

**RISK FACTORS INFLUENCING TYPHOID FEVER OCCURRENCE AMONG
THE ADULTS IN MAINA SLUM, NYAHURURU MUNICIPALITY, KENYA.**

DEPARTMENT OF PUBLIC HEALTH

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University or for any other award.

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DEDICATION

To my beloved wife Jane, and my children Hellen, Teresa and John Mark. Also to my deceased loving mother Njiku. I thank you very much for your prayers during my studies at Kenyatta University.

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TABLE OF CONTENTS

Declaration.....	i
Dedication	iii
Acknowledgement.....	iv
Table of contents	iv
List of	
Tables.....	<u>viii</u>
List of Figures.....	ix
Definition of terms.....	x
Abbreviation <u>and</u>	
<u>Acronyms.....xii</u>	
Abstract.....	xiii
CHAPTER I: INTRODUCTION.....1	
1.1 Background Information.....	1
1.2 Problem Statement	3
1.3 Justification of the Study	5
1.4 Research Questions	5
1.5 Null hypothesis	5
1.6 Objectives of the Study.....	6
1.6.1 General Objective	6
1.6.2 Specific Objectives	6
1.6.3 Significance of the Study.....	6
CHAPTER II: LITERATURE REVIEW8	

2.1 Typhoid.....	8
2.2 History of typhoid fever.....	8
v	
2.3 Typhoid Mary.....	10
2.4 History of typhoid as abiological weapon.....	11
2.5 Overview of the occurrence of typhoid and it's severity.....	12
2.6 Water contamination in developed countries and developing countries.....	14
2.6.1 The changing pollution profile.....	14
2.6.2 Water contamination overview.....	15
2.6.3 Water sources	16
2.6.4 Agricultural run offs.....	16
2.6.6 Crop production	17
2.6.8 Irrigation.....	17
2.6.9 Worker's hygiene.....	18
2.6.10 Food Processing.....	18
2.6.11 Animal Health.....	18
2.7 Risk factors associate with prevalence of typhoid.....	19
2.7.1 Water contamination.....	19
2.7.2 Health carriers of typhoid disease.....	20
2.7.3 Sanitation	
Practices.....	20
2.8 Prevention measures in place for typhoid control.....	22
2.8.1 Food and personal hygiene.....	22

2.8.2 Hand washing practices.....	23
2.8.3 Immunization and treatment.....	23
2.8.4 Provision of clean treated water.....	25

[vi](#)

2.8.5 Conceptual framework according to Wood.....	27
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CHAPTER III: STUDY

METHODOLOGY.....28

3.1 Study Area.....	28
3.2 Study Design.....	29
3.3 The Study Population.....	29
3.4 Inclusion Criteria.....	29
3.5 Exclusion Criteria.....	29
3.6 Sampling Techniques.....	29
3.7 Sample Size Determination.....	30
3.8 Data Collection Instruments.....	30
3.9 Methods of data Collection.....	31
3.10 Study Variables.....	31
3.11 Data Analysis.....	32
3.12 Ethical consideration.....	32
3.13 Assumption of study.....	32
3.14 Limitation.....	33
3.15 Scope of the study.....	33

CHAPTER IV: RESULTS AND DISCUSSION.....	34
4.1 Social demographic description of study population.....	34
4.1.1 Age, Sex, occupation, marital status, and religion of the respondents.....	34
4.1.2 Level of education of the respondents.....	34
vii	
4.1.3 Level of disease awareness.....	35
4.2 Prevalence of typhoid	35
4.2.1 Occurrence of typhoid fever	35
4.2.2 Occurrence of typhoid and sex.....	36
4.2.3 Methods used in diagnosis of typhoid.....	38
4.2.4 Risk associated with occurrence of typhoid.....	39
4.2.1 Water sources,availabilityn ,storage.....	39
4.4.5 Human waste disposal.....	40
INTERVENTION MEASURES IN PLACE.....	43
4.4.1 The effectiveness of control and preventive measures in place.....	43
4.4.14 Reasons for lack of participation in cleaning.....	38
4.5 DISCUSSION OF RESULTS.....	47
4.5.1 Occurrence of Typhoid fever in Maina slum.....	48
4.5.2 Risk factors influencing tyhoid fever occurrence in Maina slum.....	49
4.5.3 Preventive measures used in Maina slum.....	53
CHAPTER V: CONCLUSIONS AND	
RECOMMENDATIONS.....	58
5.1 Conclusion.....	58

5.2 Recommendations.....59

5.3 Recommendations for future research.....[60](#)

REFERENCES.....61

APPENDICES.....6

4

viii

LIST OF TABLES

Table 4.1 Age, sex, occupation, marital status, religion and educational level of the respondents.....**34**

Table 4.2 Levels of disease awareness in the community.....**35**

Table 4.3 The independent variables and prevalence of typhoid.....**37**

Table 4.4 Comparison of water supply with the local eating places and occurrence of typhoid.....**40**

Table 4.5 Comparison of sanitation with hand and occurrence of typhoid.....**42**

Table 4.6 Showing eating habits, food handling, and education.....**43**

Table 4.7 Showing water provision, treatment and protection.....**45**

LIST OF FIGURES

Figure 2.1 Conceptual Framework.....**27**

Figure 4.1 The claims of suffering from typhoid.....**36**

DEFINITION OF TERMS

Commercialization	Buying of water by consumers from the water service providers at a cost
Community	People living together in an area sharing similar resources and problems
Disinfections	Addition of chemicals to water in order to destroy disease-causing pathogens
Health	A state of complete physical, mental and social well being and not merely the absence of disease or infirmity.
Health promotion	A movement in which knowledge practices and values are transmitted to people for use in lengthening their lives, reducing the incidence of illness and feeling better.
Household head	The person who is fully in charge of his own household
Hygiene	The degree of cleanliness expressed by an individual or humanity. This involves food, personal and community cleanliness
Outbreak	unusual cases of typhoid exceeding the normal cases
Prevalence	The number of cases at a given place in time
Sanitation	The disposal of general wastes from the environment with an aim of keeping the human environment clean and free from disease causing agents.

Slum	A crowded part of a town where people live in deplorable health conditions including poor housing, overcrowding, and unemployment and where disease burden is high.
Treated water	Water which is free from disease causing organism after boiling or disinfecting
Typhoid	A serious systemic infection caused by the enteric pathogen <i>Salmonella typhi</i> .
Water borne diseases	Those diseases whose pathogens thrive in water such as typhoid, dysentery, cholera and paratyphoid.
Water service provider	A private organization of local authority, which spearheads the water and sanitation services.

ABBREVIATIONS AND ACRONYMS

AMREF	- African Medical Research Foundation
CDF	- Constituency Development Fund
DMOH	- District Medical officer Of Health
DPHO	-District Public Health Officer
DWO	- District Water Officer
GoK	- Government of Kenya
JICA	- Japan International Co-operation Agency
JKUAT	- Jomo Kenyatta University of Agriculture and Technology
KIPPRA	- Kenya Institute of Public Policy Research and Analysis
MoE	- Ministry of Education
MoH	- Ministry of Health
MoST	- Ministry of Science and Technology
MFWI	- Ministry of Water and Irrigation
NGOs	- Non-Governmental Organizations
NMC	- Nyahururu Municipal Council
NYAHUWASCO	- Nyahururu Water and Sanitation Company
SQKM	- Square Kilometer
UNDP	- United Nations Development Programme
UNICEF	- United Nation Children Funds
WHO	- World Health Organization

ABSTRACT

Typhoid is a disease of public health importance which affects people of all walks of lives in urban, per-urban and rural areas. Water borne diseases, typhoid included kill about five million babies annually and make one sixth of the world population ill. It is estimated that globally about 17 million cases of typhoid fever occur annually causing 600,000 deaths. Typhoid fever is still common in the developing world, where it affects about 12.5 million persons each year. In Kenya the prevalence of typhoid fever is less than one per cent annually. In Maina slum it was reported that in 2005 the prevalence rate was at five per cent. The general Objective of the study was to investigate risk factors influencing the occurrence of typhoid fever among the adults in Maina slum within Nyahururu municipality in Laikipia district. The specific objectives were to establish the level of typhoid fever in the study area based on the knowledge of people on typhoid, to establish risk factors associated with the prevalence of typhoid fever among adult in the study area and to determine the effectiveness of water and sanitation interventions in reduction of typhoid fever. The study site was Maina slum in Nyahururu municipality, Laikipia district. The study design used in this study was descriptive cross sectional design. The method used to determine the prevalence of typhoid was a laboratory diagnostic method in this study. The data collection methods used included open ended and closed structured questionnaires, key informant interviews and Observational checklist while sampling methods used were simple random sampling and systematic random sampling. The results showed that the prevalence of typhoid was found to be 6.3%. The risk factors which were revealed by the study included low education level, leaking drainage systems, the type of houses used, water pollution and eating food from commercial kiosks among others. The effective water and sanitation interventions in place were connection of piped water in Maina slum for individuals to connect to their houses, provision of health facilities and application of health education to the residents among others. This study concludes that typhoid fever increased by 1.3% in duration of five years from 2005 to 2009. There were 198 (56.6%) who felt that they had suffered yet they had used self diagnosis through experience they had acquired about the disease over the years hence they could have misdiagnosed themselves. The 6.3% prevalence was established through questionnaires yet the evidence that the respondents had suffered was the positive medical laboratory results shown as well as being on medication. This indicates that the risk factors were still persistent and that there were no effective control measures in place. Typhoid fever being a potential life threatening illness caused by a bacterium *Salmonella typhi* it is necessary to engage effective intervention measures. Therefore an understanding of factors that influence the occurrence of typhoid fever in Maina slum, Nyahururu Municipality in Laikipia district was important in the management of the typhoid fever hence the basis of this study.

CHAPTER 1: INTRODUCTION

1.1 Background Information

Salmonella infections are usually spread by the faecal-oral route through contaminated water, food and poor sanitation. These infections include mainly typhoid and paratyphoid (Wood, 1992). In the past, water contaminated by human sewage was responsible for many outbreaks of typhoid fever, paratyphoid fever and cholera. Water borne outbreaks have become rare, following the improvement in water supply, though still common in countries with primitive sanitation and water supply (Twort et al., 1990), leading to high treatment costs and deaths (Winfred, 2005).

Typhoid fever is an illness caused by bacterium Salmonella. It is common worldwide, transmitted by ingestions of food or water contaminated with feces from an infected person. Without treatment, the illness may, last for 3 to 4 weeks and death rates range between 12% and 30 % (CDC, 2000). Following ingestion, the bacteria spread from the intestine via the bloodstream to the intestinal lymph nodes, liver, and spleen via the blood where they multiply. Salmonella may directly infect the gallbladder through the hepatic duct or spread to other areas of the body through the bloodstream. Early symptoms are generalized and include fever, malaise and abdominal pain. As the disease progresses, the fever becomes higher (greater than 103 degrees Fahrenheit), and diarrhea becomes prominent. Weakness, profound fatigue, delirium, and an acutely ill appearance develop. A rash, characteristic only of typhoid and called "rose spots," appears in some cases of typhoid. Rose spots are small (1/4 inch) red spots that appear most often on the abdomen and chest. Typically, children have milder disease and fewer complications than adults

A few people can become carriers of *S. typhi* and continue to shed the bacteria in their feces for years, spreading the disease, as in the case of "Typhoid Mary" in New York over 100 years ago. The complication of typhoid infection includes, intestinal hemorrhage (severe GI bleeding), intestinal perforation, kidney failure and peritonitis (poveish, *etal*, 2003)

Tests which are used in typhoid diagnosis aim at looking for an elevated white blood cell count in blood. These test includes, blood culture during first week of the fever which can show *S. typhi* bacteria, a stool culture, an ELISA test on urine may show Vi antigen specific for the bacteria, a platelet count (decreased platelets). A fluorescent antibody study demonstrates Vi antigen, which is specific for typhoid (Kaye, *etal*, 2004)

Intravenous fluids and electrolytes may be given in management of typhoid. Appropriate antibiotics are given to kill the bacteria. There are increasing rates of antibiotic resistance throughout the world, so the choice of antibiotics should be a careful one. The expectation (prognosis) of typhoid illness usually resolves in 2 to 4 weeks with treatment. The outcome is likely to be good with early treatment, but becomes poor if complications develop. Cases in children are milder, and are more debilitating in the elderly. Relapse may occur if the treatment has not fully eradicated the infection (Tuise, *etal*, 2005)

Typhoid is a disease of public health importance which affects people of all walks of lives in urban, peri-urban and rural areas. Water borne diseases, typhoid included kill about five million babies annually and make one sixth of the world population ill

(Jackson, 1989). The effect of typhoid fever has some socio-economic effects to the infected as well as the affected for several patients takes several weeks to recover especially if early treatment is not sought (WHO, 1998). The mortality rate of typhoid is as high as 30% in developing countries. In Kenya reported cases of typhoid from 1998-2000 were 7,379 which resulted into 780 deaths from the same period of time (GOK-HIS, 2002). In Nyahururu municipality where Maina slum is situated, typhoid fever is among the top five diseases which require an immediate public health attention in terms of prevention and control.

