Yes (1), No (0)
03	Knew/ attended to someone who was sick	Yes (1), No (0)

3.5. DATA COLLECTION PROCESS

Prior to the collection of data, four (4) research assistants or data collectors (2 males and 2 females) were trained by the principal researcher in data collection (including data sourcing skills, appropriate approaches, questionnaire requirements and research ethics). The data collectors were residents from the sampled villages and were proficient in Nsenga and other local languages. The four were able to translate the questions from English to Nsenga and guided respondents during data collection with questionnaires. Using the developed instruments, 178 respondents provided responses to the questionnaires. From each of the household sampled, only one participant was subjected to the interview and priority was given to household heads or their spouses and/or knowledgeable adults present at the time of the interview. For validation purposes, interviews were also conducted with 2 key informants (Environmental Health Technologist (EHT) and a senior community member who was a plague survivor). The principle researcher guided all the interviews and discussions with key informants and during focus group discussions (FGD). One FGD was conducted with 10 participants recruited randomly (5 from each of the two villages (Nyanje and Nthope)).

3.6. DATA PROCESSING AND ANALYSIS

The qualitative data collected through focus group discussion (FGD) was thematically analyzed based on procedures that followed the stages proposed by Braun and Clarke (2006). The major stages used involved generation of codes, identification of themes among the codes, assessing the themes, description and naming themes. The summary report was then produced based on the broad thematic areas which included: knowledge about plague; Knowledge about prevention and control; methods used to prevent and control plague; Adherence to prescribed methods of control; safety of control measures; and outbreak communication among others. In this whole process, a traditional method of qualitative analysis was used that did not involve use of computer application.

Quantitative data processing begun with level one data cleaning which focused on minimizing data collection errors such as omissions and ambiguousness. Level one cleaning was conducted through physical inspection of completed paper-based questionnaires. Cleaned questionnaires were entered into the Statistical Package for Social Sciences (SPSS) version 16.0 for statistical analyses. The electronic data was further cleaned in SPSS and validated using qualitative data. Analysis in SPSS produced both descriptive and inferential statistics.

The construction and testing of hypotheses was an essential step conducted after data collection. In the analysis of quantitative data, two procedures were employed. The first procedure was aimed at testing for association which was computed using chi-square tests. The chi-square tests were critical in determination of explanatory variables of importance to the regression model. In the second procedure or stage, the assessment of the effect of the independent variable on the dependent variable was conducted based on the variables identified to be associated with the dependent variable at the first procedure. The second stage employed logistic regression, which is a class of regression where the independent variable is used to predict the dependent or outcome variable. Specifically, a Binary logistic regression (because the dependent variable has two categories) model was constructed. Below is the logistic model, described by a logit function that was used in the analysis:

$$\text{Logit (y)} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 .... + \beta_n x_n$$

In order to estimate the likelihood of an individual taking-up (using) or not taking-up prescribed prevention and control measures, the function is denoted as:

$$p(y=1) = \frac{\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 .... + \beta_n x_n)}{1 + \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 .... + \beta_n x_n)}$$

Where y = the dichotomous dependent variables called logit defined as:

1 = Taking-up (using) prevention and control measures
0 = Not Taking-up (Not using) prevention and control measures
β_0 = Intercept
$\beta_1, \beta_2, \beta_n$ = Logistic Regression coefficient of x_1, x_2, x_n
x_1, x_2, x_n = Independent variables
exp = Exponential Value

In the logistic model, the Intercept (β_0) is the value of the outcome (y) when each of the independent variables have a value equal to zero (0). The magnitude of the effect of the independent variable on the dependent variable is described by the Coefficients ($\beta_1, \beta_2, \beta_n$).

When the value of the coefficient is positive, then the independent variable increases the probability of the outcome (y). On the contrary, a negative regression coefficient means that the explanatory variable will decrease the probability of that outcome (y). For the explanatory variable to have a strong effect on the outcome, its value has to be relatively big. If the explanatory factor has little or no effect on the likelihood of the outcome, then its value is either closer to zero or zero.

The resulting ORs were computed using binary logistic regression of PCM.
The model was constructed with important predictor (independent) variables under socio-economic (education attainment, source of income), Knowledge and perceptions (knowing plague and efficacy of measures) and access to information (radio and television). After fitting fourteen (14) independent variables (education attainment, ethnicity, employment status, source of income, knowledge about plague, effectiveness of plague measures, expert involvement, experience of plague, safety of plague measures, preventability of plague, benefits of prevention and control, cultural/religious beliefs, knowing or looking after a patient and source of information) in a single model, only five (5) predictor variables (level of education, source of income, knowledge about plague, effectiveness of measures and source of information about outbreak) were found to be significant determinants of the PCM in Sinda district.

The omnibus tests of model coefficients reveal that the model built (with explanatory variables included) is an improvement over the baseline model and is significantly better fit. Here the chi-square is highly significant (chi-square= 195.771, df= 13, p<.000) hence a significantly better new model. The Hosmer and Lemeshow test of the goodness of fit further suggests the model is a good fit to the data as p=1.0 (>.05). The model correctly classifies the outcome for 98.3 percent of the cases compared to 69.1 percent in the null model indicating a marked improvement. The Nagelkerke's R^2 on the other hand suggests that the model explains roughly 94 percent of the variation in the outcome, which is a good proportion for the estimation of parameters. The model further shows that overall, 98.3 percent of the predictions in the model are correct.

