PREVALENCE OF *HELIcobacter pylori* INFECTION AMONG PATIENTS WITH PEPTIC ULCERS AND THE ASSOCIATED RISK FACTORS IN MBAGATHI LEVEL V HOSPITAL, NAIROBI COUNTY, KENYA

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JUNE, 2019
DECLARATION

This thesis is my original work and has not been presented in any University for the award of any degree.

Sign........................................ Date.................................

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DEDICATION

I dedicate this thesis to my supervisors, my family and friends.
ACKNOWLEDGEMENT

I thank God for granting me the strength to start and complete this study. I acknowledge all the participants who took part in this study. I would like to thank Kenyatta University graduate school and Ethical Review Committee for offering me their approval for this study. I also wish to express my gratitude to the Ethical approval Committee of University of Nairobi and Kenyatta National Hospital for reviewing and approving the study. I would also wish to thank my supervisors; Dr. Scholastica Mathenge of Department of Medical Laboratory Sciences and Dr. Daniel Okun of the Department of Biochemistry and Biotechnology, Kenyatta University, for their encouragement, advice and support. Last but not least I owe a big debt of gratitude to my family for the moral support and constant prayers. God bless you.
# Table of contents

<table>
<thead>
<tr>
<th>Contents</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration</td>
<td>II</td>
</tr>
<tr>
<td>Dedication</td>
<td>III</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>IV</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>V</td>
</tr>
<tr>
<td>List of Tables</td>
<td>VIII</td>
</tr>
<tr>
<td>List of Figures</td>
<td>IX</td>
</tr>
<tr>
<td>List of Abbreviations and Acronyms</td>
<td>X</td>
</tr>
<tr>
<td>Definition of Operational Terminologies</td>
<td>XI</td>
</tr>
<tr>
<td>Abstract</td>
<td>XIII</td>
</tr>
<tr>
<td><strong>CHAPTER ONE</strong></td>
<td></td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Background Information of the study</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Statement of the problem</td>
<td>4</td>
</tr>
<tr>
<td>1.3 Justification</td>
<td>5</td>
</tr>
<tr>
<td>1.4 Research questions</td>
<td>6</td>
</tr>
<tr>
<td>1.5 Hypothesis</td>
<td>6</td>
</tr>
<tr>
<td>1.6 Objectives</td>
<td>7</td>
</tr>
<tr>
<td>1.6.1 General objective</td>
<td>7</td>
</tr>
<tr>
<td>1.6.2 Specific objectives</td>
<td>7</td>
</tr>
<tr>
<td>1.7 Significance of the study</td>
<td>7</td>
</tr>
<tr>
<td><strong>CHAPTER TWO</strong></td>
<td>8</td>
</tr>
<tr>
<td>Literature Review</td>
<td>8</td>
</tr>
<tr>
<td>2.1 Prevalence of <em>H. pylori</em> infection</td>
<td>8</td>
</tr>
<tr>
<td>2.2 Pathogenesis of <em>H. pylori</em></td>
<td>11</td>
</tr>
<tr>
<td>2.3 Pathophysiology of ulcer disease</td>
<td>12</td>
</tr>
<tr>
<td>2.4 Clinical manifestation of <em>H. pylori</em> infection</td>
<td>17</td>
</tr>
<tr>
<td>2.5 Diagnosis of <em>H. pylori</em> stool antigens</td>
<td>20</td>
</tr>
<tr>
<td><strong>CHAPTER THREE</strong></td>
<td>23</td>
</tr>
<tr>
<td>Materials and Methods</td>
<td>23</td>
</tr>
<tr>
<td>3.1 Study Area</td>
<td>23</td>
</tr>
<tr>
<td>3.2 Study Design</td>
<td>23</td>
</tr>
</tbody>
</table>
3.3 Study Population .............................................................................................................................................. 23
3.3.1 Inclusion Criteria ............................................................................................................................................. 23
3.3.2 Exclusion Criteria ............................................................................................................................................. 24
3.4 Sample size Determination .............................................................................................................................. 24
3.5 Sampling Technique .......................................................................................................................................... 25
3.6 Sample Collection ........................................................................................................................................... 25
3.6.1 Laboratory analysis for H. pylori stool antigen test ...................................................................................... 25
3.6.1.1 Test outcome information .......................................................................................................................... 26
3.6.2 Patients’ age stratification ............................................................................................................................. 28
3.6.3 Questionnaires ............................................................................................................................................... 28
3.7 Ethical consideration and approval .................................................................................................................. 28
3.8 Data management, analysis and presentation .................................................................................................. 29

CHAPTER FOUR ..................................................................................................................................................... 30
Results .................................................................................................................................................................. 30
4.1 Demographics characteristics of the participants ............................................................................................ 30
4.1.1 Age of respondents ...................................................................................................................................... 30
4.2 Prevalence of H. pylori infection among patients with gastric ulcers attending Mbagathi level V hospital .................................................................................................................................................. 31
4.3 H. pylori infection pattern among various age groups in the study population ........................................... 32
4.4 Risk factors associated with H. pylori infection ............................................................................................. 33
4.4.1 Gender of respondents and Occurrence of H. pylori infection ................................................................. 33
4.4.2 Level of education and Occurrence of H. pylori antigen ............................................................................ 35
4.4.3 Source of drinking water and Occurrence of H. pylori infection ............................................................. 36
4.4.4 Place of waste disposal and Occurrence of H. pylori antigen ................................................................. 37
4.4.5 Number of household members and Occurrence of H. pylori infection ................................................... 37
4.4.6 Place of meals and Occurrence of H. pylori infection ................................................................................. 38

CHAPTER FIVE ....................................................................................................................................................... 39
Discussion, Conclusions and Recommendations .................................................................................................. 39
5.1 Discussion .......................................................................................................................................................... 39
5.2 Conclusions ..................................................................................................................................................... 42
5.3 Recommendations ......................................................................................................................................... 43
5.4 Recommendations for further studies .......................................................................................................... 43

References .............................................................................................................................................................. 45