In U.S.A, about 400 cases occur each year and 70 percent of these are acquired while traveling internationally. Typhoid fever is still common in the developing world, where it affects about 12.5 million persons each year (James 2002). Visiting or living in areas where the disease occurs is a risk (Miriam, 2005). An estimated 17 million cases of typhoid fever and 600,000 deaths occur worldwide, annually (WHO, 2005).

1.2 Problem Statement

Incidence of typhoid can be reduced through improved sanitation and hygienic behaviour and access to clean water yet it is reported that typhoid prevalence is high. Increased health and disease awareness and improved attitude of residents do indeed reduce the prevalence of typhoid but typhoid prevalence is said to be high. Typhoid fever is confirmed through proper medical laboratory tests using viable reagents though wrong diagnoses do lead to wrong reporting. Self diagnosis through experience or otherwise could lead to wrong diagnosis and medication. Purchase of drugs from the counter

without medical laboratory results with proper prescription could lead to resistance of drugs to treatment of typhoid. If clean water system, sanitation facilities and hygienic practices are not sustained it would be difficult to control and prevent typhoid effectively.

The problem in Maina slum was high prevalence of typhoid fever. Hospital record showed that typhoid prevalence was 5% in 2005(DMOH, 2005) which is higher than the National typhoid prevalence which is less than 1%. When pathogenic agent gains access to water and when consumed by a person who does not have immunity to the disease the transmission occurs (Wood, 1992). Typhoid outbreaks do occur if control and preventive measures are not taken in a timely manner. Poor waste disposal and hygiene of workers in food handling and preparation activities would provide an obvious infection route. The situation is complicated in that some people may be carriers of typhoid so that although they exhibit no outward signs of the disease their excreta contain the pathogens. Incorrect reporting of data could give a wrong impression on the prevalence of typhoid in the area of study. The reporting was made on the basis of clinical diagnosis without any medical laboratory tests done. Clinical diagnosis is not reliable because it is based on symptoms, and some diseases could present the same in terms of signs and symptoms. Self diagnosis could lead to misdiagnosis and improper treatment. Mostly the treatments were self treatment through buying drugs from the counter. This could bring about drug resistance in the future. If diagnosis is correct and treatment is not accurate, the disease may thrive and cause an increase in prevalence of typhoid fever.

1.3 Justification of the study

Since adults in Maina slum continue to suffer from typhoid fever to date it was necessary to find out risk factors behind it. Whenever the adults living in Maina slum are infected by the *Salmonella typhi*, their dependants are affected directly or indirectly.

The study will look at the methods of diagnosis and the knowledge of the residents about the disease. This study will also seek to know the conditions that are conducive to high prevalence of typhoid in Maina which is higher than the national prevalence of typhoid. After the risk factors on typhoid are established it would be possible to devise appropriate control and preventive measures by MOH. The control and preventive programmes in the study area can be formulated and government policies enhanced by MOH, MOST, MOE and NYAHUWASCO. It has taken long for this disease to decline despite the provision of piped and treated water in the Maina slum since 2003 (MD, 2006) and presence of Maina dispensary in the vicinity of Maina slum. It is hoped that results from this study would be useful in showing whether there was high prevalence of typhoid or not. If the prevalence will be found to be low than reported from the hospital records in 2005, recommendations will be made to the relevant departments in the health facilities and other agencies appropriately.

1.4 Research Questions

1. Is typhoid fever as high as reported?
2. What are the risks factors influencing high prevalence of typhoid in Maina slum?
3. Are the methods used for preventive and control of typhoid in the study area effective?

1.5 Null hypothesis

- 1) The prevalence of typhoid fever is low in Maina slum.

- 2) Poor environmental sanitation in informal settlement is not conducive to high prevalence of typhoid in Maina slum.
- 3) Preventive and control methods used in Maina slum are effective in typhoid management.

1.6 Objectives of the Study

1.6.1 General Objectives

To investigate risk factors influencing the occurrence of typhoid fever among the adults in Maina slum within Nyahururu municipality in Laikipia district.

1.6.2 Specific Objectives

1. To establish the prevalence of typhoid in Maina slum.
2. To determine factors influencing typhoid infections in Maina slum.
3. To establish methods of typhoid diagnosis in Maina slum.
4. To determine the effectiveness of preventive and control measures in place.

1.6.3 Significance of the Study

The results of this study are intended to be utilized by the interested parties such as NYAHUWASCO, MoW, and MoH and other government institutions that are concerned with provision of services in Maina slum. It is hoped that the study findings would contribute to the understanding of the risk factors that influence the spread of typhoid fever in the informal settlements. This study would shed light on whether the control measures in place are effective in control of typhoid fever. It is hoped that the results would be of great use to programme planners, academics, policy formulators and

implementers, donors, curriculum developers and other service providers in control of typhoid fever.

CHAPTER II: LITERATURE REVIEW

2.1 Typhoid

The bacteria *Salmonella enterica typhi* is one of three species of the *Salmonella* genus; together these diseases are known as salmonellosis. *Typhos* in Greek means 'to smoke' or 'cloud' or 'vapor.' Typhoid fever was thought to have been transmitted through a cloud of sickness known as miasma. The *Salmonella typhi* bacteria are an obligate parasite with no other known reservoir outside of humans. After recovering from an infection, 3-5% of humans become carriers of the disease. The bacteria infect the intestinal tract and occasionally the bloodstream. There are over 100 strains of *Salmonella typhi* but only a few strains cause typhoid fever. 100,000 organisms of *Salmonella typhi* make up an infectious dose, and the disease is typically spread through feces and urine of infected people in contaminated food and water.

2.2 History of Typhoid Fever

Typhoid fever has harassed mankind since the beginning of civilization. In 1998, an article in the *New England Journal of Medicine* suggested that the death of Alexander the Great at the age of 32 on 13 June 323 CE was caused by typhoid rather than poison or malaria. Researchers at the University of Maryland's School of Medicine argued that Alexander's symptoms- sharp abdominal pain, chills, and steadily rising fever- matched the symptoms of typhoid fever. Historical accounts suggested that Alexander's body did not deteriorate for several days following his death. Although the tale was possibly exaggerated, the event could be explained by ascending paralysis, a complication of typhoid, which causes slow paralysis from the feet up. A body may seem dead as the

paralysis develops before he actually died. Other scholars have suggested that West Nile Virus was the disease that killed Alexander (Berth P.A, *etal*)

Prince Albert, the Consort of Queen Victoria, contracted typhoid fever and died four weeks later in December 1861. During his illness, he experienced intermittent but increasingly more severe fevers that led to delirium, a worsening cough, and salmon-colored skin lesions on his torso. The son of Albert and Victoria, Edward, also died of typhoid.

Typhoid fever had always threatened densely population areas with inadequate sanitation. In the settlement of Jamestown, Virginia, the first permanent English settlement in North America, outbreaks pf typhoid fever was a constant threat to survival. Between 1607 when the colony was founded and 1624, at least 6,000 settlers died from typhoid fever. By 1623, only 4,500 inhabited the settlement. During the Spanish American War in 1898, typhoid fever raged through the armies. 82% of all sick soldiers suffered from typhoid, which also accounted for 87% of total deaths from disease. During the South African War (1899-1902), the British lost more to typhoid (13,000 soldiers) than those that died due to battle (8,000 soldiers).

The *Salmonella typhi* bacteria were first described by Karl Joseph Eberth, a German bacteriologist, in 1880. Eberth found the bacteria in the spleen and mesenteric lymph nodes of a patient who died of typhoid fever. Robert Koch had also observed and recorded the bacilli. In 1884, Georg Theodor August Gaffky, another German bacteriologist who worked under Robert Koch, confirmed the *Salmonella typhi* bacteria

as the causal agent of typhoid. At first the bacterium was called *Eberth Bacillus*. In 1896, the British pathologist Sir Almroth Wright and his team developed the first vaccine of heat-denatured whole-cell typhoid bacilli. During World War I, British troops were immunized and largely escaped the disease.

2.3 Typhoid Mary

In the Journal of American Medical Association published on 15 June 1907, George Soper, a sanitary engineer, revealed the results of his investigation into a typhoid outbreak at the home of Charles Henry Warren, a wealthy New York City banker. 6 of the 11 people in the house contracted the illness. At first, Soper suspected clams or other contaminants, but then discovered that the family's cook, Mary Mallon, an Irish immigrant, was a healthy carrier of the typhoid bacteria. 'Typhoid Mary' was the first healthy carrier of typhoid discovered in the United States. In March 1907, Soper found Mallon, who was serving as a cook in a Manhattan house. He told her she was spreading disease through her cooking, and demanded samples of her feces, urine and blood for tests. She chased him away with a carving fork.

When Soper carefully charted Mary Mallon's work history, out of the 8 households she cooked for, 7 had typhoid outbreaks. On this evidence, the New York City health inspector removed Mallon to be tested in March 1907. Salmonella typhi bacteria were discovered in Mallon's feces samples. Mallon was moved to Riverside Hospital on North Brother Island near the Bronx. She remained in the hospital for three years and protested every moment of her captivity. When she was released in 1910, the New York City health commissioner Ernst J. Lederle helped Mallon locate a job washing clothes.

Mallon's new occupation did not afford the same social and economic opportunities as her previous job as a cook, and Mallon felt authorities treated her unjustly. Unconvinced that her cooking caused the deadly disease, Mallon disappeared and returned her former occupation. In 1915, she was working in Sloane Maternity Hospital in Manhattan as a Mrs. Brown when a typhoid outbreak in the hospital led authorities to Mallon. She was returned to North Brother Island where she was kept in isolation for 23 years until her death. Children of former employees reported that in addition to working in the laboratories, Mallon apparently baked and sold cakes on the hospital grounds. At the time of her death, Typhoid Mary was one of hundreds of healthy carriers of the *Salmonella typhi* bacteria in New York City. Many later believed her harsh treatment revealed underlying social prejudices against her Irish background.

2.4 History of Typhoid as a Biological Weapon

The *Salmonella typhi* bacteria were weaponized by the Japanese biological weapons program Unit 731. Like cholera, typhoid was used to contaminate drinking water. Chinese, Russian, Korean and American prisoners of war were injected with typhoid bacteria to study the disease. Reports suggested that the Japanese infected rivers between Manchuria and the Soviet Union with typhoid bacteria, but with the successful invasion of the Soviet Union in 1939, the effectiveness of the typhoid was never determined.

Reports by the International Committee of the Red Cross (ICRC) released 50 years after the incident revealed that the Israeli forces, at the siege of Acre in 1948, released typhoid bacteria into the city's water supply. According to Dr. Uri Milstein, an Israeli historian, a typhoid outbreak seized the city a few days before the city fell. Israeli soldiers disguised

as Arabs were caught on 23 May 1948 in Gaza near wells. Egyptian authorities maintained these soldiers carried liquid with dysentery and typhoid bacteria. The Israeli soldiers were charged, convicted, and executed. The Israelis have denied all charges of the use of biological weapons (ICRC, 1990)

In 1972, the Order of the Rising Sun, a US extremist group dedicated to the rise of a new master race, was found with 30-40 kilograms of typhoid bacteria cultures. The group had intended to use the bacterial agents against water supplies in Midwestern US cities including Chicago and St. Louis. In September 1984, in an attempt to influence local elections in Antelope, Oregon, it was suspected that the Rajneesh cult contaminated local salad bars with *Salmonella enterica*, a variant of *Salmonella typhi*. Hundreds were affected, 45 were hospitalized but no fatalities resulted.

Typhoid fever in aerosolized form can be a potential biological weapon, and sources reported that both Iran and Iraq experimented with typhoid fever as a possible biological weapons agent.