3.7. ETHICAL CONSIDERATIONS

This study was approved by the ethics committee of the University of Zambia. Further approval was sought from the medical superintendent at Nyanje Mission Hospital in Sinda who recommended the involvement of the Environmental Health Technologist (EHT) in the study. Consent to collect information was also obtained from the participants who were accorded the right to participate or not to participate in the study. Participants in the interviews and discussions were not asked to submit their names or contact details.

CHAPTER FOUR

RESULTS

This chapter presents results of the study. The results are presented as descriptive statistics, variable associations and determinants of the uptake of prevention and control measures of plague.

4.1. DESCRIPTIVE STATISTICS

The results of demographic and socio-economic variables are presented in this section as follows;

4.1.1. Demographic and Socio-economic characteristics

The frequencies of background information are presented in Tables 2.0. and 2.1. In the study, both sexes were given an opportunity to participate. Majority of the respondents were female (60.7 (108) percent), compared to male counterparts (39.3 (70) percent). The minimum and maximum ages were 21 years and 82 years respectively. This implies that during the most recent plague outbreak of 2007, the youngest and oldest respondents were then aged 13 years and 74 years respectively. Majority (28.7 (51) percent) of the respondents were aged over 45 years compared to age group 25-29 years which had the lowest proportion (10.7 percent). A high proportion of the respondents were married (66.9 percent) while 14.6 percent were single. The most prevalent tribe among the study participants were Nsenga (52.2 (19) percent). Over half (52.2 (93) percent) of the respondents were living in Sinda during both outbreaks of 2001 and 2007. Those who only experienced the first outbreak of 2001(25.5 (46) percent) were more than those who had experienced the most recent outbreak of 2007 (21.9 (39) percent).

The results reveal that majority of the respondents have only attained primary school (42.7 (76) percent) as their highest level of education. Only 1.7 (3) percent have gone beyond secondary school to college or university education. Almost 30 (53) percent of the study participants have never been to school. Out of the 178 respondents, 48.9 (87) percent) are self-employed and 44.9 (80) percent are without any form of employment. Farming is one of the major sources of income for almost 19 (33) percent of the 178 respondents. In comparison, majority of the respondents (47.2 (84) percent) are involved in some forms of trading, either at the market or shop. Other sources of income are charcoal production (5.1 (9) percent) and carpentry (1.1 (2).

At least half (56.2 (100) percent) of the respondents have combined monthly income from all their sources not exceeding 600 Zambian Kwacha (ZMK). Only 1.1 (2) percent earn over 2000 ZMK.

Table 2.0. Frequency and percent distributions of Demographic Characteristics

Demographic Characteristics	Number	Percent (%)
Age Group		
20-24	31	17.4
25-29	19	10.7
30-34	20	11.2
35-39	32	18.0
40-44	25	14.0
45+	51	28.7
Sex		
Male	70	39.3
Female	108	60.7
Marital Status		
Single	26	14.6
Married	119	66.9
Divorced	19	10.7
Separated	7	3.9
Widowed	7	3.9
Religious Affiliation		
Adventist(SDA)	8	4.5
Catholic	40	22.5
Pentecostal	34	19.1
Protestant	70	39.3
Islam	1	0.6
Witness	20	11.2
Not affiliated to any religion	2	1.1
None of the affiliations above	3	1.7
Tribe (Ethnicity)		
Chewa	49	27.5
Nsenga	93	52.2
Ngoni	4	2.2
Tumbuka	3	1.7
Bemba	10	5.6
Lozi	9	5.1
Tonga	10	5.6
Experience of outbreak by year		

2001 Outbreak	46	25.8
2007 Outbreak	39	21.9
Both Outbreaks	93	52.2

Table 2.1. Frequency and percent distributions of Socio-Economic Characteristics

Socio-Economic Characteristics	Number	Percent (%)
Education Attainment		
Primary	76	42.7
Secondary	46	25.8
College or University	3	1.7
Never been to School	53	29.8
Employment Status		
Employed	8	4.5
Un-employed	80	44.9
Self-employed	87	48.9
Student	3	1.7
Source of Income		
Farming	33	18.5
Charcoal Production	9	5.1
Carpentry	2	1.1
Trading at the market/shop	84	47.2
None of above sources	50	28.1
Estimated family monthly income from all sources		
Under K600	100	56.2
K600 to K1000	11	6.2
Over K1000	2	1.1
No response	65	36.5

4.2. RELATIONSHIPS BETWEEN VARIABLES

This section presents results for associations among variables of interest, the dependent and independent variables. The significance level was established at 95 percent (P=0.05).

4.2.1. Demographic characteristics verses Uptake of prevention and control measures

The cross-tabulations were computed to examine relation between respondents' demographics and uptake of prevention and control measures (PCM) and results are presented in Table 3.0.