Appendix i: A map of Mbagathi Hospital .............................................................................................................. 54
Appendix ii: Questionnaire ................................................................................................................................... 55
Appendix iii: Informed consent form………………………………………………………………………………………………………………………………………………58
Appendix iv: Authorization and Approval letters ……………………………………………………………………………………………………………………………60
List of tables

Table 2.1: Diagnosis methods for detection of \textit{H. pylori} infection.............................22
Table 4.1: Demographic representation of age groups of the participants..................31
Table 4.2: Occurrence of \textit{H. pylori} in various age groups of the participants........33
Table 4.3: Occurrence of \textit{H. pylori} based on gender of participants......................34
List of figures

Figure 2.1: Schematic diagram of *H. pylori* infection and pathogenesis..........................13
Figure 2.2: Schematic representation of pathology and the disease outcome in *H. pylori* infection........................................................................................................................................19
Figure 3.1: Sample preparations for *H. pylori* stool antigen testing........................................26
Figure 3.2: Testing Procedure for *H. pylori* stool antigen test..............................................26
Figure 3.3: Interpretation of the test results for *H. pylori* stool antigen test..........................27
Figure 4.1: Prevalence of *H. pylori* infection............................................................................32
Figure 4.2: Gender of participants and *H. pylori* infection......................................................34
Figure 4.3: Level of education of the participants........................................................................35
Figure 4.4: Sources of drinking water of the respondents.........................................................36
Figure 4.5: Waste disposal methods of the respondents.........................................................37
Figure 4.7: Places where the participants took their meals......................................................38
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ag</td>
<td>Antigen</td>
<td>Antigen</td>
</tr>
<tr>
<td>Cag</td>
<td>Cytotoxin associated gene</td>
<td>Cytotoxin associated gene</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence interval</td>
<td>Confidence interval</td>
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<tr>
<td>EIA</td>
<td>Enzyme immunoassay</td>
<td>Enzyme immunoassay</td>
</tr>
<tr>
<td>Elisa</td>
<td>Enzyme linked immunosorbent assay</td>
<td>Enzyme linked immunosorbent assay</td>
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<tr>
<td>G-C</td>
<td>Guanine to Cytosine content</td>
<td>Guanine to Cytosine content</td>
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<tr>
<td>GI</td>
<td>Gastrointestinal</td>
<td>Gastrointestinal</td>
</tr>
<tr>
<td>Hcp</td>
<td><em>Helicobacter</em> cysteine-rich protein</td>
<td><em>Helicobacter</em> cysteine-rich protein</td>
</tr>
<tr>
<td>ICH GCP</td>
<td>International Conference for Harmonisation and Good clinical Practice</td>
<td>International Conference for Harmonisation and Good clinical Practice</td>
</tr>
<tr>
<td>LPS</td>
<td>Lipopolysaccharide</td>
<td>Lipopolysaccharide</td>
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<tr>
<td>NSAIDs</td>
<td>Non Steroidal Anti-Inflammatory Diseases</td>
<td>Non Steroidal Anti-Inflammatory Diseases</td>
</tr>
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<td>OD</td>
<td>Optical Density</td>
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<tr>
<td>OMP</td>
<td>Outer membrane protein</td>
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<tr>
<td>SPSS</td>
<td>Statistical package for the social sciences</td>
<td>Statistical package for the social sciences</td>
</tr>
<tr>
<td>VBNC</td>
<td>Viable but non-culturable state</td>
<td>Viable but non-culturable state</td>
</tr>
</tbody>
</table>
DEFINITION OF OPERATIONAL TERMINOLOGIES

**Antibody:** A protein produced by the body in response to and usually counteracts the establishment of a disease causing agent.

**Commensal:** An association involving two organisms in which one benefits and the other derives neither benefit nor harm.

**Developing country:** Also called less developed country, it is a country with reduced amount of developed industrial base and little human development index relative to other countries.

**Duodenal ulcers:** Defects in the upper area of the small intestines when acid overwhelms normal protective course leading to an open sore.

**Gastric ulcers:** Open sores that occur in the stomach.

**Gastritis:** An inflammation, irritation or erosion of the lining of the stomach. It can be sudden (acute) or gradual (chronic).

**Infection:** Process of affecting a person through introduction of a disease-causing organism on or in to the person’s body.

**Inflammation:** A localized physical condition in which part of the body becomes reddened, swollen, hot and often painful, especially as a reaction to injury or infection.

**Microaerophilic:** Anaerobic bacteria that require minimal oxygen for growth at concentration lower than what is present in the atmosphere.

**Peptic ulcers:** Is an open sore. Usually found in the lining of stomach, esophagus or upper small intestine.
Risk factors: Are any attributes, characteristics or exposure of an individual that increases the likelihood of developing a disease or injury.

Transmission: The action or process of causing a disease to pass on from one place or person to another.

Virulence: The degree of the ability to cause disease within an organism as indicated by case fatality rates and or ability of the organism to invade host tissues.
Abstract

*H. pylori* is a microaerophilic organism and a gram negative bacterium which is found in the alimentary canal. It causes chronic gastritis and gastric ulcers. It is also linked to the development of duodenal ulcers and stomach cancer, conditions that were not previously believed to have a microbial cause. The persons infected with *H. pylori* usually have a 10 to 20% danger of developing peptic ulcers and a 1 to 2% likelihood of acquiring stomach cancer in lifetime. Nearly 15% of infected persons will develop peptic ulcer (duodenal or gastric) or gastric cancer as a long term end result of the infection. The outcome of infection depends primarily on the severity and topography of histological gastritis, which may possibly be determined by the age at which infection is acquired. Knowing the risk factors associated with the infection, it is necessary to put in place interventions and advice on suitable preventive measures.