2.5 Overview of the occurrence of typhoid and its severity

Typhoid fever is still common in the developing world, where it affects about 12.5 million persons each year (James, 2002). Visiting or living in areas where the disease occurs is a risk (Miriam, 2005). An estimated 17 million cases of typhoid fever and 600,000 deaths occur worldwide, annually (WHO, 2005). Globally, there are four billion cases of diarrhea among children; cholera water borne bacteria infected 120,000

people in 2002 and in the same year there were 50,000 cases of guinea worm in thirteen African countries.

Six million people are blind because of trachoma and twelve million people are infected with typhoid annually (WHO, 2000). Maina slum being densely populated is potentially a high-risk area for typhoid outbreak. In Maina slum the prevalence of typhoid fever was estimated to be five percent by the year 2005 despite provision of treated water, and sanitation services by Nyahururu Municipal Council (DMOH, 2005). The effects of typhoid fever range from negative socio-economic impact to the majority of the patients who require several weeks to recover, and hence is a major public health concern (WHO, 2004). In addition of typhoid having a direct socio-economic effect (Wood, 1992) to those infected and affected, its' treatment is also quite expensive. This study therefore sought to investigate the risk factors influencing the occurrence of typhoid among adults in Maina slum.

This is an indication that typhoid fever is a disease of public health importance in this slum. Typhoid fever (enteric fever) is a septicaemic illness characterized initially by fever, bradycardia, splenomegally, abdominal symptoms and rose spots, which are clusters of pink macules on the skin. Complications such as intestinal hemorrhages or perforation can develop in untreated patients or when treatment is delayed (CDC, 2006). Typhoid fever is treated using antibiotics. A person will usually recover in 2-3 days with prompt antibiotics treatment. People who do not get prompt medical treatment may continue

to have fever for weeks or months and as many as 20% may die from complications of the infection (Levine, 1990). Typhoid is caused by *Salmonella typhi*, which is exclusive to humans and may lead to severe symptoms in the digestive system in the second phase of the illness. Without therapy the illness may last between three to four weeks and death ranges between 1% and 30% (WHO, 2005). Persons with typhoid fever usually have a sustained fever as high as 103⁰ to 104⁰F (39⁰ to 40⁰ C). The diagnostic test for typhoid is demonstration of antibodies to *Salmonella typhi* in blood (CDC, 2005).

2.6 Water Contamination in Developed Countries and Developing Countries

The sight and smell of grossly polluted waterways provided some of the original impetus to the environmental movement in the 1970s. Nearly a century before that, the dangers of polluted water to human health drove what became known as the "sanitary revolution" in Europe and the United States, emphasizing clean water supplies and sewer systems in cities. Today, despite progress in cleaning up waterways in some areas, water pollution remains a serious global problem, with impacts on the health of freshwater ecosystems and the human communities that rely on them for water supply.

2.6.1 The Changing Pollution Profile

Water pollution spans a wide range of chemical, physical, and microbial factors, but over the years the balance of major pollutants has shifted markedly in most industrialized countries. One hundred years ago, the main water contamination problems were fecal and organic pollution from untreated human waste and the byproducts of early industries. Through improved treatment and disposal, most industrialized countries have greatly reduced the effects of these pollutants, with consequent improvements in water quality.

Pollution laws and pollution control technologies have succeeded especially well in cutting emissions from concentrated "point sources" like factories and sewage treatment plants. For example, from 1972 to 1992 the amount of sewage treated at wastewater treatment plants in the United States increased by 30 percent, yet the organic pollution (measured as the Biological Oxygen Demand) from these plants dropped 36 percent.

Unfortunately, a new suite of contaminants from intensive agriculture and development activities in watersheds has kept the cleanup from being complete. In general, national clean-up programs have not been effective in reducing "nonpoint" pollutants such as nutrients, sediments, and toxics that come in runoff from agriculture, urban and suburban stormwater, mining, and oil and gas operations (Carmen Refenga and Greg Mock, 2000)

Meanwhile, in most developing countries, the problems of traditional pollution sources like sewage and new pollutants like pesticides have combined to heavily degrade water quality, particularly near urban industrial centers and intensive agricultural areas. An estimated 90 percent of wastewater in developing countries is still discharged directly to rivers and streams without any waste processing treatment

2.6.2 Water Contamination Overview

Over the past few decades, the increase in population and advances made in farming technology has increased the demand for crops and livestock from the agricultural industry. This growth in agricultural production has resulted in an increase in contaminants polluting soil and waterways. The increase in contaminants has prompted

efforts to reduce the amount of pollutants in waterways in order to improve overall water quality.

2.6.3 Sources

Agriculture in many parts of the world is highly efficient in producing and delivering high-quality products to consumers. However, when agricultural activities are not well-monitored and managed, certain practices can negatively affect water quality.

2.6.4 Agricultural Runoff



According to the U.S. Environmental Protection Agency (EPA), nonpoint source (NPS) pollution is pollution that comes from many diffuse sources, unlike pollution from point sources such as industrial and sewage treatment plants. “Polluted runoff is created by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into watersheds via lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water” .

In 2002, in the National Water Quality Inventory report to U.S. Congress, the states reported that agricultural nonpoint source (NPS) pollution is the leading cause of river and stream impairment and the second leading cause of impairment in lakes, ponds, and reservoirs . Agricultural activities that cause nonpoint source pollution include:

- Poorly managed animal feeding operationsOvergrazing

- Overworking the land (for example, plowing too often)
- Poorly managed and ineffective application
- of pesticides, irrigation water, and fertilizer

2.6.5 Effects

Agricultural water can become contaminated through a variety of ways and can potentially spread bacteria, viruses, and parasites to crops and animals.

2.6.6 Crop Production

Fresh fruits and vegetables come in contact with water during various stages of the production process. Contaminated water that is used during crop production, harvesting, and processing can lead to health issues.

Below is a list of the potential food production points where contaminated water sources can affect crop production:

2.6.7 Chemical Application

Crops with contaminated water used for pesticide or herbicide application. Water used for mixing chemicals should be of appropriate quality.

2.6.8 Irrigation

Irrigating crops with contaminated water. Water used for irrigation should be of appropriate quality. People who consume fruit or vegetables that were exposed to contaminated water are at risk of developing a foodborne illness. Some of the bacteria that are spread through water within the United States include *E. coli*, *Salmonella spp.*, *Shigella spp.*, *Cryptosporidium*, *Giardia*, *Toxoplasma*, norovirus, and hepatitis A virus. Irrigation of foods imported from international locations can spread these and other microbes (for example, *Cyclospora*) not usually found in developed countries. Small

amounts of any of these organisms can cause foodborne illness. In order to keep microbes out of water sources, growers should use practices that are appropriate for their operation and make sure that they are using the best quality water. Water quality is also important in ensuring post harvest quality by decreasing decay.

2.6.9 Worker Hygiene

Lack of potable water for hand hygiene affects hand washing practices. There should be an established handwashing and hygiene policy for farm workers.

2.6.10 Food Processing

Wash crops in the final wash process with quality water. Water should be of drinking water quality and should not be recycled.

2.6.11 Animal Health

It is important that livestock are provided with adequate amounts of quality water, free of contamination. Contaminated water can contain disease-causing organisms which can rapidly spread if animals are drinking from the same trough. If there is reason to question the quality of the water that is provided to livestock, it is important to test the water to ensure its safety. There are many chemicals and microorganisms that can be potentially dangerous to livestock. Some chemicals include nitrates, sulfates, and chemicals found in pesticides like DDT, Chlordane, and Endrin. Certain microorganisms such as blue-green algae, *Cryptosporidium*, or *Staphylococcus*, can be toxic to animals and cause symptoms like diarrhea, lack of coordination, labored breathing, or death of animals can then release millions of infectious microbes into the soil that can further contaminate other water sources.

2.7 Risk factors associated with prevalence of typhoid fever

2.7.1 Water Contamination

The bacterium *Salmonella typhimurium* lives inside humans. The bacterium lives and multiplies in the blood stream and digestive tract of infected persons. Transmission is through contaminated faeces in water or food (Ray, 2002). Faecal pathogens are frequently transferred to the water borne sewage system, through flush toilets and pit latrines subsequently contaminating surface and ground water (Pruss *et al.*, 2006). In regions with poor sanitation, the bacteria often spread after water supplies are contaminated by humans waste (WHO, 2000).

The principal carrier of typhoid bacteria is water. Water can be extremely dangerous when it becomes the vehicle of the transmission of disease. The principal sources of water contamination are man, animal and bird excreta (Twort, 1990). Untreated sewage is dangerous to public health because it contributes to environmental water, land and air pollution. Discharging highly polluting waste into a body of water has negative effects on human, animal and plant life. Too many pollutants reduce the self-purification capacity of water, especially at the point of mixing and, they promote excessive growth of aquatic plants. Polluted waters are aesthetically unacceptable because they emit unpleasant odours (Rukunga, 2001).

Pathogenic organisms that cause typhoid fever enter into the water as a result of a damaged or faulty sewer or water pipes, excreta soaking through the surface solid into subsoil water, deep well contaminations due to faulty construction, maintenance or personal carelessness and contamination of animals or birds particularly seagull (Twort,

1990). Water which sewage gain access into causes diarrhea (Notter, 1994). Water borne diseases are the prime cause of premature deaths worldwide, especially for young children (WHO, 2002). Increase in urban population may lead to an increased risk in food and water supply contamination (WHO, 1992).

2.7.2 Health carriers of typhoid disease

Since Salmonella typhi bacteria live in humans, it is only humans who can be carriers. Persons with typhoid fever carry the bacteria in their bloodstream and intestinal tract. In addition, a small number of persons, called carriers, recover from typhoid fever but continue to carry the bacteria. Both ill persons and carriers shed *Salmonella typhi* in stool (WHO, 2005). When people who are carriers of typhoid fail to wash their hands thoroughly with soap and clean water after defecation they risk passing the causative organism to others.

2.7.3 Sanitation practices

Sanitation refers to the safe collection, storage and disposal of various wastes resulting from human activities. These include solid wastes, refuse and liquid wastes effluent from sewage works, kitchen sink and even hazardous waste from industries. It also refers to the general maintenance of the human environment in a safe condition free from pollution. It involves the behaviour change and availability of adequate facilities that ensure a hygienic environment (MOH, 1999; Nyamwaya *et al.*, 1999; WHO, 1987). Poor sanitation practices are a cause of bacterial, viral, protozoa and helminthic infections (Feachem, 1997).

In many developing countries there exists a high prevalence of water and sanitation related diseases causing many people to fall sick or even die (WHO, 1987). Faeces can be the source of much sickness in the community if it is accessible to flies, fingers, and fluid and eventually to food. This is referred as the five-F connection (Wood, 1992). This pathway is known as the faecal-oral route of disease transmission (Donald, 2004).

In order to combat diseases caused by inadequate sanitation more efficiently installation of sanitary excreta facilities should be encouraged with measures taken to dispose of wastes (Charles, 1995). In regions of the world where sanitation and garbage disposal are lacking, typhoid fever continues to destroy life (Donald, 2004). Moreover, the rapid increase in the population combined with a massive migration to urban areas has led to the formation of urban centres of high population density in many countries. The increase in urban population has occurred at such a pace that it has outstripped the development of the health related infrastructure including basic sanitation.

Endemic typhoid fever in Uzbekistan was transmitted by contaminated water. Recent use of antimicrobials also increased risk of infection. Targeted efforts at improving drinking water quality, especially for students and young adults, are likely to decrease transmission of typhoid fever. Measures to decrease the unnecessary use of antimicrobials would be expected to reduce the risk of typhoid fever and decrease the spread of multiple drug-resistant *Salmonella typhi* (Padmini Srikantiah. *Etal*, 2007)

2.7.4 Lack of hygiene

Transmission is by contact with contaminated water and food through food handlers, sewage, contamination of drinking water or food. Large epidemics are most often

related to faecal contamination of water supplies or street foods (WHO, 1998). Therefore, typhoid fever is more common in areas where hygienic practices are not observed and with poor sanitation practices. Infection with *Salmonella typhi* results in development of fever and other signs and symptoms (Levine, 1990). Typhoid fever can also be spread through irrigation of crops using sewage contaminated with *Salmonella typhi*. Humans are the only natural hosts of *Salmonella typhi* (Donald, 2004).

Food and water is rendered unfit for human consumption when contaminated with *Salmonella typhi* (GOK, 2005) and many naturally occurring water sources are liable to such contamination at some point (WHO, 1969). Typhoid fever is spread in faecally contaminated food and water and often comes in epidemics; hence it is one of the dangerous infections (David, 1993).