Only tribe and experience of outbreak were related to uptake of PCM. The other demographics (age (χ^2=69.23 and p=0.11), sex (χ^2=0.62 and p=0.43), marital status (χ^2=5.96 and p=0.20), religious affiliation (χ^2=11.67 and p=0.11)) had no relations. Although tribe had significant relationship (χ^2 (N=178) = 19.38 and $p < 0.01$), majority (61.8 percent (N=93)) among the local people (Nsenga) did not take up PCM. This is different for any of the other tribes (Lozi, Tonga or Bemba) that are not considered indigenous to the region where it was discovered that most of them had taken up PCM. Additionally, of all the respondents who had experienced both 2001 and 2007 outbreaks, 75.6 percent took up the PCM. A significant relationship (χ^2 (N=178) = 1.32 and $p < 0.001$) was also established between all respondents who had experienced both 2001 and 2007 outbreaks and uptake of PCM.

4.2.1.2. Socio-Economic Characteristics Verses Uptake of prevention and control measures

Some socio-economic characteristics (education attainment, employment status and the source of income for the respondents) were related to uptake of PCM (Table 3.0). Although source of income was significantly associated ((χ^2 (N=178) = 1.23 and $p < 0.001$) with uptake of PCM, no relation existed between level of family monthly income (χ^2 (N=178) = 8.99 and $p < 0.66$) and uptake of PCM. Education was significantly associated (χ^2 (N=178) = 75.66 and $p < 0.001$) with uptake of PCM. A higher proportion (89.4 percent (N=125) of the respondents who had attended any level of education took up PCM. In contrast, majority (72.7 percent (N=53)) of the respondents among those who had never been to school did not report to have taken up any prescribed PCM. The results had also shown some significant relations (χ^2 (N=178) = 13.96 and $p < 0.01$) between employment status and uptake of PCM. Within the unemployed (N=80), 65.5 percent did not take up PCM. Majority (62.6 percent) of respondents in any form of employment (N=95) had taken up the PCM.

Table 3.0. Cross tabulations of demographic and socio-economic characteristics against uptake of prevention and control measures in Sinda

	Not taking-up	Taking-up	Chi - square (χ^2) test	
	% within Group		χ^2 Value	P-Value
Demographic Characteristics				
Age			*69.233*	*0.11*
20-24	20	15.4		
25-29	10.9	10.6		
30-34	3.6	14.6		
35-39	10.9	21.1		
40-44	14.5	13.0		
45+	40	25.2		
Sex			0.620	0.431
Male	43.6	37.4		
Female	56.4	62.6		
Marital Status			5.958	0.202
Single	20.0	12.2		
Married	58.2	70.7		
Divorced	12.7	9.8		
Separated	7.3	2.4		
Widowed	1.8	4.9		
Religious Affiliation			11.670	0.112
Adventist(SDA)	9.1	2.4		
Catholic	21.8	22.8		
Pentecostal	7.3	24.4		
Protestant	47.3	35.8		
Islam	0.0	0.8		
Witness	10.9	11.4		
Not affiliated to any religion	1.8	0.8		
None of the affiliations above	1.8	1.6		
Tribe (Ethnicity)			19.375	**0.004
Chewa	34.5	24.4		
Nsenga	61.8	48.0		
Ngoni	0.0	3.3		
Tumbuka	3.6	0.8		
Bemba	0.0	8.1		
Lozi	0.0	7.3		
Tonga	0.0	8.1		
Experience of outbreak by year			1.321	***0.000
2001 Outbreak	80.0	1.6		
2007 Outbreak	20.0	22.8		
Both Outbreaks	0.0	75.6		
Socio-Economic Characteristics				
Education Attainment			75.661	***0.000

	Not taking-up	Taking-up	Chi - square (χ^2) test	
	% within Group		χ^2 Value	P-Value
Primary	27.3	49.6		
Secondary	0.0	37.4		
College or University	0.0	2.4		
Never been to School	72.7	10.6		
Employment Status			13.964	**0.003
Employed	3.6	4.9		
Un-employed	65.5	35.8		
Self-employed	29.1	57.7		
Student	1.8	1.6		
Source of Income			1.232	***0.000
Farming	58.2	0.8		
Charcoal Production	16.4	0.0		
Carpentry	3.6	0.0		
Selling at the market or shop	9.1	64.2		
None of above sources	12.7	35.0		
Estimated family monthly income from all sources			8.985	0.661
Under K600	50.9	58.5		
K600 to K1000	1.8	8.1		
Over K1000	0.0	1.6		
No response	47.3	31.7		

Note: +p<0.10, * =p<0.05, ** =p<0.01 and ***=p<0.001

Table 4.0. Cross Tabulation of major source of income verses Estimated monthly family income (including all sources)

Major source of income	Percent estimated monthly family income (all sources)					
	Less than K250	K250 to less K600	K600 to K1,000	More than K1,000	I don't want to respond	Total
Farming	23.1	9.1	0.0	0.0	20.0	18.5
Charcoal Production	3.8	0.0	0.0	0.0	9.2	5.1
Carpentry	2.6	0.0	0.0	0.0	0.0	1.1
Trading	46.2	68.2	100.0	50.0	32.3	47.2
None of the above	24.4	22.7	0.0	50.0	38.5	28.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

Note: Pearson Chi-Square computations - Value = 29.370[a], df =16, P-Value = 0.022

The level of monthly family income was associated (χ^2 = 29.37, df = 16 and p < 0.05) with the sources of income are demonstrated in Table 4.0. Although this relationship existed, there was no association between the level of income (wealth) and the uptake of PCM. The common source of income was trading and respondents whose source of income was trading reported the highest level of monthly income compared to their counterparts in farming, charcoal production and carpentry.