The main objective of this research was to determine the occurrence of *H. pylori* infections in patients with chronic gastritis and gastritic ulcers attending Mbagathi level V hospital in Nairobi. The study design was a cross-sectional hospital-based study and purposive sampling technique was used. Participants included all the patients with symptoms of ulcers and who were at the age of 6 months and above. 381 Stool samples were collected from the patients and their demographic information recorded after which, they were given questionnaires. The *H. pylori* stool antigen test was performed on the stool samples and the questionnaires analysed for risk factors. In conclusion, prevalence was found to be 46.2% (*r* = 12.28; *p* = 0.015). The *H. pylori* infection among various age group was found to be high at 32.4% in the age group between 31 to 40 years, and found to be low at 3.4% in the age group between 81 to 90 years (*r* = 3.15; *p* = 0.031). Among the risk factors, female gender (*p* = 003) and water for drinking and other domestic usage were found to be statistically significant (*r* = 0.3; *p* = 0.007). The findings of this study will give the authorities in health sector a good chance to put in place adequate preventive measures against *H. pylori* infection. Importantly, all confirmed cases of *H. pylori* infections should be treated to avoid the chances of transmission and steady supply of clean water to the residents.
CHAPTER ONE

Introduction

1.1 Background Information of the study

*Helicobacter pylori* is a helix-shaped, curved rod bacterium and it is gram negative measuring a length of about three (3) micrometres with about 0.5 micrometres of diameter. It colonizes the host stomach and it is the major cause of peptic ulcers, gastritis, and gastric cancer especially in adulthood (Shiotani *et al*., 2000). *H. pylori* colonize over 50% of people worldwide. The infections caused by *H. pylori* have been proved to be of great public health importance in developing countries, especially in low socioeconomic groups. Poor hygiene, and sanitation, and crowded conditions have been reported as the risk factors for *H. pylori* infection (Brown, 2000).

*H. pylori*, initially, had not been recognized as an infectious agent until 1982, in the seminal work of Nobel Laureates, Warren and Marshall. *H. pylori* colonizes various regions of the upper digestive system, mainly the stomach and duodenum, causing stomach and duodenal ulcers and certain stomach cancers. The infection is today surprisingly common, and the bacteria are believed to colonize more than half of the world’s population (Aziz *et al*., 2015).

*H. pylori* is moreover associated with serious diseases and also causes various disorders of the upper gastrointestinal tract in adults and also children. Over 50% of the world’s inhabitants are infected with the bacteria, with the highest prevalence being found in the developing countries (Go, 2002; Suerbaum and Michetti (2002). Although some reports have shown that *H. pylori* positive patients tend to have dyspepsia, the relationship between *H. pylori* and dyspepsia remains controversial.
Colonization by the bacterium is frequently acquired during early days in life. It may as well be linked to duodenal ulceration, peptic ulcer, gastric adenocarcinoma, and mucosa-associated lymphoid tissue (MALT) lymphoma (Alazmi et al., 2010). At least half of the world's inhabitants harbor the bacterium, making it the main prevalent illness in the world. Furthermore, the *H. pylori* infection rate varies from country to country with the developing countries of the world having a much elevated infection rates than the developed countries. In the developed countries, the infection rates are estimated to be 25% and below (Crowe, 2005). There are considerable differences in the occurrence of the infections globally and even in various parts of any specific country, which is closely linked to socioeconomic status and overcrowding (Ford et al., 2007).

Worldwide the most common cause of chronic gastritis is infection with *H. pylori*. The organism is known to cause progressive damages to the gastric mucosa and it is now accepted as playing a causative role in a number of important diseases, including duodenal ulcer disease, gastric ulcer disease, gastric adenocarcinoma and gastric mucosa-associated lymphoid tissue (MALT) lymphoma (Sugano et al., 2015). The prevalence increases generally with age, but decreases have also been noted in narrow age ranges in childhood (Torres et al., 2000; Sugano et al., 2015). In developing countries, the occurrence is comparatively high in children and the occurrence of *H. pylori* ranges starting from less than 10% to more than 80%. The risk factors to *H. pylori* infection includes but not limited to lower socioeconomic status, overcrowding conditions, migration to high prevalence regions, and infection status of family members (Mitchel, 2001).

Inflammation of the pyloric antrum (the opening of the stomach into the duodenum) is more prone to lead to duodenal ulcers, while inflammation of the corpus (body of
the stomach) is more likely to lead to gastric ulcers and gastric carcinoma (Suerbaum and Michetti, 2002; Schubert 2017). However, it may be possible that *H. pylori* takes part in a significant function just in the initial stage which leads to common chronic inflammation, but not in later stages that leads to carcinogenesis (Brown, 2000). A meta-analysis conducted in 2009, was in agreement that the complete elimination of *H. pylori* minimizes the danger of gastric cancer in formerly infected persons, suggesting that the persistent existence of *H. pylori* infection constitutes a relative risk of 65% for gastric cancers; in terms of absolute risk, the increase was from 1.1% to 1.7% (Fuccio et al., 2009).

*H. pylori* is contagious, with faecal oral route being the main mode of transmission and person to person transmission through either the oral-oral or fecal-oral route is most likely (Mehmood et al., 2010). Consistent with these transmission routes, the bacteria have been isolated from feces, saliva and dental plaque of some of the infected persons. Results from previous research also suggest that *H. pylori* is also more easily transmitted by way of gastric mucus than transmission through saliva (Brown, 2000). Transmission occurs mainly within families in developed nations yet can as well be acquired from the community in developing countries (Delport and Van der Merwe, 2007). *H. pylori* might also be transmitted orally by means of contaminated water, that is, through drinking of waste-tainted water. So a hygienic environment could help decrease the risk of *H. pylori* infection (Brown, 2000). The practice of improvement of the hygienic conditions has significantly decreased the prevalence of this infection in various parts of North America and Europe (Elitsur et al, 2009).
In Kenya, incidences of *H. pylori* infection is staggering high (Kimang’a *et al.*, 2010). The increasing evidence of the incidences links the infection of gastric mucosa by *H. pylori* with subsequent development of the gastric pathologies (Kimang’a *et al.*, 2010). However, more than 80 percent of persons who become infected with the bacterium are usually asymptomatic and it have been suggested that it might take part in a vital role in the natural stomach ecology (Kaakoush *et al.*, 2015).

Although it has been shown that *H. pylori* infection is associated with age, sex, and the condition of the social economy, the main risk factors for infection and transmission vary by countries. In both developing and developed countries, high prevalence of *H. pylori* is apparently related to poor socioeconomic conditions, such as overcrowded housing, low income, and the use of a stove for heating (Shi *et al.*, 2008).