The majority of urban populations are tenants in informal settlements where basic services such as water and sanitation are inadequate (UNDP, 2001). Visiting or living in areas where the disease occurs is a risk (Miriam, 2005).

2.8 Preventive measures in place for typhoid control

2.8.1 Food and Personal hygiene

Hygienic practices include food and personal hygiene. Food hygiene is concerned with all measures necessary for ensuring the safety, wholesomeness and soundness of food at all stages of production, preparation, marketing and distribution (Wood, *et al.*, 1992). Although food is a basic human need it can sometimes cause a number of illnesses arising from pathogenic and toxic substances, which find their way into food through contamination or spoilage (WHO, 2005)

2.8.2 Hand washing practices

People should wash their hands after visiting toilets, before and after eating foods in order to prevent typhoid fever since hygiene is the best method of preventing it (typhoid fever) and many other bacterial diseases (WHO, 1994). People should wash their hands with soap and hot water before handling food items. Using soaps kills the typhoid bacteria (Ray, 2002). One of the key ways to stop the spread of typhoid fever is to promote and practice good hygiene. Even where there is excellent sanitation, disease will spread rapidly if hygiene is poor (WHO, 1996). Proper hand hygiene is important in preventing further spread in hospitals. The Kenyan Public Health Act, chapter 242, provides that infectious diseases should be controlled and prevented.

2.8.3 Immunization and treatment

Vaccination of high-risk populations is considered the most promising strategy for the control of typhoid fever (Wood et al., 1992) but control of typhoid fever outbreaks is mainly by sanitation and not immunization (Wood et al., 1992). Usually the prevention of enteric disease comprises basic sanitary and hygiene measures, including purifying water supplies, improvising water delivery and sewage control, supplying hand washing facilities, construction and use of latrines, boiling water and supervising of food handlers (WHO, 1998).

Typhoid fever is common in developing countries. The licensed typhoid vaccines confer only about 70 percent immunity, do not protect young children, and are not used for routine vaccination. A newly devised conjugate of the capsular polysaccharide of *Salmonella typhi*, Vi, bound to nontoxic recombinant *Pseudomonas aeruginosa* exotoxin

A(rEPA), has enhanced immunogenicity in adults and in children 5 to 14 years old and has elicited a booster response in children (Lin FY,2001)

National decisions concerning strategies to control typhoid fever should be based on thorough analyses of age- specific incidence on groups at particular risk of infection and on cost benefit aspects of the planned control measures (WHO, 2002). Typhoid fever can be prevented and is treated with antibiotics such as chloramphenicol, ampicillin, tetracycline, co-trimaxazole, trimethoprim-sulfamethaxaole and ciprofloxacin (WHO, 1999, 2005). Within the hospital setting, infected people are cared for in isolation.

We review the significance of the Widal agglutination test in the diagnosis of typhoid fever and Over 100 years since its introduction as a serologic means of detecting the presence of typhoid fever, the Widal test continues to be plagued with controversies involving the quality of the antigens used and interpretation of the result, particularly in endemic areas. Areas of concern with clinical and laboratory significance discussed in this review include: the techniques of test performance, interpretation of results, limitation of the value of the test results in endemic typhoid areas, the quality of the antigens used, and alternative diagnostic tests(Olopoenia LA *et al*)

Household refuse can be a real threat to health if proper arrangements are not made for its disposal. Each home must therefore practice appropriate methods of rubbish disposal (Julia, 1999). To improve sanitation it is necessary to provide simple facilities, which are cheap and easily made by any family and also help people understand the importance

of using them (Wood, 1992). The hygienic disposal of excreta is important because the infective organism for typhoid fever leaves the body in the faeces and some in urine. 58.9% of households in Rift valley province use traditional pit latrine, and access to sanitation facilities are important determinants of health status (GOK, 2003). In Laikipia District, 72.9% of households have pit latrine as the main human waste disposal (GOK, 2001). The Ministry of Health in its National Health Sector Strategic Plan targets to increase provision of safe water and improve sanitation in rural areas by 30%.

The clinical setting, user preference and local conditions will be important in determining which test is more appropriate (Baridalyne N. *etal*, 2000)

A key factor in disease prevention among children is an efficient means of sanitary disposal. Sanitary conditions in any human settlement have a direct impact on the prevailing environmental and health standards of the inhabitants. At National level of 83% of households had access to decent sanitary facilities such as main sewer and pit latrine by 1999 (GOK, 1999). Sanitation on the other hand remains a major challenge in Kenya, largely due to inadequate provision and poor management of existing facilities (GOK, 2002). According to the Kenya National Development Plan (2002-2008) there are 142 gazetted urban areas in Kenya of which only 30 per cent had a sewerage system posing serious environmental and health problems. Latrines are used to break the transmission of diseases associated with human waste disposal (Rukunga, 2001).

2.8.4 Provision of clean treated water

Nyahururu water and Sanitation Company Limited is the one which carry out waste disposal in Maina slum and was incorporated as a private company in accordance with the company Act Cap 456 of the Laws of Kenya in February 2002 and became fully

functional by July 2003. The objective of the company was to provide quality affordable water and expand water distribution and sewerage networks in order to deliver sewerage services to all consumers.

The company is also improving on water revenue collection since the company was started, consumers' complaints have reduced drastically and billing is up to date and the rate of payment has increased, boosting the revenue collection up to 30 percent. Water theft has reduced from 70 per cent to 40 per cent. The management of the company claims that water quality has improved, hence reducing water borne diseases (MD, 2006).

Nyahururu water and sanitation services have been expanded to provide water to places such as Kibathi, Laikipia campus and Mairo Inya. The company plans to take over Marmanet water supply, Nyahururu / Gatimu water scheme and Leshau / Karago-ini water projects. The company also plans to extend the existing sewerage treatment works. The company was formed as a result of water sector restructuring process that is on going according to the Water Act, 2002.

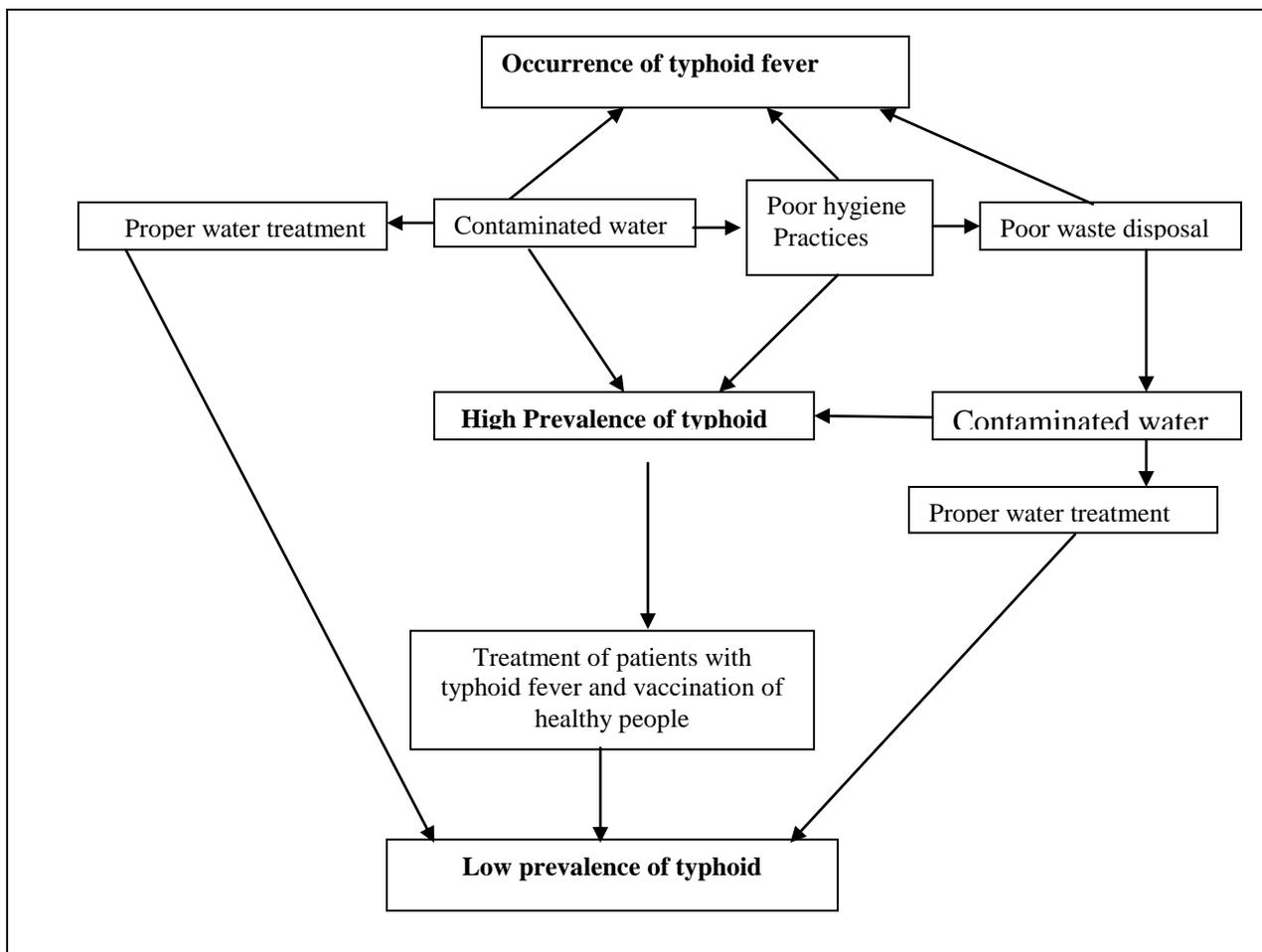
In summary there are three key hygienic practices which are paramount to prevention of typhoid fever (WHO, 1994). Disposal of faeces particularly those of young children, babies and ill people should be carefully and quickly be disposed off. People washing their hands regularly with soap and water particularly after defecating, after handling babies faeces, before feeding and eating and before preparing food for the germs on their hands are removed or killed. Maintaining drinking water free from faecal contamination,

the source of water must be protected and drinking water boiled and stored in a clean covered container to prevent post faecal contamination

2.8.5 Conceptual Framework according to wood, 1992.

Contaminated water, poor hygiene practices and poor waste disposal are expected to facilitate the occurrence of typhoid fever. Poor waste disposal do contaminate water as well, adding up to the increase of typhoid fever. However, proper water treatment and treatment of people suffering from typhoid, and vaccination of healthy people would reduce the prevalence rate of typhoid fever (Figure 2.1)

Figure 2.1 Conceptual Framework



CHAPTER III: STUDY METHODOLOGY

3.1 Study Area

The study area is congested with many houses of different types as shown on (page 59). In Maina slum there are many leaky and perforated waste pipes and as such do possibly contaminate the surface water sources. The solid wastes are scattered in many parts of the slum without being collected for disposal. The collection of wastes is a responsibility of the Nyahururu municipal council yet the frequency of collection is minimal. Some parts are not accessible by a vehicle hence the accumulation of the wastes is great. The residents do live in dilapidated houses some of which are temporary, semi-permanent and others permanent. Treated water is connected in the slum but not all who access the water. The reason of not accessing the water mainly is the high cost of connection to an individual household and the water charges after consumption.

The study was carried out at Maina slum situated 2 kilometers away from Nyahururu town in Laikipia district. Maina slum had high prevalence of typhoid in Nyahururu municipality by 2005 (MOH, 2005). Since Maina slum forms part of Nyahururu municipality the following services are given which include garbage collection, water and sewerage provision all at a cost (MD, 2006). The population of Maina slum has continued increasing since 1999 partly due to rural –urban migration and internally displaced persons.

By 1999 the slum had a population of 10,243 people of whom 5188 were females. There are 2886 households covering an area of 6.8 square kilometres (CBS, 1999). There are

various water sources in Maina slum such as springs, seasonal rivers, tap water, and rain water through roof harvesting (GOK, 2002) which are shared among the general population. Water borne diseases are common in the slum with majority of typhoid cases reported at Nyahururu district hospital being from the slum.

3.2 Study Design

This was a descriptive cross sectional study. The design was appropriate to this study which was on the risk factors influencing typhoid fever occurrence in Maina slum because it was descriptive in nature. The study sought to describe the state of affairs as they existed in the study area (Orodho, 2003).

3.3 The Study Population

The study population consisted of adults aged 18 years and above.