4.2.1.3. Knowledge about plague verses uptake of prevention and control measures

The study examined three major categories of knowledge, which include knowing what plague is about, plague symptoms and the causes. Among these categories of knowledge, a relationship was observed between uptake of PCM and knowing plague (χ^2 = 7.03 and $p < 0.01$) but no association existed between knowing causes (χ^2 = 4.80 and p=0.19) and uptake of PCM or knowing symptoms (χ^2 = 3.33 and p=0.07) and uptake of PCM. These results are depicted in Table 5.0.

4.2.1.4. Perceptions about plague verses Uptake of prevention and control measures

The key variables of perceptions about plague and measures are summarized as follows: plague preventability; involvement of health professionals in prevention and control; effectiveness of PCM; benefits of prevention and control; and safety of PCM. Results in Table 5.0 reveals that all the variables under perceptions were related to uptake of PCM. The involvement of health professionals in prevention and control (χ^2 = 107.98 and p-value < 0.001), benefits in prevention and control (χ^2 = 34.75 and p-value < 0.001) and safety of PCM (χ^2 = 34.23 and p-value < 0.001) were more significantly related to uptake of PCM.

4.2.1.5. Access to information about plague verses uptake of prevention and control measures

Results presented in Table 6.0 indicates existence of a relationship between access to information and uptake of PCM. Receiving information about plague outbreaks was more statistically significant via radio (χ^2 = 34.30 and p-value < 0.001) or newspaper (χ^2 = 36.48 and p-value < 0.001) than through community education (χ^2 = 7.76 and p-value < 0.05).

4.2.1.6. Cultural and psychological characteristics verses Uptake of prevention and control measures

Cultural and psychological characteristics are significantly associated with the uptake of prevention and control measures (PCM) of plague. This association is illustrated in Table 6.0 below. There was a statistically significant association (χ^2 = 26.65 and p-value < 0.001) between respondents' religious or cultural beliefs and uptake of PCM. Another significant relationship (χ^2 = 40.18 and p-value < 0.001) was established between experience of a previous outbreak and taking up PCM. Having cared or knowing someone who cared for a patient during the outbreak was also strongly associated (χ^2 = 34.6 and p-value < 0.001) with taking up PCM.

Table 5.0. Cross tabulations of knowledge and perceptions about plague against uptake of prevention and control measures in Sinda

Selected Independent Variable	Taking-Up Prevention and Control Measures			
	Not taking-up	Taking-up	Chi - square (χ^2) test	
	% within Group		χ^2 Value	Asymp. Sig. (2 - sided)
Knowledge about plague				
Knowing what plague is			7.034	**0.008
Does not know plague	23.6	8.9		
Know what plague is	76.4	91.1		
knowing symptoms of plague			3.334	0.068
Does not know symptoms of plague	29.1	17.1		
Know symptoms of plague	70.9	82.9		
Knowing causes of plague			4.799	0.187
Does not know causes of plague	30.9	17.1		
Know causes plague	65.5	77.2		
Perceptions about plague and measures				
Plague preventability			10.061	**0.002
Does not know plague is preventable	20.0	4.9		
Know that plague is preventable	80.0	95.1		
Involvement of health professionals in prevention and control			107.983	***0.000
Very involved	7.3	82.9		
Somewhat involved	5.5	6.5		
Not very involved	38.2	3.3		
Not at all involved	49.1	5.7		

Effectiveness or Efficacy of measures			8.269	*0.016
Measures not effective	38.2	21.1		
Measures are effective	60.0	78.9		
Benefits in prevention and control			34.753	***0.000
There are no benefits	52.7	65.9		
There are benefits	21.8	33.3		
Safety of prevention and control measures			34.228	***0.000
All harmful	34.5	18.7		
Some harmful	36.4	10.6		
All safe	7.3	41.5		
Some safe	0.0	3.3		
I don't know	14.5	18.7		

Note: +p<0.10, * =p<0.05, ** =p<0.01 and ***=p<0.001

Table 6.0. Cross tabulations of variables on access to information, cultural and psychological characteristics against uptake of prevention and control measures in Sinda

Selected Independent Variable	Taking-Up Prevention and Control Measures			
	Not taking-up	Taking-up	Chi - square (χ^2) test	
	% within Group		χ^2 Value	Asymp. Sig. (2 - sided)
Access to Information through media and other means				
Community education about prevention and control			7.760	0.041
Community not educated	32.7	29.3		
Community educated	60.0	69.9		
Source of information about outbreak-Radio			34.299	***0.000
Did not listen to Radio	25.5	32.5		
Listened to Radio	49.1	66.7		
Source of information about outbreak-Newspaper			36.476	***0.000
Did not read Newspaper publication	45.5	46.3		
Read Newspaper publication	29.1	52.8		
Cultural and Psychological				
Cultural or Religious beliefs			26.649	***0.000
Measures are against beliefs	20.0	1.6		
Measures not against any beliefs	3.6	0.0		
Experience of previous plague outbreak			40.178	***0.000
2001 outbreak did not have influence	89.1	40.7		
2001 outbreak influenced response	10.9	59.3		
Knowing/looking after patient			34.423	***0.000
Did not know/look after patient	65.5	84.6		