### 1.2 Statement of the Problem

*H. pylori* infection is recognised as a global health problem and it is the most frequent cause of the chronic gastritis and is also strongly associated with peptic ulcer disease and gastric cancer. *H. pylori* infection in Kenya is staggeringly high and the bacteria have been found to be present in patients with chronic gastritis and gastric ulcers, circumstances that have not been in the past believed to have a microbial cause. There is high morbidity and mortality resulting from gastritis due to gastric malignancies and peptic ulcers of which may vary from county to county in Kenya. Although *H. pylori* is regarded as normal flora and also linked with the ulcers manifestation, no study has been done across the age groups.

Gastric cancer which arises from gastritis does not frequently manifest until old age. Hence, there is the need to determine the pattern of *H. pylori* infection in various age
groups within the community. The infection is more rampant in developing countries, and the prevalences are decreased in Western countries. Whereas only minorities of children in developed countries are infected with \textit{H. pylori}, the infection in developing countries is characterized by a high prevalence rate during childhood, so that the majority of young adults acquire a chronic infection persisting throughout adult life. Thus there was need to establish the group with the highest prevalence rate among the participants which will be important for the management treatment of the infection. The test used was non invasive, reliable and very useful to evaluate success of eradication after treatment of \textit{H. pylori}.

\subsection*{1.3 Justification}

About 15\% of those infected with \textit{H. pylori} worldwide, will possibly develop peptic ulcer (duodenal or gastric) or gastric cancer as a long term end result of infection. The organism causes much health burden rather than just being known as normal flora. The study seeks to determine the prevalence of \textit{H. pylori} infections among the patients with gastritis and peptic ulcers who were attending Mbagathi level V hospital, Nairobi County. It is also to establish the occurrence of the \textit{H. pylori} infection based on the participants’ age groups as well as find out the risk factors linked with to the infections. The end result of infection depends mostly on the severity and topography of histological gastritis, which may well be determined by the period at which \textit{H. pylori} infection is gotten.

Thus, it is prudent to know the occurrence of the infection in various age groups. This will help the clinicians to give the appropriate health messages to the individual centered on facts from the prevalence based age groups and also on the predisposing factors linked to \textit{H. pylori} infection. The infection may lead to increased morbidity
and mortality rates among the affected individuals. Due to the poor and low living conditions and unhygienic surroundings in the people living around Mbagathi level V hospital, in Nairobi County of the republic of Kenya, the risk of the \textit{H. pylori} infection is generally higher and therefore there is need to study the prevalence of the infection pattern among the individuals. \textit{H. pylori} infection probably occurs after consumption of fecal contaminated food or water and the bacteria can also be spread from one person to another among the family members and those who are in overcrowded dwellings places.

\subsection*{1.4 Research Questions}

i. What is the prevalence of \textit{H. pylori} infection among the patients with symptoms of peptic ulcers, gastritis and gastric ulcers, attending Mbagathi hospital?

ii. What is the infection pattern in the various age groups among patients attending Mbagathi level V hospital?

iii. What are the predisposing factors linked to \textit{H. pylori} infection in the patients attending Mbagathi level V hospital?

\subsection*{1.5 Hypothesis}

i. There is no significant infection of \textit{H. pylori} among the patients with gastritis and ulcers attending Mbagathi level V hospital.

ii. There is no significance on \textit{H. pylori} infection and the age of the participants attending Mbagathi level V hospital.

iii. There are no predisposing factors are associated with \textit{H. pylori} infection in the patients attending Mbagathi level V hospital.
1.6 Objectives

1.6.1 General Objective

To determine the prevalence of *H. pylori* infection, establish the most infected age group and also the risk factors in patients with gastritis and peptic ulcers who were attending Mbagathi level V hospital.

1.6.2 Specific Objectives

i. To determine the prevalence of *H. pylori* in patients with peptic ulcers, gastritis or gastric ulcers attending Mbagathi level V Hospital.

ii. To determine the *H. pylori* infection pattern among various age groups in patients with ulcers attending Mbagathi level V hospital.

iii. To determine the risk factors associated with *H. pylori* infection in patients with ulcers attending Mbagathi level V hospital.

1.7 Significance of the study

The study findings will give guidelines to policy makers to know how well to deal with the *H. pylori* infections appropriately. This will enable the clinicians put in place good measures to curb the spread of the infection from one infected person to another. The numbers of positive cases are now at alarming rate and they have been reported across all age groups from young to the elderly.

A better understanding regarding the occurrence of *H. pylori* infection in relation to the persons’ age distribution is necessary so as to develop public health measures that will control the spread of the bacterium among individuals.
CHAPTER TWO

Literature Review

2.1 Prevalence of *H. pylori* infection

Understanding the epidemiological aspects of *H. pylori* infection is significant and helpful in illustrating the consequences and complications of the infection. It is also fundamental for the eradication, treatment, and the establishment of the pattern of antibiotic resistance. Several Countries in the World Health Organization, Eastern Mediterranean Regional Office (EMRO) including a group of developing countries in southwest and western Asia as well as North Africa and the ancient land of Iran, have no systematic reviews on the prevalence and epidemiology of *H. pylori* infections (Eshraghian, 2014).

In many countries, the incidence of *H. pylori* infection has been decreasing steadily in association with improved standards of living. Yet the occurrence of this bacterium is still ever present, especially in the Far East (Brown *et al.*, 2002). It is the main cause of chronic gastritis and the main etiological agent for gastric cancer and peptic ulcer disease (Bauer and Meyer, 2011). In most regions, the main mechanism of spread is intrafamilial transmission. The prevalence remains high in most developing countries and it is generally related to socioeconomic status and levels of hygiene. Understanding the global epidemiologic patterns of *H. pylori* will aid us in prioritizing and customizing public health efforts to better manage the burden of this disease (Hooi *et al.*, 2017). In Brazil, epidemiological studies of *H. pylori* infection have reported a 40% seroprevalence in children less than 6 years of age from a low income population (Camilo *et al.*, 2011). *H. pylori* infection is very common among adults in southern Brazil as it is in the other developing countries. Socio-economic conditions in childhood besides ethnicity and presence of dyspeptic symptoms in
Brazil were found to be the factors significantly associated with the infection (Santos et al., 2005).