3.4 Inclusion Criteria

All household heads or their representatives aged 18 years or above who were living at Maina slum at the time of the study and gave an informed consent to the study.

3.5 Exclusion Criteria

All household heads or their representatives aged below 18 years and those who were not living in the study area by the time of data collection.

3.6 Sampling Techniques

Maina slum has approximately 2886 households with an estimated population of 10243 people (CBS, 1999). Systematic random sampling was used to determine the number of

households to be visited. The sampling interval was determined by dividing the total number of households by the sample size and every 8th household was visited as described by Mutai ((2000)

$$K = \frac{\text{sampling frame (N)} = 2886}{n=350} = 8$$

3.7 Sample Size Determination

The formula of Fisher *et al*, (1998) for population greater than 10,000 was used in sample size determination.

$$\text{Thus } n = \frac{z^2 pqD}{d^2}$$

n= desired sample size of the population valid only when the population is more than 10,000

Z= the standard deviate, usually 1.96 which corresponds to 95% confidence level.

p = proportion of the target population estimated to have the particular characteristics under the study. In this case 35.1 per cent have treated piped water (CBS, 1999)

$$p = 0.351$$

$$q = 1 - p, \text{ i.e. } 1 - 0.351 = 0.649$$

d=Degree of accuracy usually (0.05)

D= design effect usually 1 where there are no replications or comparisons

$$\text{Thus } n = \frac{1.96^2 \times 0.351 \times 0.649 \times 1}{0.05^2} = 350$$

Hence 350 respondents were selected.

3.8 Data Collection Instruments

These instruments included structured and semi-structured questionnaires, key informant interview schedule and observation checklists. Key informant interviews were

administered to the Maina slum chief and the Nyahururu water and sanitation company managers

3.9 Methods of data Collection

A pilot study was conducted which tested the validity and reliability of the instruments. Three research assistants were trained on data collection procedures and monitored during the process of data collection by the researcher. The response rate was 100% for there were no non-consenting respondents.

3.10 Study Variables

The study variables were independent and dependent. The independent study variables were the risk factors associated with the high prevalence of typhoid fever while the dependent variable was the prevalence of typhoid in Maina slum. Independent variables (predictor variables) are those which manipulate the problem in study. This means they are the causes of the problem. The dependent variable is the one which relies on the independent variable in order for it to occur thus the dependent variable refers to the effects (outcomes) of the causes.

The independent variables were drainage systems, human waste disposal, sale of food in hotels, health education, water treatment, sex, age of respondents, religion, occupation, while the dependent variable is the occurrence of typhoid fever in Maina slum. The respondents were required to show a medical evidence of their suffering from typhoid. Those on medical treatment with medical laboratory results as an evidence and were

suffering from typhoid during the data collection formed the prevalence of typhoid in Maina slum.

3.11 Data Analysis

Data was analyzed using SPSS computer software version 11. Data was processed by use of a computer and statistical calculator. The processed data was presented in tables, pie-charts, and bar graphs. Chi-square test of independence (contingency tables) was used to determine if there was a relationship between control measures of typhoid and its occurrence in the study area.

3.12 Ethical consideration

Permission to conduct the study was obtained from Kenyatta University, Provincial Administration, NMC, DWO, MOH, DPHO, MOE and MOST. Informed consent was obtained from the respondents after providing them with all the necessary details about this study. Confidentiality of the data collected was upheld throughout this study.

3.13 Assumptions of study

There were general assumptions that the results would reveal the factors behind the high prevalence of typhoid in the study area after the necessary research steps were followed. The researcher assumed that all the respondents were literate and that they would answer all the questions as asked hence a response rate of 100% realized though a pilot study was carried out. There was an assumption that tap water was potable hence fit for human use before boiling.

3.14 Limitations

Those who had only achieved primary level education had problem in completing the questionnaires as detected during the pilot study. This affected the time scheduled for the data collection. Dry spell of weather also affected the time planned for the collection of the answered questionnaires from the respondents because most of the subjects were away from their homes seeking relief food. However the respondents who were away were visited in the evening or very early in the morning before leaving their homes.

3.15 Scope of the Study

The study was done at Maina slum which is within Nyahururu municipality in Laikipia district. This was because Maina slum was established to have high prevalence of typhoid fever from the medical records found in Nyahururu district hospital than other areas seeking health care in the same district health facility. Questionnaires, key informant interviews and observation checklists were the data collection tools used in this study while the study design was a descriptive cross-sectional. The study was restricted to adults, both males and females because they composed the study population in this study. This study was quantitative and not qualitative.

CHAPTER IV: RESULTS AND DISCUSSION

4.1 Social-demographic description of the study population

Table 4.1 Age, sex, occupation, marital status, religion and educational level of the respondents

Age of respondents(Years)	Frequency	Percentage (%)
18-27	90	25.7
28-37	116	33.1
38-47	121	34.6
>50	23	6.6
Sex		
Males	168	48.0
Females	182	52.0
Occupation		
Employed	74	21.2
Un-employed	123	35.1
Self-employed	153	43.7
Marital status		
Married	203	58
Single	105	30
Separated	35	10
Divorced	7	2
Religion		
Christians	336	96
Muslims	14	4
Educational Level		
Primary	202	57.7
Secondary	115	33.0
College	23	6.5
Non-formal	10	2.8
Total	350	100

4.1.1 Occupation, marital status, and religion of the respondents by age and sex

All the respondents were adults, majorities (58.8%) were aged 18-37 years and 41.2% were aged from 38 years and above. Females constituted (52%) while males were 48%. Fifty eight percent were married and 42% were single, separated or divorced. The

research findings revealed that 97% of the respondents were Christians while 4% Muslims. This showed that Christian faith was dominant in Maina slum with a few professing muslim faith (Table 4.1)

4.1.2 Level of education of the respondents

As indicated in table 4.1, 57.7% of the respondents had attained primary education, while 33.0% had secondary level, 6.5% college level and 2.8% non-formal education. These results suggested that more than half of the respondents had attained primary and non-formal levels of education indicating a low level of education in the study area.

4.1.3 Levels of Disease awareness.

The level of community awareness of typhoid and some common diseases in the community with similar signs and symptoms is indicated in Table 4.2. The study findings revealed that majority (88.3%) had knowledge about typhoid. The residents were informed and far much knowledgeable on typhoid suggesting that control of typhoid would be easy for them if such knowledge is applied. Majority of the residents (98%) reported that typhoid was a preventable disease while 2% did not.

Table 4.2 Levels of disease awareness in the community

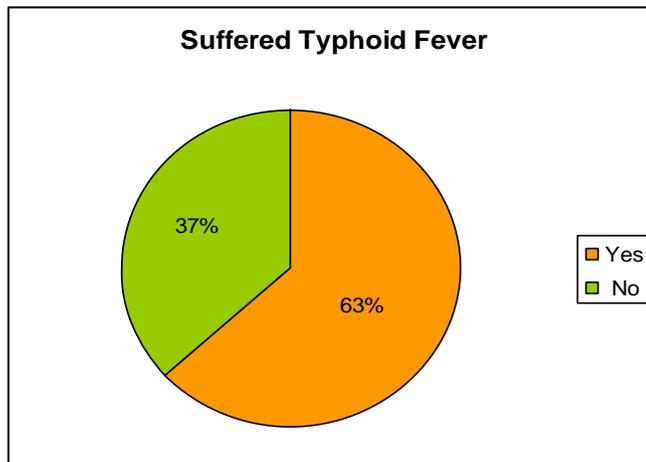
Knowledge of typhoid	Frequency	Percentage (%)
Typhoid	309	88.3
Malaria	14	4.0
Amoebiasis	26	7.3
Brucellosis	1	0.4
Total	350	100.0
Awareness		
Aware on typhoid prevention	343	98.0
Unaware on typhoid prevention	7	2.0
Total	350	100.0

4.2 Prevalence of typhoid

4.2.1 Occurrence of typhoid fever

The results in figure 4.1 show that majority (63%) of the study population said they had suffered typhoid episode one time or another in their lifetime, while (37%) did not. Out of 220(63%) only 121(34.57%) showed medical cards as an evidence of having suffered from the disease. 77(22%) showed a medical card and medical laboratory results as evidence. The remaining 22(6.3%) showed positive medical laboratory results and were on medication during the time of data collection hence the prevalence of typhoid in the area.

Figure 4.1 The claim of suffering from typhoid at one time in their lifetime in Maina slum.



4.2.2 Occurrence of typhoid and sex, Occurrence of typhoid and level of education, Occurrence of typhoid and occupation, Occurrence of typhoid fever and age

These study results revealed that out of 48% males, 30.57% of them claimed to have suffered from typhoid, out of 52% females, 32.28 % of them claimed to have suffered typhoid in one time or another in their life time. This is an indication that males and

females were at risk with equal chances of contracting the disease and therefore equally vulnerable ($p \geq 0.424$). ($\chi^2 = 1.638$ $df = 1$ $p = 0.424$) (Table 4.3)

The study also revealed that those with low level of education suffered from typhoid more than those who had attained a higher level of education and therefore education played a key role in the prevalence of typhoid in Maina slum. In table 4.3 it is shown that the higher the level of education the more the typhoid prevalence decreased among the adults as in primary, secondary and college levels respectively ($\chi^2 = 9.835$ $df = 3$ $P = 0.020$) (Table 4.3)

In table 4.3 is indicated that self-employed and un-employed people had suffered from typhoid fever in one time or another in their lifetime for both categories were above 65% ($\chi^2 = 5.168$ $df = 2$ $p = 0.075$) (Table 4.3). The findings presented in table 4.3 showed that age determined the prevalence of typhoid and its patterns. The majority (73.1%) aged 38-47 years suffered from typhoid than others in other age brackets in lifetime ($\chi^2 = 10.345$ $df = 3$ $p = 0.016$)

Table 4.3 The Independent variables and prevalence of typhoid

Sex	Independent variables	Perceived typhoid	Did not suffer typhoid	Total (N=350)	Chi-square Statistic
	Males	107(30.57%)	57(16.29%)	164(46.86)	$\chi^2= 1.638$ df=1 P= 0.424
	Females	113(32.28%)	73(20.86%)	186(53.14)	
	Total	220(62.85%)	130(37.15)	350(100.00%)	
status Education	Primary	123(35.14%)	79(39.1%)	202(57.71)	$\chi^2=9.835$ df=3 P=0.020
	Secondary	79(22.57%)	37(31.9%)	116(33.14)	
	Non formal	10(28.57%)	14(58.3%)	24(6.86)	
	College	8(2.29%)	0	8(2.29%)	
	Total	220(62.85%)	130(37.15)	350(100.00%)	
Occupation	Self-employed	99(28.29%)	52(14.86%)	151(43.14%)	$\chi^2=5.168$ df=2 P=0.075
	Un-employed	99(28.29 %)	51(14.57 %)	150(42.86)	
	Employed	22(6.29 %)	27(7.71%)	49(14.00%)	
	Total	220(62.85%)	130(37.15%)	350(100.00%)	
Age in years	18-27	54(15.43%)	31(8.86%)	85(24.29%)	$\chi^2=10.34$ 5 df=3 P=0.016
	28-37	62(17.71%)	60(17.14%)	122(34.86%)	
	38-47	87(24.86%)	32(9.14%)	119(34.00%)	
	Above 47	17(4.86 %)	6(1.71%)	23(6.58%)	
	Total	220(62.85)	130(37.15)	350(100.00%)	

4.3 Methods used in Diagnosis of Typhoid

In Maina dispensary it was revealed during the focus discussion group session that the only method in use for typhoid diagnosis is clinical diagnosis. The medical staff also disclosed that this method was not reliable. This method was used due to lack of a medical laboratory in the facility. As a result residents of Maina slum did self diagnosis based on experience. The self diagnosis method was not reliable due to the fact that the residents were not trained on this and that the method was not reliable. After the self diagnosis some residents bought drugs from the counter without a prescription from a trained clinician. Therefore much of the data of self diagnostic method is not captured in the health facility.

In Nyahururu district hospital the medical laboratory staff did disclose that they were not involved in purchase of reagents. The tests used were widal test which involved blood testing for typhoid pathogenic organisms. It was revealed that even when reagents are available some of the residents of Maina village do not afford the cost and they go back home without being diagnosed in the laboratory. This method gives results which need sometimes to be confirmed through a culture test which is done through stool. The reagents are never expired and that they are never adequate for the operations in the medical laboratory. Some residents of Maina end up going back home without laboratory diagnosis due to high cost of the diagnosis.