Knew/looked after patient	9.1	14.6

Note: +p<0.10, * =p<0.05, ** =p<0.01 and ***=p<0.001

4.3. DETERMINANTS OF UPTAKE OF PREVENTION AND CONTROL MEASURES

This section presents the determinants of the uptake of prevention and control measures (PCM) of plague. The predictor variables: education attainment, source of income, knowledge about plague, knowledge about plague, effectiveness of measures and source of information about outbreak were retained in the final regression model as shown in Table 7.0.

The Nagelkerke's R^2 on the other hand suggests that the model explains roughly 94 percent of the variation in the uptake of PCM. The model further shows that overall, 98.3 percent of the predictions in the model are correct.

4.3.1. Multiple Logistic Regression Analysis

This section illustrates how a model fitted with at least two independent variables has been able to predict the likelihood of taking up PCM of plague.

4.3.1.1. Binary logistic regression of predictor variables (determinants) of uptake of prevention and control measures in a single model

The results of multiple logistic regression analysis according to the outcome (uptake of prevention and control measures (PCM)) are illustrated in Table 7.0. In this section, the object of conducting a regression analysis is to ascertain the casual effect of several independent variables (predictors) on one outcome (PCM).

Table 7.0. Determinants of uptake of prevention and control measures of plague in Sinda district: Results from Logistic Regression for all predictors in one model.

Predictor Variables	R^2 (94.0)	β	Wald	df	P-Value	Odds Ratio (OR)
Socio-Economic Characteristics						
Education Attainment			9.391	3	0.025	
Never been to School (r)		0.000	……	……	1	……
Primary		5.986	9.391	1	**0.002	397.789
Secondary		113.4	0.001	1	0.975	1.77E+49
College or University		22.373	0	1	0.999	5.21E+09
Source of Income			5.520	4	0.381	
Farming (r)		-11.419	4.178	1	*0.041	0.010
Charcoal Production		-27.562	0.000	1	0.998	0.000
Carpentry		-24.308	0.000	1	0.999	0.000
Trading at the market/shop		0.908	1.327	1	*0.047	1.846
Knowledge about plague						
Don't know plague (r)		0.000	……	……	1	……
Know plague		2.09	3.839	1	*0.041	1.200
Perceptions about plague and measures						
Effectiveness or Efficacy of measures						
Measures not effective (r)		0.000	……	……	1	……
Measures are effective		5.027	3.707	1	*0.044	0.070
Access to Information through media						
Source of information about outbreak						
Other media (r)		0.000	……	……	1	……
Radio		1.964	4.851	1	*0.028	1.381

Note: results are expressed as odds ratios (exponentiated coefficients from the multiple logistic regression) Also note: *=p<0.05 , **=p<0.01, and r =reference category

The Odds Ratios (OR) for the determinants of uptake of control and prevention measures (PCM) of plague are shown in Table 7.0. The resulting ORs were computed using binary logistic regression of PCM. A model was constructed with important predictor (independent) variables under socio-economic (education attainment, source of income), Knowledge and perceptions (knowing plague and efficacy of measures) and access to information (radio and television). After fitting fourteen (14) independent variables (education attainment, ethnicity, employment status, source of income, knowledge about plague, effectiveness of plague measures, expert involvement, experience of plague, safety of plague measures, preventability of plague, benefits of prevention and control, cultural/religious beliefs, knowing or looking after a patient and source of information) in a single model, only five (5) predictor variables (level of education, source of income, knowledge about plague, effectiveness of measures and source of information about outbreak) were found to be significant determinants of the PCM in Sinda district.

The omnibus tests of model coefficients reveal that the model built (with explanatory variables included) is an improvement over the baseline model and is significantly better fit. Here the chi-square is highly significant (chi-square= 195.771, df= 13, p<.000) hence a significantly better new model. The Hosmer and Lemeshow test of the goodness of fit further suggests the model is a good fit to the data as p=1.0 (>.05). The model correctly classifies the outcome for 98.3 percent of the cases compared to 69.1 percent in the null model indicating a marked improvement. The Nagelkerke's R^2 on the other hand suggests that the model explains roughly 94 percent of the variation in the outcome, which is a good proportion for the estimation of parameters. The model further shows that overall, 98.3 percent of the predictions in the model are correct.

Beginning with the results for education attainment in Table 7.0, there is a highly significant overall effect (Wald=9.39, df = 3, p<0.05). The b-coefficients (β) for all education attainment (primary, secondary, college or university) are significant and positive (5.99) indicating that increasing education attainment level is associated with increased odds of prevention and control measures (PCM) of plague. The corresponding Odds Ratio (OR) tells us that individuals who have been to school up to primary level are 397.79 times (or 78.9 percent) more likely than those who have never been to school (reference category) to take-up PCM.