*H. pylori* is a pathogen that plays a major role in the development of gastritis and it is also an important risk factor for peptic ulcers in Chinese population. *H. pylori* was classified as a class I carcinogenic agent, which includes agents that can cause gastric carcinogenesis and primary gastric B-cell lymphoma. The prevalence of *H. pylori* differs significantly among various countries, with higher prevalence in developing countries compared to developed countries. In both developing and developed countries, high prevalence of *H. pylori* is apparently associated to poor socioeconomic conditions (Shi et al., 2008). In Kenya, a study on prevalence of *H. pylori* infection by Nabwera et al., 2000 on school going children from the age of 3 years to 15 years was found to be 80.7%.

The age at which this bacterium is acquired seems to control the possible pathologic outcome of the infection: individuals who are infected with *H. pylori* at an early age are likely to develop more intense inflammation that may well be followed by atrophic gastritis with a higher subsequent risk of gastric ulcer, gastric cancer or both (Mitchell et al., 2003). Acquisition at an older age brings diverse gastric changes more likely to result to duodenal ulcer (Brown, 2000). Adult individuals who lived in precarious conditions during childhood constitute the population at the highest risk for *H. pylori* infections since the infections are by and large acquired in early childhood in all countries. However, the infection rate of children in developing nations is higher than in the industrialized nations, perhaps due to poor hygienic conditions and other predisposing factors (Kusters et al, 2006). Childhood stages appears to be the most critical period in life during which *H. pylori* is acquired,
especially in areas of overcrowding and low socioeconomic. However, adults can also become infected with *H. pylori*, and in developed countries this has been reported to occur at the rate of around 0.3% to 0.5% per year. Various studies of *H. pylori* infection among the low-income adult population in developing countries have also shown that the prevalence of the infection increases with age, although slightly (Rodrigues *et al.*, 2005). In developed countries it is rare to find infected children, but the percentage of infected individuals increases with age, with about 50% of infected cases being those with more than 60 years of age compared to approximately 10% between 18 and 30 years old (Crowe, 2005).

This higher occurrence rate amongst the elderly reflects higher infection rates when they were children rather than infection at later ages (Torre *et al.*, 2015). On the other hand, incidence in childhood is related to prevalence in adults, since the children are more exposed to the bacteria by contagion within the family members, particularly the infected siblings or parents (Escobar *et al.*, 2004). Presently it is believed that the infection is acquired during childhood, mainly in the populations at risk and studies have shown a 2.2% to 3.3% incidence among children of developing countries or groups at high risk than in developed countries (Malaty *et al.*, 2002), although most of these studies are based on serology, a test of less accuracy in smaller children (Portorreal and Kawakami, 2002).

Chronic gastritis and peptic ulceration are prevalent in high magnitude throughout the world (Ghazzawi *et al.*, 2004). *H. pylori* gastritis is the principle basis of active persistent gastritis furthermore it causes major complications like adenocarcinoma and mucosa associated lymphoid tissue lymphoma (Ozbek *et al.*, 2010). Worldwide, peptic ulcer disease is a major cause of morbidity and distal gastric adenocarcinoma,
which is the second biggest cancer killer worldwide (Porta et al., 2011). *H. pylori* infection is contracted primarily in childhood, and infection from childhood appears to enhance the risk for carcinogenesis (Blaser and Atherton, 2004). When *H. pylori* colonize other areas of the stomach, the inflammatory reaction can end up in atrophy of the stomach lining and finally lead to ulcers in the stomach. This may also enhance the risk of stomach cancer (Suerbaum and Michetti, 2002).

### 2.2 Pathogenesis of *H. pylori*

*H. pylori* was discovered in 1982 by Australian scientists Barry Marshall and Robin Warren, in patients with chronic gastritis and gastric ulcers, conditions that were not in the past thought to have a microbial basis (Pajares and Gisbert, 2006). The bacterium colonizes the stomach of humans and it induces severe mucosal inflammation and a local and systemic immune response. *H. pylori* is a bacterium that is capable of changing its membrane potential at external pH levels from 3.0 to 7.0 in order to maintain a neutral internal pH (Vandenplas et al., 2000). *H. pylori* produce oxidase, catalase, and urease enzymes.

The Urease enzyme breaks down urea (which is normally secreted into the stomach) to carbon dioxide and ammonia. The ammonia is then changed to ammonium by accepting a proton (H$^+$), which subsequently neutralizes gastric acid (Mégraud and Lehours, 2007). The organism is also capable of forming biofilms and can convert from the spiral form to a viable but nonculturable coccoid form which both are likely to favor the survival of the bacteria as evasive mechanism and also act as a factor in the epidemiology of the bacterium (Capon et al., 2006; Andersen and Rasmussen, 2009). The coccoid form have been further classified into three categories, a dying form, a viable culturable form, and a viable but non-culturable state (VBNC), found
to be metabolically active but not actively growing (Azevedo et al., 2007; Gia˜o et al., 2008).

Unceasing efforts to easily understand the pathophysiology of H. pylori infection have shown the most crucially and important contribution of various bacterial factors for H. pylori pathogenesis, in particular the cag pathogenicity island (PAI), the effector protein CagA, and the vacuolating cytotoxin VacA (Sgouras et al., 2015). After entering the host stomach, H. pylori utilizes its enzyme urease activity to neutralize the unfriendly acidic condition (in the stomach). At the beginning of infection, H. pylori releases several effector proteins and toxins, including cytotoxin associated gene A (CagA), and vacuolating cytotoxin A (VacA), which cause host tissue damage (Gray, 2011). Flagella-mediated motility is then required for H. pylori to move towards host gastric epithelium cells, followed by specific interactions between bacterial adhesins and the host cell receptors, which then leads to successful colonization and persistent infection (Huang et al., 2016).