4.4 Risk Factors associated with occurrence of typhoid

4.4.1 Water sources, availability, storage, food eating habits and occurrence of typhoid

Results in table 4.4 showed that 54.6% of the respondents obtained drinking water from the tap, while 39.6% from the river, 4.6% got water from the river while 1.7% from the roof harvesting. These results indicated that there were more than one sources of water in the study area with the tap water being the most used in the area followed by river, spring and the roof catchment respectively. ($\chi^2=2.431$ df= 3 p= 0.488) (Table 4.4

The results in table 4.4 show that those who suffered from typhoid (24.28%) of 163 with treated water at home were fewer than those without drinking water at home. Those without treated drinking water at home suffered more as evidenced in table 4.4 below. This indicated that clean water was available at home for drinking ($\chi^2 = 2.622$ df= 1 p= 0.103) (Table 4.4). Table 4.4 shows that the all water sources in the study area were near the household. This shows that water was accessible and hence available for any use in

the study area. The resident did not take a lot of time in fetching the water from long distances ($\chi^2 = 1.386$ df = 3 p = 0.709) (Table 4.4). Water storage increased the availability of water at home level. As in table 4.4 below it is shown that those with storage facilities and suffered from typhoid were fewer than those without ($\chi^2 = 2.431$ df = 3 p = 0.488) (Table 4.4). The results in table 4.4 show that eating kiosk prepared foods was a risk factor to suffering from typhoid infection. Those who ate from such food outlets suffered from typhoid more than those who did not, as indicated in table 4.4 below ($\chi^2 = 4.472$ df = 1 p = 0.034)

Table 4.4 Comparison of water supply with local eating places and occurrence of typhoid

Independent variables		Claim of suffering	No claim of Suffering	n=350	p-value
Water sources	Tap	45(12.86%)	118(33.71%)	163	$\chi^2 = 2.431$ df=3 p=0.488
	Spring	10(2.90%)	3(0.86%)	13	
	River	110(31.43%)	59(16.86%)	169	
	Roof	2(0.57%)	3(0.26%)	5	
	Total	220	130	350	
Unavailability of treated water at household level	Treated	85(24.28%)	78(22.28%)	163	$\chi^2 = 2.622$ df=1, p=0.103
	Not treated	135(38.57%)	52(14.86%)	187	
	Total	220	130	350	
Water storage facilities	Did have	129(36.86%)	101(28.86%)	230	$\chi^2 = 2.431$ df=3 p=0.488
	Did not	91(26%)	29(8.29%)	120	
	Total	220	130	350	
	Not	111(31.71%)	106(30.29%)	217	
	Total	220	130	350	
Kiosk food	Ate	99(70.7%)	41(29.3%)	140	$\chi^2 = 4.472$ df = 1 p = 0.034
	Didn't eat	121(57.6%)	89(42.4%)	210	
	Total	220	130	350	

4.4.5 Human waste disposal, Solid wastes disposal, Usage of pit latrines, State of drainage systems, nature of the houses of Maina slum in comparison with occurrence of typhoid fever

Eighty three percent (83%) of the residents disposed their human wastes in a pit latrine while 17% did not. Table 4.5 shows that those who disposed off wastes suffered more from typhoid. It was observed that, the latrines were in deplorable state of repair. Those who disposed off their wastes in a latrine were almost five times more than those who did not, yet they suffered from typhoid as well ($\chi^2=1.129$ df=1 p=0.288) (Table 4.5). In this study 38% of the solid wastes other than human wastes, were disposed off compared to 62% which were not. The results show that 31.14% of those who disposed wastes suffered from typhoid and 30.29% did not dispose off the wastes, yet they did not suffer typhoid($\chi^2=1.529$ df= 1 p=0.467) (Table 4.5). The findings indicated that 60% of the pit latrines were not in use because they were filled compared to 40% which were in use. These results show those with and without toilet suffered from typhoid. It was observed that those without toilet used the toilets which were usable.

During usage of a pit latrine one can easily contaminate his hands with germs that causes typhoid ($\chi^2= 0.587$ df=1 p = 0.444) (Table 4.5).The finding of this study revealed that 47.1% of drainage system was leaking, 36% were smelly and 16.9% contaminated some water sources. During rainy seasons the situation was worse as observed because of the water stagnation and offensive smell accelerated by the season. The surface water is contaminated by the water runways and if that water was used for drinking without any form of treatment, it becomes a prime suspect of the cause of the typhoid fever.

Those whose drainage leaked, suffered from typhoid most ($\chi^2=8.028$, $df=3$ $p=0.045$) (Table 4.5). Those who washed their hands after visiting a toilet did not suffer much as those who did not wash hands after going to the toilet ($\chi^2=0.587$ $df=1$ $p=0.444$). It was evident from the study that majority (78.29%) lived in temporary houses, 15.14% in semi-permanent houses while (6.57%) lived in permanent houses. Typhoid episodes were more to those who lived in temporary houses as seen in table 4.5 below ($\chi^2=6.202$ $df=2$ $p=0.045$) (Table 4.5)

Table 4.5 Comparison of sanitation with washing and occurrence of typhoid

Independent Variables		Claim of suffering	No claim of suffering	Total	p-value
Human wastes disposal	Disposed	134(38.28%)	83(23.71%)	217	$\chi^2=1.129$ $df=1$ $p=0.288$
	Not disposed	86(24.57%)	47(13.43%)	133	
	Total	220	130	350	
Solid wastes disposal	Disposed	109(31.14%)	24(6.86%)	133	$\chi^2=0.529$ $df=1$ $p=0.467$
	Not disposed	111(31.71%)	106(30.29%)	217	
	Total	220	130	350	
Drainage systems	Leaking	120(34.29%)	51(14.57%)	171	$\chi^2=8.028$ $df=3$ $p=0.045$
	Water pollution	35(10%)	22(6.28%)	57	
	Smell	65(18.57%)	57(16.29%)	122	
	Total	220	130	350	
Washing hands after toilets	Practiced	100(28.57%)	40(11.43%)	140	$\chi^2=0.587$ $df=1$ $p=0.444$
	Not practiced	120(34.29%)	90(25.71%)	110	
	Total	220	130	350	
Kinds of houses	Permanent	20(5.71%)	10(2.86%)	30	$\chi^2=6.202$ $df=2$ $p=0.045$
	Semi-permanent	13(3.71%)	20(5.71%)	33	
	Temporary	187(53.43%)	100(28.57%)	287	
	Total	220	130	350	

4.4 Effectiveness of preventive and control measures

4.4.1 The Effectiveness of the intervention measures in place

The prevalence of typhoid fever was 5% by 2005 and 6.3% by 2009 despite water and sanitation preventive intervention measures being in place. This shows that the preventive measures are ineffective for they had failed to reduce the occurrence of typhoid fever hence its prevalence. It is also possible that other factors would have played a role in transmission of typhoid other than water and sanitation factors alone. Table 4.6 and table 4.7 shows the interventions measures in place in Maina slum.

Table 4.6 Showing eating habits, food handling, education with cleaning exercises and occurrence of typhoid

Interventions Measures	Response	Claim Suffered	No claim suffered	Total (n=350)	p-value
Hand washing before eating	Done	7 (2%)	3(0.86%)	10	$\chi^2=2.423$ df=3 p=0.489
	Not done	213(60.86%)	127(36.29%)	340	
	Total	220	130	350	
Improvement in food premises and handling	Prosecution done	50(14.29%)	38(10.86%)	88	$\chi^2 = 5.211$ df=3 p=0.157
	Health education	104(29.71%)	59 (16.86%)	163	
	Inspections done	66(18.86%)	33(9.4%)	99	
	Total	220	130	350	
Health education done	Carried out	2(0.57%)	7(2%)	341	$\chi^2=4.025$ df=1 p=0.045
	Not done	218(62.29%)	123(35.14%)	9	
	Total	220	130	350	
Participation in cleanliness	Adequate	103(29.43%)	64(18.29%)	167	$\chi^2=2.146$ df=3 p=0.543
	Not adequate	117(33.43%)	66(18.86%)	183	
	Total	220	130	350	

The results from this study indicated that 69.7% of the respondents practiced hand washing, 30.3% did not. The respondents stated that they did not wash their hands due to either lack of enough water, cost of water, had never suffered from typhoid before and due to hunger of food. Those who washed their hands did not suffer from typhoid as much as those who did not as shown in table 4.6($\chi^2=2.423$ df=3 p=0.489).

In this study 56.6% suggested that health educating the food handlers on hygienic practices was the way forward towards improving the food premises, 24.3% suggested that there was need of public health officers' involvement, 19.1% felt that prosecution of the food handlers was the solution ($\chi^2 = 5.211$ df=3 p=0.157).

The results revealed that 98% had heard about typhoid fever through a health education session and the rest 2% had not. These results showed that health education was being carried out immensely as a typhoid preventive measure in Maina slum.($\chi^2=4.025$ df=1 p=0.045) (Table 4.6).

The findings showed that 73% of the residents did not participate in the cleaning up of the area. This compared to 27% of the participants who participated in the cleaning exercises. These findings reveals that participation in cleaning though done minimally had not shown any impact in prevention of typhoid in Maina slum ($\chi^2=2.146$ df=3 p=0.543) (Table 4.6)

Table 4.7 Showing water provision, treatment and protection, health seeking behaviour, and occurrence of typhoid fever

Interventions	Responses	Claim of suffering	No claim of suffering	Total	p-value
Water provision by the CDF through NYAHUWA SCO	Provided	90(25.71%)	35(10%)	125	$\chi^2=9.112$ df=3 p=0.028
	Not provided	130(37.14%)	95(27.1%)	225	
	Total	220	130	350	
Domestic water treatment	Boiled	147(42%)	75(21.43%)	222	$\chi^2=2.707$ df=2 p=0.258
	Sedimentation	4(1.14%)	6(1.71%)	10	
	No treatment	69(19.71%)	49(14%)	118	
	Total	220	130	350	
Protection of underground water sources	Protected	92(26.29%)	45(12.86%)	137	$\chi^2=1.152$ df=1 p=0.283
	Not protected	128(36.57%)	85(24.29%)	213	
	Total	220	130	350	
Water cost reduction	Yes	204(58.29%)	126(36%)	330	$\chi^2=1.561$ df=1 p=0.212
	No	16(4.57%)	4(1.14%)	20	
	Total	220	130	350	
Enhancement of health care seeking behaviour	Dispensary	73(20.86%)	42(12%)	115	$\chi^2=10.056$ df=4 p=0.039
	District hospital	131(37.43%)	75(21.43%)	206	
	Herbal clinic	3(0.86%)	6(1.71%)	9	
	No treatment sought	13(3.71%)	7(2%)	20	
	Total	220	130	350	

In this study (37.5%) of the respondents who participated in CDF water provision activities,(62.5%) did not participate. This suggests that the agenda in prevention of typhoid via provision of water by the CDF was not fully implemented. This shows that water provision influenced the prevalence of typhoid as an effective measure toward control of typhoid fever ($\chi^2=9.112$ df=3 p=0.028) (Table 4.7). 63.3% boiled water before drinking. There were also other forms of domestic water treatment which were practiced in Maina slum by individual household. The finding further pointed out that,

typhoid prevention is not fully done for there were 33.9% respondents who did not treat their drinking water before drinking. Domestic water treatments in Maina slum were not effective interventions in control of typhoid fever for there was no significance between the treatments and the prevalence of typhoid fever ($\chi^2=2.707$ df=2 p=0.258 (Table 4.7). A smaller number (44.4%) had protected their water sources. This shows that there was minimal effort done towards the water protection in prevention of water contamination and ultimately prevention of typhoid fever in Maina slum by the respondents. The findings further showed that protection of underground water sources was not a priority to Maina slum dwellers hence protection of the water sources had no influence on control of prevalence of typhoid fever ($\chi^2=1.152$ df=1 p=0.283) (Table 4.7). A majority (57%) of the residents did not afford tap water services, 43% afforded. This suggested that tap water was not affordable to facilitate proper hygiene practices thus making prevention of typhoid in Maina slum difficult throughout the year. The cost of water would not have any influence on typhoid prevalence. These results show that there was no statistical relationship between cost of tap water and prevalence of typhoid fever ($\chi^2=1.561$ df=1 p=0.212) (Table 4.7).