Furthermore, Table 7.0 illustrates that the overall effect of source of income in the model is not significant (Wald=5.52. 194, df = 4, p>0.05). However, farming (Wald=4.18, df = 1, p<0.05) and Trading at the market/shop (Wald=1.327, df=1, p<0.05) are two significant classifications of the source of income. The b coefficient (β) for Trading at the market/shop is positive (0.91) indicating that involvement in any form of trading increases the odds of taking up control and prevention measures of plague. However, the b-coefficient of farming is negative (-11.42) indicating that involvement in farming as source of household income decreases the odds of taking-up control and prevention measures of plague. The OR for individuals involved in any form of trading reveals that those individuals are 1.85 times (or 84.6 percent) more likely than those involved in farming (reference category) to take-up PCM of plague. Having farming as a major source of income decreases the likelihood of taking-up PCM by 0.01 times (or 1.0 percent) for the farmers than the traders whose likelihood is over 84 percent.

Knowledge about a phenomenon is critical in making informed decisions about that aspect. Knowledge about plague was found to be an important determinant of the uptake of PCM of plague. The odds of an individual taking up PCM is 1.20 ($p<0.05$) times (or 20 percent) higher among those who know what plague is than those who reported not knowing what plague is ($P=1$). Relative to knowledge about plague, perceptions about the effectiveness or efficacy of the PCM of plague is statistically significant ($p<0.05$). The likelihood of taking-up the PCM is 0.07 times (or 7 percent) higher for an individual who views the measures as being effective compared to an individual uncertain about the effectiveness or efficacy of the PCM.

Access to information about plague outbreaks is observed as being a significant factor ($p<0.05$) in the uptake of PCM. People get to hear about the outbreaks via multiple sources under media. From the multiple logistic computations, it can be observed that individuals who heard about the plague outbreaks from radio announcements are 1.38 times (or 38 percent) more likely to take-up PCM than those who heard from other media sources.

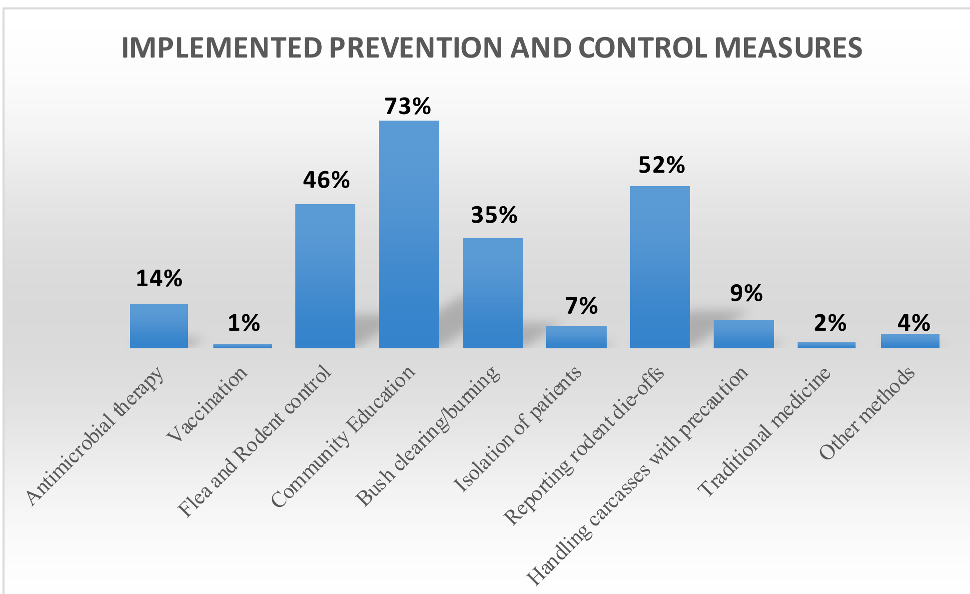
4.4. TYPES OF PREVENTION AND CONTROL MEASURES USED IN SINDA DURING OUTBREAKS

A number of prevention and control measures were utilized by the people in the villages that were affected by the outbreaks in Sinda district. This section presents these various measures by magnitude in Nyanje and Nthope villages.

4.4.1. Distribution of common Prevention and Control Measures in Sinda

Plague prevention and control strategies have involved control of both, the vector and reservoirs, public health education, epidemiological surveillance and isolation of all patients undergoing treatment. Similar strategies were introduced to prevent and control plague outbreaks in Sinda district. The respondents reported having used multiple strategies from among those that were introduced during the outbreaks. As shown in Figure 7.0, community education for plague prevention with a magnitude of 73 percent was the most common strategy used by the respondents. Public health education is effective in sensitizing community members about many issues that include disease etiology, treatment, prevention and control. The other common strategy involved reporting of rodent die-offs to the environmental health office in Nyanje. This was reported by 52 percent of the respondents. Other strategies the respondents mentioned include; vector (flea) and reservoir (rat) control (46 percent), clearing/burning of bush (35 percent), use of antimicrobial therapy (14 percent), proper handling and disposal of carcasses (9 percent), isolation of patients (7 percent), use of traditional medicines (2 percent) and vaccines (1 percent) and other methods of prevention and control (4 percent).