### 2.3 Pathophysiology of ulcer disease

Generally, H. pylori is very much adapted to the gastric environment where it lives within or beneath the gastric mucous layer. The bacterium generally does not invade gastroduodenal tissue. Instead, it renders the underlying mucosa more vulnerable to acid peptic damage by disrupting the mucous layer, liberating enzymes and toxins, and adhering to the gastric epithelium (Eusebi et al., 2014). In addition, the host immune response to H. pylori incites an inflammatory reaction which further perpetuates tissue injury.

The chronic inflammation induced by H. pylori upsets gastric acid secretory physiology to varying degrees and leads to chronic gastritis which, in most
individuals is asymptomatic and does not progress. In some cases, however, altered gastric secretion coupled with tissue injury leads to peptic ulcer disease, while in other cases, gastritis progresses to atrophy, intestinal metaplasia, and eventually gastric carcinoma or rarely, due to persistent immune stimulation of gastric lymphoid tissue, gastric lymphoma (El-Serag et al., 2018).

In addition, the gastric epithelium layer, which forms the major interface between \textit{H. pylori} and the host, secretes chemokines to initiate innate immunity and activate neutrophils, and further lead to the formation of clinical diseases such as gastritis and ulcer. In summary, four steps are critical for \textit{H. pylori} colonization and pathogenesis, that’s is; survival under acidic stomach conditions, movement toward epithelium cells through flagella-mediated motility, attaching to host receptors by adhesins and causing tissue damage by release of toxins (Kao et al., 2016), as shown in figure 2.1 below:

![Figure 2.1: Schematic diagram of \textit{H. pylori} infection and pathogenesis (Kao et al, 2016).](image-url)
The end results of *H. pylori* infection is considered to be dictated by the bacterial virulence determinants, the host genetic factors, and the environmental components such, living conditions and predisposing factors (Yamaoka, 2012). The primary disorder, which occurs after colonization with *Hecobacter pylori*, is chronic active gastritis. This condition can be observed in all *H. pylori* positive subjects. The intragastric distribution and severity of this chronic inflammatory process depend on a variety of factors, such as characteristics of the colonizing strain, host genetics and immune response, diet, and the level of acid production. *H. pylori* induced ulcer disease, gastric cancer, and lymphoma are all complications of this chronic inflammation; ulcer disease and gastric cancer in particular occur in those individuals and at those sites with the most severe inflammation (Kusters *et al.*, 2006). When the bacteria colonize the stomach, inflammation induces G cells of the antrum; the G cells then secrete gastrin hormone, which travels to parietal cells of the fundus via blood stream (Blaser, and Atherton, 2004). Gastrin stimulates secretion of the acid from the parietal cells and also increases the number of parietal cells. Increased load of acid damages epithelial cells of the duodenum resulting in ulcers (Schubert and Peura, 2008).

Understanding of some of these risk factors may thus be very important for the recognition of the function of *H. pylori* in the etiology of upper gastrointestinal pathology (Kusters *et al.*, 2006). Infection in infancy is thought to lead to pangastritis, whereas acquisition in later childhood may lead to a predominantly antral gastritis only. *H. pylori* is capable of sensing the pH gradient in the mucus and move towards the reduced amount of acidic area (a process called chemotaxis). This also keeps the bacteria from being swept away into the lumen with the bacteria’s mucus environment, which is regularly moving from its location of manufacture at the
epithelium to its dissolution at the lumen interface (Schreiber et al, 2004). With antral gastritis there is loss of regulatory feedback (but with an intact and undamaged acid secreting gastric corpus), and the high acid load reaching the duodenum leads to the development of duodenal gastric metaplasia (Kusters et al, 2006). Evidence links the infection of the gastric mucosa by *H. pylori* with subsequent development of gastric pathologies which includes inflammation, ulceration and to an extent cancer (Kao et al., 2016). While the infection is usually acquired during the childhood ages, there is typically a long period of latency with disease manifestations not appearing until adulthood (Malaty, 2007).

Urease is basically a cytoplasmic enzyme (Aguetoni and Mercier, 2009), and it hydrolyzes urea to bicarbonate and ammonia, resulting in a net increase in the ambient pH. Ammonia is a nutrient for the bacteria, and cause lesions of the gastric epithelium by many different mechanisms (Cover and Blaser, 2009). A number of the virulence factors such as urease and flagella are present in all strains and are necessary for pathogenesis and colonization. Flagella, and thus motility, are needed for persistent gastric colonization (Ottemann and Lowenthal, 2002). *H. pylori* may be found in the mucus, on the internal surface of the epithelium, and occasionally inside the epithelial cells themselves (Petersen and Krogfelt, 2003). It adheres to the epithelial cells by producing adhesins, which attach to lipids and carbohydrates in the epithelial cell membrane. One such adhesion is BabA, which binds to the Lewis b antigen displayed on the surface of stomach epithelial cells (Magalhaes et al, 2009) (Camilo et al., 2017). In addition to using chemotaxis to keep away from areas of low pH, *H. pylori* also neutralizes the acid in its environment. It does this by producing large amounts of the enzyme urease, which breaks down the urea which is present in
the stomach to carbon dioxide and ammonia. The ammonia, which is a base, subsequently neutralizes the acid in the stomach (Montecucco and Rappuoli 2001).

Studies of the *H. pylori* genome have been centered on attempts to understand its pathogenesis. About 29% of the loci are in the "pathogenesis" group of the genome database. Two of sequenced strains have just about 40-kb-long cytotoxin associated gene (*Cag*) pathogenicity island (a common gene sequence thought to be responsible for pathogenesis) that contains over 40 genes. This pathogenicity island is generally absent in *H. pylori* strains isolated from humans who are carriers of *H. pylori* but who remains asymptomatic (Khatun, 2014).

The *cagA* gene codes for one of the main *H. pylori* virulence proteins. Bacterial strains that have the *cagA* gene are linked to the ability to cause ulcers (Mehmood *et al*., 2010). The *cagA* gene codes for a relatively long (1186 amino acid) protein. The *cag* pathogenicity island (PAI) have approximately 30 genes, part of which code for a complex type IV secretion system. The low GC-content of the *cag* PAI relative to the rest of the *Helicobacter* genome suggests that, the island was acquired by horizontal transfer from another bacterial species (Mehmood *et al*., 2010).