The result in table 4.7 shows that the respondents were seeking treatment in different health facilities. The majority (94.4%) sought treatment from Government medical institutions and the rest (4.6%) sought treatment from herbal clinics, thus contributing towards prevention of typhoid in Maina slum. Those who did not seek any form of treatment were (5.6%) and failed to prevent the spread of typhoid in the study area. These results strongly revealed that through treatment of the sick, typhoid prevalence is

reduced and controlled; hence lack of treatment of the sick was a risk factor on typhoid prevalence. This shows that there was an association between treatment of typhoid patients and control of prevalence of typhoid ($\chi^2=10.056$ df =4 p=0.039) (Table 4.7)

The results revealed that 85% of the respondents had no initiative such as building water storage tanks in place to cater for water provision while 15% had. These results show that there were willing members of the community who contributed toward prevention of typhoid through provision of safe water to others through community initiative. This meant that the community had taken a positive move toward prevention of typhoid no matter how minimal (Table 4.7)

In this study 54.9% of respondents identified poor politics as a barrier towards water provision in the area, while 45.1% identified poverty. These results show that prevention of typhoid through provision of clean water is thwarted in Maina slum mainly by poor politics. Table 4.7 shows that water provision is an effective control measure toward measure.

The results of this study showed that the majority 97.4 % sited cost of water as the major reason as to why they were not connected to the tap water supply. This suggested that the respondents would have wished to be connected to tap water but high cost of connection was mainly prohibitive among other reasons making the consumers use other water sources (Table 4.7). The result shows (57.7%) sited politics as the main reason why people do not participate in cleaning the area, 25.1% sited poverty, 14.6% sited lack of unity among the people, and 2.6% that people are not willing. This scenario portrays that

if poverty and politic issues are addressed (82.8%) people will start cleaning the area (Table 4.7)

4.5 Discussion of results

4.5.1 Occurrence of Typhoid fever in Maina slum

The findings of this study showed that 63% of the residents had suffered from typhoid fever in one or more times in their life time, and only 37% had not. This is a clear indication that typhoid fever is prevalent in Maina slum. These results showed that those with low level of education were more than 50% and they suffered from typhoid episodes in their lifetime more than those with higher level of education.

The elderly people were more vulnerable to typhoid as 87% (38-47years) fell sick from typhoid. This suggests that likelihood of getting infected with typhoid was high to an individual with a prolonged stay in this slum as opposed to newcomers in the slum. These results concurred with the findings of Miriam (2005) who found out that visiting or living in areas where typhoid fever occurs is a risk factor.

The employed suffered the least though the un-employed and the self-employed suffered equally (28.28%) from typhoid. The success of control of typhoid fever would focus on the age limit and brackets. Both gender suffered from typhoid similarly. This means that the best strategy in control of typhoid fever would be to target both males and females adults because all were at risk of contracting typhoid.

4.5.2 Methods of typhoid diagnosis

Clinical Method of typhoid diagnosis was not reliable though it was the common method used in Maina slum for lack of a medical laboratory at Maina slum dispensary. There was also a general self diagnosis among the adults of Maina slum. This meant that the method used by the villagers was not accurate to give reliable results. \In view of that, the methods in use were both unreliable. In Nyahururu district hospital the method of diagnosis was laboratory tests carried out to the patients. The residents of Maina who sought medical treatment there were diagnosed through that method. The reagents used were said not to be readily available, something that led to discontinuation of those tests at a point. This frustrated the patients and hence this created a gap and a state of unreliability. These two scenarios of lack of a medical laboratory in Maina slum and depletion of reagents in a medical laboratory triggered this self diagnosis practices by the residents.

4.5.3 Risk factors influencing typhoid fever occurrence in Maina slum

The results of this study showed that 54.6% of the respondents got their drinking water from taps, 39.1% from the river and 6.3 % from the roof harvesting. Tap water was treated and supplied to the consumers by Nyahururu water and sanitation company (MD, 2006) and the untreated water sources posed a health risk to the consumers. Further more the results of this study showed that 97.4% of the respondents felt that connection of tap water to the houses was a costly exercise. This was mentioned as the main reason why tap water was not found in every household under study, and residents therefore relied on other accessible and affordable water sources. Surface and ground water were

not guaranteed safe supply for faecal matter could gain access into the water through water borne sewage system, through flush toilets, and pit latrines as found by Pruss *et al.* (2006). Disconnection from tap water due to either nonpayment or any other reason was a risk factor to high prevalence of typhoid fever ($\chi^2=2.622$ df=1 p=0.003).

Since 53% of Maina slum were connected to tap water it means that if typhoid was to be contracted it would only occur to a minority. This is because it is suggested that the tap water is treated considering that a further 1.6% either borrowed tap water from the neighbours or bought from the water kiosks provided. This suggests that tap water was required in households that were not connected, and this agreed with the GOK (1999) that targeted to increase the provision of tap water by 30% by 2004 which did not materialize since.

Some respondents (34%) had their water sources as near as 0-4metres, 10.6% at 14 metres and 64% at 14metres away from the households. A total of 64% got their drinking water from a distance above 14metres reflecting the compliance with the Public health act cap. 242 laws of Kenyan which require that water be within reach.

This study revealed that 63% did not have water storage facility while 37% provided water storage facilities within their households. This suggested that majority did not have a preserve for drinking water. These results disagreed with recommendations by Wood (1992) that water storage should be encouraged at all times. This disagreement could be because the study was done in slum while the Wood study was in rural set up.

The results of this study showed that 57% had no reliable water sources while 43% had reliable water sources. This showed that the study area had inadequate supply of water for storage and immediate use.

The results of the study found that 80.2% of the residents had temporary houses, 14.4% had semi-permanent houses and 5.4% had permanent houses. These statistics suggest that most of the residents were poor and that they were vulnerable to poor housing which could promote poor state of sanitation. Poor sanitation practices are a cause of bacterial, viral, protozoa, and helminthic infections (Feachem, 1997).

On waste collection 82.9% were dissatisfied about it, and 17.1% were satisfied. The main reason of dissatisfaction on waste collection was that it was done unprofessionally (52.9%) and irregularly (36.3%). Typhoid fever is more common in areas with poor sanitation practices (WHO, 1998).

The majority (47.1%) of the residents of Maina slum felt that the drainage systems posed a problem of leaking, 36% felt the problem with drainage was smell and 16.9% felt that drainage system were contaminating their surface water sources. These findings agreed with the findings of WHO (1999) that many naturally occurring water sources are contaminated by wastes at some point.

The results of this study showed that 31.4% and 43.5% of the respondents said that their drainage systems were blocked and filthy, respectively. Only 25.2% of the respondents lived near a clean drainage. The state of drainage was associated with the prevalence of

typhoid fever ($\chi^2=8.028$, $df=3$, $p= 0.045$). In regions with poor sanitation *Salmonella typhi* often spreads after water supplies are contaminated by human waste (library congress, 1996). These results denoted that exhaustion of the pit latrine facility was not sought for though it was being provided at a certain rate (cost) by Nyahururu water and sanitation company. There were more temporary houses than permanent houses. This indicated general poverty in this area. The type of houses and suffering from typhoid had a relationship and was a risk factor to contracting typhoid fever($\chi^2=6.202$, $df=2$, $p= 0.045$). This act of not exhausting filled up pit latrine compromised the health of the residents for wastes were spilled in the environment causing blockages of drains, contamination of surface water sources, and even emission of foul smell in the atmosphere. These menaces are an eye sore and need to be addressed to avert an outbreak of water borne diseases such as typhoid fever in the area. These results agreed with a study done by DFID(1998) which found that uncontrolled wastes often fill up the drains, causing blockages, which results in flooding and faecal contamination, flies breeding sites in solid wastes, and are very infective vectors that spread diseases, such as typhoid fever.

The study results found out that 62% of the residents did not have their solid wastes disposed off, and only 38% had. The wastes were collected by the municipal council through Nyahururu water and Sanitation Company though the role of sanitation was not taken by the company but the council under which the company was formed. Role conflict between Nyahururu municipal council and Nyahururu water and Sanitation Company resulted to poor waste management in the study area.

Where sanitation and garbage disposal are lacking, typhoid fever continues to destroy life (Donald, 2004). The hygienic disposal of excreta was important because the infective organism for typhoid fever leave the body in faeces. Eating food prepared in hotels was a risk factor towards suffering of typhoid ($\chi^2=4.472$, $df=1$, $p=0.034$). Further results revealed that 79% of Maina slum residents did not have refuse storage facilities while 21% had. This agreed with UNDP (2001) that the majority of urban populations were tenants in informal settlements where basic services such as water and sanitation are inadequate as stated by Julia (1999) that each home must therefore practice appropriate methods of rubbish disposal. The results of this study showed that 39.4% did not wash their hands because of unavailability of adequate water and 28% did not wash their hands due to cost of water, while 23.7% did not wash hands because they had not suffered from typhoid fever before. These results suggested that if water supply was adequate in the study area the practice of hand washing would increase. A study by MOW (2008) had shown that access to safe water was a requirement for hand washing and other hygienic practices which were still insufficient in both rural and urban areas. If the millennium development targets for reduction of diarrhea diseases are to be met, hand washing habits must be improved along with access to safe water and sanitation. Accessibility to continuous quality and affordable water services was key in hand washing as stated by MPHS (2008) which also agreed with the results of this study that the cost of water impeded the hand washing practices.

4.5.4 Preventive measures used in Maina slum

Majority (85.5%) of respondents had knowledge about typhoid being a water borne disease, yet (66.1%) of them suffered from typhoid constituting (58.4%) of grand total of people who suffered from the disease. This implied that the knowledge that typhoid fever was a water borne disease as stated by the majority respondents, agreed with the World Health Organization that typhoid fever is a disease of public health importance (WHO, 1998). This further could be interpreted to mean that *Salmonella typhi* the causative organism of typhoid fever was favoured by some conditions in the study area, hence high prevalence. Ninety seven percent of Maina slum residents had heard about typhoid fever yet (65.2%) among them suffered from the disease. These results showed that the majority of the resident though had heard about the disease it was necessary to undertake a collective role in prevention in order to avoid contracting the disease, thus an indication that typhoid fever was prevalent in the study area (DMOH, 2005). Further results of this study revealed that 56.7% sought treatment in Nyahururu District Hospital which is about 3kilometre away from the slum, as compared to 33.71% who sought treatment from Maina slum dispensary, and 1.4% who went to the herbal clinic for the same services. This suggested that since the majority patients sought treatment in a district health facility which was 3km away from their home there was a marked delayed treatment due to distance, time consumption which would have been used in other productive issues, and long out-patient queues which could jeopardize the sixth millennium development goal on prevention of infection by 2015 (GOK) and could lead to death (Wood, 1992). Ninety two percent sought treatment after falling sick while 8.32% did not seek any form of treatment from anywhere after falling sick; something that could lead to complications, yet the disease is treatable. This could increase the

prevalence rate of typhoid fever in the area through different ways of spread and lack of prompt and accurate treatment due to the patient health seeking behaviour.

Additionally, this study revealed that 98% of the resident knew that typhoid fever was preventable disease with only a trace 2% who did not identify typhoid fever as a preventable disease. These findings clearly suggested that the community was in good position regarding prevention practices of the disease under study. The results of this study concurred with Wood (1992) who reported that typhoid fever is preventable through various levels of prevention namely: primary, secondary and tertiary preventive methods.

In this study it was evident that 86.6% thought that drinking boiled water and observing hygiene would help in prevention of typhoid fever, while 13.4% did not. This study agreed with a study done by WHO (1998) which stated that maintenance of drinking water free from pathogenic micro-organisms through simple domestic methods such as boiling and observing personal hygiene did control and prevent typhoid fever.

These results revealed that 97% knew the importance of toilets, as compared to those who did not see any need of having toilets. These outcomes of this study were in agreement with those of UNICEF (1999) which stressed and stated that installation of sanitary excreta disposal system and use helps to combat diarrhea diseases and intestinal worms.