Figure 7.0. Percent distribution by type of prevention and control measures in Sinda



CHAPTER FIVE

DISCUSSION

4.0. INTRODUCTION

This section discusses the findings of the study. Each of the key determinants of prevention and control measures has been discussed in detail with reference to either corroborating or contradicting literature under specific sub-sections.

5.0.1. Description of Research Questions and Expectations

The objective of the study was to determine the factors that influence uptake of recommended prevention and control measures against plague outbreaks. Furthermore, the study needed to identify the various forms of interventions that were introduced to prevent and control plague outbreaks in Sinda.

The study had a general presumption that some factors play a critical role in the uptake of prevention and control of plague outbreaks. What could these factors be? It was therefore, expected that demographic (such as age, sex, place of residence, marital status, tribe, religion), socio-economic (education level, occupation, source income, level of income, mass media exposure), cultural and psychological factors (living with patients of plague and experience of other outbreaks) are among predictor variables that influence people in taking up prevention or control measures of plague. These characteristics are presumed to determine the success of any control or prevention interventions during plague outbreaks.

5.0.2. Demographic characteristics and uptake of prevention and control measures

Some demographic factors such as age and marital status have been associated with high uptake of health interventions. The study established, based on computed cross-tabulations that relationships exist between demographic variables such as the tribe (ethnicity) ($\chi^2 = 19.38$ and $p < 0.01$) and experience of previous outbreak of plague by the respondents ($\chi^2 = 1.32$ and $p <$

0.001). However, logistic regression analysis ruled out any possibilities of associations in the sense that not a single variable under demographic characteristics was statistically significant to determine or predict the uptake of prevention and control measures of plague. This finding contradicts what other researchers (Ali, 2002; Ouma *et al.*, 2007;) discovered in their studies where it was consistently shown that demographic characteristics such as gender (sex), age, religion and marital status influence health behavior change, and would compel an individual to take up alternative preventive interventions so that they remain in a healthy state. On the other hand, findings from this study (computation in Table 3.0) are consistent with results from other studies (Mutulei (2013)) where it was reported that an individual's particulars such as age, marital status and religious affiliations are not significantly associated with uptake of preventive treatment for malaria, which is a vector-borne disease like plague. Therefore, more studies must be conducted to check whether other unknown factors are confounding the significant results reported by Ouma (2007) and Ali (2002).

5.0.3. Socio-economic characteristics and uptake of prevention and control measures

Socio-economic factors have been found to be the major determinants of health in people of all ages (Spencer, 2000) and must therefore, be taken into account when implementing any public health intervention. Interventions will not yield significant levels of benefit in populations of high economic status because prevalence of given health problems may already be low. However, intervention may have a more significant effect if a population is of low economic status (Macfarlane, 2005).

Education is significantly associated with uptake of prevention and control measures (PCM) of plague (cross-tabulation computation in Table 3.0). The results from a binary logistic analysis also suggest that education attainment (at least some form of primary education) is statistically significant and predicts or determines the uptake of PCM. The lack of any form of education is significantly associated with the failure of respondents to take up PCM. In a study to understand health seeking behavior, Case and others (2005) documented that individuals with more education are significantly more likely to seek out treatment from a public doctor or clinic, which includes acting upon prescriptions by public health specialists in the communities. In contrast, those who are less well educated or not educated at all are more likely to seek treatment from a traditional healer, which in many cases deviates away from appropriate recommendations by health specialists or doctors. Another study (Brieger *et al.*, 1990) reported significant association between education and the choice of treatment. Education is not only associated with greater earning capacity (which may enable individuals to afford better health services), but also with enhancement of self-esteem and confidence (Penny *et al.*, 2005). It can be argued, therefore, that uptake of PCM is associated with education level, and particularly an individual with post education has confidence in the information received from health experts and is likely to take up preventive recommendations.

Computation from regression analysis revealed that uptake of PCM is only significantly associated with primary level of education but not significantly associated with progression in the level of education, such as secondary or tertiary education. This means that only a basic level of education will determine uptake of PCM. Since primary education is the staring place for literacy for most of the world's population (Chowdhury, 1995), it can be argued that the association observed maybe consistent with the literacy levels of the respondents. This argument is supported by Lam *et al* (2013) who concluded that literacy was indeed associated with an increase in odds of possessing health-related decision making power. This association remained significant even when accounting for primary school attainment.

The results indicate that uptake of PCM of plague is significantly associated with the source of income for the respondents. It was observed that individuals who depend on farming as their source of income are less likely to take-up PCM. However, dependence on other sources of income, such as trading at the market or shop is associated with high uptake of PCM. Prevention and control of plague involves termination of habitats for reservoirs and vectors by clearing or burning of bushes and fields. Since a farmer’s livelihood is linked to the field, then the process of tempering with the fields may indirectly affect agricultural production and farmers are less likely to adopt such an intervention. Wiegers and Curry (2009) argues that in complying with a prevention/control measure, farmers weigh the resulting specific costs and benefits. This implies that if an intervention will hamper their agro produce, then such an intervention yields more costs than benefits. The fact that most measures of plague prevention involve termination of habitats for reservoirs and vectors by clearing or burning of their agricultural fields will influence farmers to weigh their specific costs and benefits before deciding whether to comply with such measures. To facilitate adoption of prevention/control measures among farmers, it requires a good understanding of what motivates them to adopt because the incentives for farmers are subjective and differ.