*H. pylori* infection is very strongly associated with peptic ulcer disease (duodenal and gastric ulcers) and chronic active gastritis. *H. pylori* infection is also an independent risk factor for gastric cancer and primary malignant lymphoma of the stomach. Successful treatment of *H. pylori* infection may increase, decrease or have no overall effect on acid secretion. The effect on acid secretion depends upon the initial pattern of gastritis. The infection can be treated successfully in most cases with a combination of medications for 10 to 14 days (Malfertheiner *et al*., 2012).
2.4 Clinical manifestation of *H. pylori* infection

Colonization with *H. pylori* is not a disease in itself but a condition that affects the relative risk of developing various clinical disorders of the upper gastrointestinal tract and possibly the hepatobiliary tract (Kao *et al.*, 2016). Acute infection may well emerge as an acute gastritis with abdominal pain (stomach ache) or nausea (Butcher and Graham, 2003), Where this develops into chronic gastritis, the symptoms, if present, are often those of non-ulcer dyspepsia; stomach pains, nausea, bloating, belching, and occasionally vomiting or black stool (Abdou *et al.*, 2014).

For these reasons, a correct understanding of the clinical symptoms of *H. pylori* associated disorders and the effect of *H. pylori* eradication is needed. *H. pylori* harm the stomach and duodenal linings by a number of mechanisms (Sumbul *et al.*, 2011). The ammonia produced to regulate pH is toxic to epithelial cells (Van Vliet *et al.*, 2003). Additional biochemicals produced by *H. pylori* such as proteases, vacuolating cytotoxin A (VacA) and certain phospholipases, damages epithelial cells, disrupts the firm junctions and thus causes apoptosis, (Delahay and Rugge, 2012). Cytotoxic associated gene A [CagA] is also able to cause inflammation and is potentially a carcinogen. The *cagA* protein product is a cryptic 128-kDa immunodominant antigen which is usually produced by *H. pylori* (Cover and Blaser, 2009). *H. pylori* own five most important outer membrane protein (OMP) families (Kusters *et al.*, 2006). The major family of Outer Membrane Proteins includes the well-known putative adhesins. The additional four families of OMP are porins, iron transporters, flagellum-associated proteins, and proteins of less known roles (Van Vliet *et al* 2003). Similar to other typical Gram negative bacteria, the outer membrane of *H. pylori* consists of phospholipids and lipopolysaccharide (LPS).
The O antigen of LPS may possibly be fucosylated and mimic Lewis blood group antigens found on the gastric epithelium. The outer membrane also contains cholesterol glucosides, which are found in a small number of other bacteria (Kusters et al., 2006). *H. pylori* have four to six lophotrichous flagella; all gastric and enterohepatic *Helicobacter* species are extremely motile owing to flagella (Josenhans et al., 2000). The characteristic sheathed flagellar filaments of *Helicobacter* species are composed of two copolymerized flagellins, FlaA and FlaB (Rust et al., 2008). Urease stimulates the release of a variety of inflammatory cytokines, including IL-β, IL-6, TNF-α, and chemokines such as IL-8. Although the exact mechanism by which urease functions in the pathogenesis of gastric disease remains unclear, it is likely that urease is an important virulence factor (Vandenplas, 2000) (Kusters et al., 2006).

The inflammatory response caused by the bacteria colonizing in close proximity to the pyloric antrum induces G cells in the antrum to produce the hormone gastrin, which travels through the bloodstream to parietal cells in the fundus (Blaser and Atherton, 2004). Gastrin stimulates the parietal cells to produce more acid into the stomach lumen, and over time increases the amount of parietal cells as well (Schubert and Peura, 2008). The increased acid load damages the duodenum, which might in the long run result in ulcers forming in the duodenum. *H. pylori* can produce different kinds of phospholipases, weakening the hydrophobicity of the gastric mucus and mucosa. Phospholipase can also generate ulcerogenic substances (Tulassay, and Herszényi, 2010). Many other enzymes, such as mucinase, neuraminidase, fucosidase and alcohol dehydrogenase, have been reported to be produced by *H. pylori* (Cover and Blaser, 2009).
Ulcers in the stomach and duodenum usually occur as a result when the effects of the inflammation permit the stomach acid and the digestive enzyme pepsin to overwhelm the defensive mechanisms of the stomach and duodenal mucous membranes (Kahrilas, 2003). The location of colonization by *H. pylori*, which affects the site of the ulcer, depends on the acidity of the stomach (Shiotani and Graham, 2002). In the persons who produce bulky amounts of acid, *H. pylori* colonizes in close proximity to the pyloric antrum (exit to the duodenum) to avoid the acid-secreting parietal cells at the fundus (close to the entrance to the stomach) (Schubert, 2012). In the individuals producing normal or reduced amounts of acid, *H. pylori* can also colonize the rest of the stomach. Establishment of the *H. pylori* in the stomach can often lead to chronic gastritis, an inflammation of the stomach lining, at the site of infection. *Helicobacter* cysteine-rich proteins (Hcp), particularly the HcpA (hp0211), are well recognized to
elicit an immune response, which in turn causes inflammation (Zanotti, and Cendron, 2014). Chronic gastritis is likely to underlie *H. pylori*-related diseases (Shiotani and Graham, 2002). There is also an association between *H. pylori* infection and malnutrition, short stature and diarrhea which have also been demonstrated in children (Ertem et al, 2003). Despite *H. pylori* having a high morbidity rate, the infection is curable with drugs such as, proton pump inhibitors and antibiotic therapy (Malaty, 2007).

Testing for *H. pylori* is suggested if there is peptic ulcer disease, low grade gastric MALT lymphoma, after endoscopic resection of early gastric cancer, if there are first degree relatives with gastric cancer, and in certain cases of dyspepsia (Stenström et al, 2008).

### 2.5 Diagnosis of *H. pylori* stool antigens

Testing for *H. pylori* infection have become a very essential part of the diagnostic process for gastric and duodenal inflammatory disease, since the presence or absence of the bacterial infection determines the type of treatment to be applied (Malfertheiner et al., 2007). Testing is also a useful means of monitoring the effectiveness of courses of antimicrobial treatment. Various diagnostic tests have been developed for the detection of *H. pylori* and each has its specific advantages and disadvantages (Malfertheiner et al., 2002).