The research findings revealed that 83% of the residents used pit latrines, while 17% did not. This therefore meant that the public health department of Laikipia district should

aim at increasing the latrine coverage by at least 17% in-order to attain the optimal 100% coverage. The national latrine coverage is 72% according to the National Development Plan (2002-2008). Faeces could be the source of much sickness in the community if it was accessible to the fingers, fluid, and eventually food (Wood, 1992). According to Rukunga (2001) latrines are used to break the transmission of diseases associated with human waste disposal such as typhoid. This study established that 60% of the pit latrines were full compared to 40% which were in use. In-order to combat diseases caused by inadequate sanitation more efficiently, the installation of sanitary excreta facilities should be encouraged with measures taken to dispose of wastes and improve personal and food hygiene (Charles, 1995). The findings showed that 56.6% felt that health educating the food handlers could improve the eating places, 24.3% felt that involvement of public health officers could cause improvement to eating places while 19.1% thought taking the dirty food handlers to court could lead to improvement of eating places. These results suggest that health education and promotion was an important tool which could twice as much cause improvement as compared to involvement of public health officers in eating places. Taking food handlers to court was seen as the least effective way of impacting any viable improvement to eating places.

The study findings were that majority 65.1% of the respondents were treating water by boiling and 32.9% of the residents did not boil. Boiling of water prior to drinking prevented the spread of typhoid fever in Maina slum. This suggests that health education and promotion could bring about positive change on those who did not find any reason of

boiling drinking water or applying other domestic water treatment methods. In Maina slum 45.4% got their drinking from other sources other than tapped water.

In Kenya 28% depended on lakes and rivers as their sources of water supply, and according to CBS (2002b) such water was regarded as unclean, because it was not subjected to any form of treatment. These results suggest that 85% of the residents did not have any initiative in place to cater for water provision. This meant that little can be expected from the community on water provision unless they are assisted by other players and stakeholders. This tendency of lack of a viable community initiative could probably be due to over-dependence on the external assistance.

The results showed that 54.9% of the community thought that lack of community initiative towards water provision was due to poor politics in the area, while 45.1% thought non-participatory attitude in clean water provision was due to poverty. These results pointed out that 73% of the residents did not participate in the cleaning up of the area, as compared to 27% who participated. This meant that just a few of the residents saw the need of cleaning the slum yet the area needed to be cleaned. As a result of that the area has remained unserved by the residents. The study revealed that 57.7% attributed poor politics as the main reason of failure to participate in cleaning up the area, while 25.1% quoted poverty as the reason and 14.6% said that people were not united together for a common goal. It was clear that politics played a great role in health under-development as compared to any other reason. Further to this, the results did show that politics affected majority of the residents negatively and hence destroyed the spirit of community participation.

CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

In conclusion though this study found out that 198(56.7%) had suffered in one time or another in lifetime from typhoid fever while 6.3% were suffering from typhoid and were on medication by 2009 it could not be true. Since by 2005 the prevalence was reported to be at 5% the difference cannot be said it was 1.3% because the methods used were different in typhoid diagnosis. The reporting also from the hospital could have been erroneous due to the methodology used which was based on clinical signs and symptoms with no laboratory test done to confirm. This signified that most of the people in Maina slum did self diagnosis through experience because 198(56.7%) had no empirical evidence to show that they had suffered from typhoid. Those who visited Maina slum dispensary for diagnosis between 2005 and 2009 had themselves diagnosed clinically for lack of a medical laboratory in the place. Clinical diagnosis could have been inaccurate and on the other hand can be contradicted with other diseases with similar signs and symptoms. The outcome could not be fully relied on for methods used in diagnosing typhoid were not similar. It was evidenced from the study results that treated water at household level was available at 53% in household level. Low education level ($\chi^2=9.835$ df=3 p=0.020) were some of the causative factors toward contracting typhoid infection, and leaking drainage systems was associated with prevalence of typhoid ($\chi^2=8.028$, df=3, p= 0.045).

5.2 Recommendations

- ❖ It is recommended that diagnosis of typhoid be done in a medical laboratory run by qualified medical laboratory technologists.
- ❖ That any typhoid diagnosis done clinically should be taken as false positive until proven through a medical laboratory testing.
- ❖ Clinical diagnosis and self diagnosis through experience should be stopped by the residents of Maina slum in order to avoid wrong information and reporting.
- ❖ A medical laboratory should be established in Maina slum at Maina dispensary and qualified medical laboratory technologists posted by the ministry of medical services.
- ❖ Adequate supply of reagents for typhoid laboratory tests should be provided by the ministry of medical services medical laboratory in Nyahururu hospital
- ❖ Usage of proper reagents in the medical laboratory which are not expired is recommended as well as adhering to the laid down analysis procedures.
- ❖ A monitoring and evaluation group comprised Medical laboratory technologists should be formed to ensure that professional ethics are followed in the laboratory diagnosis.
- ❖ Purchase of drugs from the counter should be discouraged by the chemists and insists on medical laboratory results so that proper drugs can be sold to the sick.
- ❖ The cost of medical laboratory tests in government health facilities with medical laboratories should be reduced or made free of charge in order to encourage people to utilize the facilities.
- ❖ There is need to create projects and programmes that will help educate the residents on how to control and prevent typhoid fever effectively in the area.

- ❖ Community strategy policy should be rolled out in Maina slum by the ministry of Public health and sanitation in the area. and proper use of community health workers enhanced.
- ❖ Health campaigns should be carried out by all the stakeholders with a view of creating awareness to the residents of Maina slum on the importance of control and prevention of typhoid and seeking early treatment from health facilities.

5.3 Recommendations for future research

- ❖ It is recommended that another study be done targeting the under five (>5 years) other than the adults (target population) in this study.
- ❖ A qualitative study on quality and safety of water sources should be done to ascertain the degree of water treatment by the Nyahuwasco.
- ❖ The study used the questionnaire and key informant Interview schedule as well as a checklist, as data collection tools, therefore future studies should incorporate other methods of data collection such as direct observation.

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APPENDICES

RISK FACTORS INFLUENCING OCCURRENCE OF TYPHOID FEVER AMONG THE ADULTS IN MAINA SLUM, NYAHURURU MUNICIPALITY, KENYA

Citation: This questionnaire is a tool for data collection only. The information given by the respondents will be the respondents will be treated with utmost confidentiality and that no victimization whatsoever.

DEMOGRAPHIC DATA

Age: (Years) 18-27 28-37 38-47 Above 47years
Sex: Male Female
Occupation: Self employment Unemployed Employ
Marital status: Married Single divorced Separated
Religion: Christianity Islamic
Education Status: Primary Level secondary Level College

SECTION 1 WATER SUPPLY

1. For how long have you been living here?
 0-1 month 2-3 months 4-5 months over six
 months
2. What is the source of your drinking water?
 River Tapped Water roof
 Any other
 (Specify).....
3. How do you treat water for drinking?
 Don't treat Boil sieve decanting
 Any other (Specify).....
4. How far is your water source from where you stay?
 0-4m 5-9m 9-14m above 14m
5. Is your plot connected with tapped water from Nyahururu Water Company?
 Yes No
6. If the answer is No in Q 5, why haven't you connected to tap water?
 Costly Not reliable tasty

7. Is there anything that this community is doing together towards clean water provision?

Yes No

8. If answer in Q (7) above is No why is the community not working together towards clean water provision?

Poor politic poverty Illiteracy

9. Is tap water provided for a certain fee by Nyahururu water Company?

Yes No

10. Are you satisfied with the charges from the selling company?

No

Yes

11. If the answer in Q 10 above is No that would be the best way forward?

Reduce water charges Payment by instalment

Vary water cost per capita income Wave the accumulated charges

12. Which one of the following diseases is water borne?

a. Typhoid fever

b. Malaria

c. Bilharzias

d. Tuberculosis (Tb)

13. Is there any water project in this area initiated by the constituency development fund (CDF)?

Yes

No

Not aware

SECTION II SANITATION

1. Do you find it useful to have a toilet

Yes No

2. What is the main use of a pit latrine?

To dispose off wastes

To dispel flies

Control of diseases

Any other

(specify).....

3. Are you satisfied with waste collection in this place?

Yes

No

4. If the answer is No in Q3 above why are you not satisfied?
The number times of waste collection are few not done well
5. Who is responsible of waste collection in this area?
State.....
6. In your own opinion is the drainage system in good state of repair?
Yes No
7. If the answer in Q6 above is No what is wrong with the drainage?
The drainage leaks water is contaminated
There is a lot of smell any other (Specify) -----
8. Is there anything that the people here do together in cleaning up this area?
Yes No
9. If the answer in Q8 above is No, what makes it hard for people not to have any role in the clean up?
People are scattered people here are poor poor politics
Any other (Specify).....
10. Is it of any importance to clean up this area?
Yes No
11. If the answer in Q 11 above is yes, what is the importance to clean up this area?
To control flies to prevent and control diseases such as
typhoid
To make people happy to make surrounding look better
Any other (specify).....

SECTION III

HYGIENIC PRACTICES

- 1) Is it important to wash hands before and after visiting toilet? Yes No
- 2) If the answer in Q 1 above is yes, why is it important to wash hands?
To feel good is a habit to control typhoid
Any other (Specify).....
- 3) If the answer in Q1 above is No, what makes it hard to wash hands before and after visiting toilet?
Lack of enough water hunger of food cost of water
I have not suffered from typhoid before any other
(specify).....
- 4) Is it important to wash hands before and after eating? Yes No
- 5) If the answer in Q4 above is No, why is it not important to wash hands before and after eating?
Explain.....
- 6) Do you have eating-place in this area where food is sold? Yes No
- 7) Do you prefer eating there? Yes No
- 8) If the answer in Q7 above is No, why don't you prefer eating in commercial places?
Food is not clean food is expensive fear of getting typhoid
Any other (Specify).....
- 9) What do you think must be done to make these eating places better?
Take the dirty food handlers to court

To health educate the food handlers on hygiene practices
 To involve public health personnel
 Any other (specify).....

**SECTION IV
 TYPHOID FEVER**

1. Have you heard of typhoid fever Yes No
2. Have you ever suffered from typhoid fever in the last two months?
 Yes No
3. Can you kindly show me the evidence you have, showing that you suffered from typhoid? Medical card Medical lab. results On typhoid drugs
4. Are you on medication now? Yes No
5. Where did you get your treatment?
 In Maina slum dispensary Nyahururu district Hospital
 Herbal clinic didn't go for treatment
 Any other (specify).....
6. If the answer in Q4 above is that you did not go for treatment, why was it so?
 Cultural hindrances religion lack of money
 Any other (specify).....
7. Is typhoid fever a preventable disease? Yes No
8. If the answer in Q6 is yes, what is that healthy people can do to prevent?
 To drink boiled water and observe hygiene can do nothing
 Any other (specify).....

**APPENDIX 2: NYAHURURU WATER AND SANITATION PERSONNELS
 KEY INFORMANT INTERVIEW SCHEDULE**

1. When was Nyahururu water and sanitation initiated?
 State the year.....
2. What is the main objective in formation of this company?
 State.....
3. Does the company extend its services to Maina slum? Yes No
4. If the answer in Q3 above is yes, what are the services that you give to Maina residents?
 State
 1.....
 2.....
 3.....
5. If the answer in Q3 above is yes, is there hindrances encountered so far in provision of services?
 Yes No
6. If the answer in Q5 above is Yes what are the hindrances?
 State 1.....

- 2.....
- 3.....
- 7. What do you propose can be done about the hindrances stated inQ6 above (if any)?
State 1.....
2.....
3.....
- 8. What is you long term plan concerning water and sanitation on Maina slum?
- 9. State 1.....
2.....
3.....

**APPENDIX 3.
PROVINCIAL ADMINISTRATION
(MAINA SLUM AREA CHIEF)**

- 1. For how long have you been working here? State
.....
- 2. How do you rate the sanitation status of this place?
Good fair satisfactory poor
- 3. What are your recommendations towards improvement of the sanitation status in this area?
State
1.....
2.....
3.....
- 4. Who is responsible for the above achievement?
State.....
- 5. According to you what is the role of the community towards prevention of typhoid fever?
State.....
- 6. Are you satisfied with the way that Nyahururu water and sanitation is operating in you work? Yes No
- 7. If the answer inQ6 above is No why are you not satisfied?
- 8. State the reasons
1.....
2.....
3.....

APPENDIX 4: OBSERVATIONAL CHECKLIST

- 1. Are the underground water sources protected yes No
- 2. How is the vegetation surrounding the source? Tall Short
Any other (Specify).....
- 3. Are there water storage facilities? Yes No

4. Are the water sources reliable? Yes No
5. Is the homestead connected with piped water? Yes No
6. How is the housing status? Permanent Temporary
7. semi-permanent
8. Is pit latrine available? Yes No
9. If the answer in Q7 above is yes, is the pit latrine full? Yes No
10. Has the solid waste be disposed off? Yes No
11. Are there refuse storage facilities available? Yes No