The level of monthly income was highest among respondents involved in trading than those in farming. It can thus be argued that the effect of income was significant in the adoption of PCM among traders. Some of the prescribed intervention in Sinda had involved changing the type of housing materials such as replacing thatched roofs with iron sheets and also resurfacing mud floors with concrete. These changes may have proved manageable among households with higher incomes. However, specific studies must be conducted to ascertain the cost effectiveness of all the PCM introduced during the outbreaks.

5.0.4. Knowledge and perceptions about plague measures and uptake of prevention and control measures

The bivariate analysis results have indicated that the uptake of PCM is significantly associated with respondents' Knowledge and perceptions about plague. Positive perceptions about efficacy or effectiveness of PCM will positively influence uptake of plague PCM. Ali (2002) noted that perceptions are influenced by modifying factors/characteristics such as knowledge, occupation and past experiences which determines personal perceptions regarding a particular intervention and the likelihood of intervention adoption. The significant association reported between uptake and effectiveness of PCM may be supported by the fact that people invest their time and resources in the adoption of an intervention that will yield positive results.

5.0.5. Access to health information and uptake of prevention and control measures

Health information (information for preventing and managing disease, and making other decisions related to health and health care (Rippen and Risk, 2000) shapes knowledge, perceptions and attitudes to facilitate behavior change. Not only is access to such information important but its source is equally critical for its internalization, acceptability and translation into action.

The analysis revealed significant association between uptake of PCM and respondents reporting having received information about outbreak and prevention through radio announcements. Moreover, other mass media (such as newspaper and public announcements by community health workers) and health education at health facilities were used in dissemination of similar information but these have not been associated with significant change in the uptake. To the contrary, Mutulei (2013) had established that information accessed from health facilities was bound to be clearer and more authoritative than information provided via other media, including radio. In the study area and surrounding villages, there is one health facility. The likelihood of some community members not visiting the health facility during the outbreak prevented a number of them from accessing the health information and making informed actions. The findings by Mutulei (2013) suggest that the Government must consider expanding health education programs and sensitizations via health facilities, including mobile facilities in underserved areas.

In most rural areas of Zambia such as Sinda, radio continues to be a powerful communication medium with a lot of people using it as a source of health, agricultural and political information etc. In terms of cost, radio is an extremely economical medium and suitable in rural areas where electricity supply is limited to fewer households. It could be argued that people were able to adopt PCM after hearing from the radio because the information was considered credible. Here credibility refers to the trustworthiness, reliability or dependability of information perceived by the respondents as important. Kakade (2013) corroborates that radio is considered as a credible source of information and is taken as authentic, trustworthy and prestigious medium of communication.

CHAPTER SIX

6.0. CONCLUSION AND RECOMMENDATIONS

The study has established the following key determinants on the uptake of prevention and control measures (PCM) of plague.

1. Socio-economic factors are significantly associated with high uptake of PCM (outcome).
2. Education is significantly associated with the outcome and literacy is indeed associated with an increase in odds of taking up prevention and control measures of plague.
3. Source of income or livelihoods is an important factor that drives the uptake of plague PCM.
4. Knowledge and perceptions about plague PCM are associated with uptake of PCM. Individuals would otherwise invest their time and resources in the adoption of an intervention that will yield positive results.
5. Access to health information is important in shaping knowledge, perceptions and attitudes to facilitate behavior change towards uptake of PCM.
6. Radio as a source of information is considered as a credible source of information and is taken as authentic, trustworthy and prestigious medium of communication for plague outbreaks.
7. Demographic characteristics such as age, sex, marital status, ethnicity and religious affiliation have been established as non-determinants of the uptake of PCM. More studies must be conducted to check whether other unknown factors confound the influence of demographic characteristics on behavior change.

The study also proposes the following recommendations concerning the prevention and control of plague.

1. Socio-economic factors are key determinants of health in people of all ages and must therefore, be taken into account when designing and implementing prevention and control measures of plague.

2. The costs and benefits analyses of strategies for preventing/controlling plague must be prioritized especially when such strategies intervene for instance with agro produce through alteration of agricultural fields for farmers. This calls for use of strategies yielding less cost than benefits to users of prevention and control measures. There must be deliberate actions to compensate people when PCM entail destroying of their sources of livelihoods or habitats.
3. Initial dissemination of information about plague outbreaks by the government must be conducted via local radio stations because listeners consider such information credible and radio is an extremely economical medium and covers wider listenership.
4. Government must consider expanding health education programs and sensitizations at health facilities and intensify mobile facilities in underserved areas. Education must be tailored in a sensitive manner that considers community members without any form of education to ensure prescribed strategies are fully understood.
5. The re-emergence of plague after longer periods of silence calls for continuous epidemiological surveillance which must include periodic laboratory analysis especially in all active plague foci.

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