The diagnostic tool used for *H. pylori* infections involves the use of *H. pylori* stool antigen test which detects the presence of *H. pylori* antigens shed in the human faeces. This test for *H. pylori* have been developed and used by many clinical laboratories and research investigators worldwide and they have proved to be excellent tools for studies of the prevalence and epidemiology of *H. pylori*
Therefore, testing for *H. pylori* has no relevance by itself, but it should be performed to find out the cause of an underlying condition, such as gastric ulcer disease, or for the purpose of disease prevention, such as in individuals with familial gastric cancer (Koletzko *et al.*, 2011). In these cases, a positive test result justifies treatment and a negative test result may indicate that there is need to search for other etiologic factors or preventive measures.

In addition, cost-effectiveness studies suggest that a choice of noninvasive testing should be based on the prevalence of infection in the community. In low and intermediate prevalence situations, the stool antigen test or urea breath test dominate (Vakil *et al.*, 2000). As compared with endoscopy, enzyme-linked immunosorbent assays (ELISAs) have proved to be sensitive and specific for detection of active disease. Serologic testing has proved successful in identifying ongoing infection that it has been suggested that serologic analysis rather than biopsy be considered the gold standard for the diagnosis (Gisbert, and Abraira, 2006). The stool antigen test, being highly sensitive and specific, is a very helpful tool in diagnosing *H. pylori* infection in children (Ni *et al.*, 2000). Despite *H. pylori* having a high morbidity rate, the infection is curable with drugs such as, proton pump inhibitors and antibiotic therapy (Malaty, 2007).

The available tests are generally divided into invasive tests, based on gastric specimens for histology, culture, or other methods, and noninvasive tests, based on peripheral samples, such as blood, breath samples, stools, urine, or saliva for detection of antibodies, bacterial antigens, or urease activity of *H. pylori* (Westblom *et al.*, 2012). A detailed over view of the methods used in diagnosis of *H. pylori* are shown in the table 2.1 below;
### Table 2.1: Diagnosis Methods for detection of *H. pylori* infection

<table>
<thead>
<tr>
<th>Diagnostic method</th>
<th>Sensitivity and specificity</th>
<th>General Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Invasive methods</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Histology</td>
<td>&gt;95%</td>
<td>Requires expert pathologist; also provides histological data on inflammation and atrophy</td>
</tr>
<tr>
<td>Culture biopsy</td>
<td>&gt;95%</td>
<td>Allows for testing of antimicrobial sensitivity; requires specific microbiological expertise</td>
</tr>
<tr>
<td>Rapid urease test</td>
<td>&gt;90%</td>
<td>Requires an additional test for confirmation of <em>H. pylori</em> infection</td>
</tr>
<tr>
<td><strong>Non invasive</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urea breath test</td>
<td>&gt;95%</td>
<td>Very useful, reliable test to evaluate success of eradication treatment of <em>H. pylori</em>; limited availability due to requirement of expensive equipment</td>
</tr>
<tr>
<td>Stool antigen test</td>
<td>&gt;90%</td>
<td>Simple test and may be reliable for testing the achievement of eradication treatment of <em>H. pylori</em></td>
</tr>
<tr>
<td>Serology</td>
<td>80 – 90%</td>
<td>Insufficient reliability for routine screening; cannot prove ongoing infection due to immunological memory</td>
</tr>
</tbody>
</table>

**Global range, depending on regional variations and subjects.**

*H. pylori* antigen detection in stool is a non invasive, rapid test, ease to collect the specimen and easy to perform test (Cardinali et al., 2003). The test can be used to detect active infection, monitor effectiveness during therapy and to confirm cure after antibiotic use adds to the tests advantage (Vaira et al., 2002). Also, prior preparation of the patient is not necessary unlike in upper gastrointestinal endoscopy. The sensitivity and specificity of this test is higher compared to the other *H. pylori* detection methods (Vaira et al, 2000). *H. pylori* stool antigen test has a 95% correlation with reference methods such as endoscopy, histology and urea breath test. It is more developed as an alternative to the urea breath test (Gisbert et al, 2006).
3.1 Study Area

The sample collection and analysis was carried out at Mbagathi level V Hospital. It was built in the 1950s to offer health care services, mainly for infectious diseases which required isolation such as Tuberculosis, Measles, Meningitis and Leprosy. The hospital is situated in Kenyatta Golf Course Location, Dagoretti District of Nairobi County. The hospital was originally known as “Infectious Diseases Hospital” (IDH) under the then “King George VI Hospital,” currently Kenyatta National Hospital. In the year 1995, the infectious diseases hospital (IDH) was curved out from Kenyatta National Hospital and transformed into an autonomous District Hospital for Nairobi, currently upgraded to level V hospital. It serves mainly the people of Mbagathi, Ngumo estate, Kibera and its environs, as shown in appendix I.

3.2 Study Design

The study adopted a cross-sectional hospital-based study.

3.3 Study Population

The study involved both male and female patients with symptoms of ulcers and who are at the age of 6 (six) months and above, during the study period.

3.3.1 Inclusion Criteria

i. All patients who were at the age of six months and above attended Mbagathi level V hospital. This was because it was anticipated that below six (6)
months, the child was feeding on breast milk exclusively and therefore not predisposed to the risk of *H. pylori* infection.

ii. The patients with symptoms of gastritis and duodenal ulcers were involved in the study.

### 3.3.2 Exclusion Criteria

The patients were excluded from the study based on the following characteristics;

i. Children below six (6) months old.

ii. Patients who were on treatment for ulcers, using drugs like proton pump inhibitors and antibiotics within the last seven days before the study.

iii. Patients who had diarrhoea within the last seven days to the study.

### 3.4 Sample Size Determination

The minimum sample size was calculated using the formulae of Fishers *et al* of 1998 method, using a prevalence of *H. pylori* infection of 54.8% (Kimang’a *et al.*, 2010).

\[
\begin{align*}
n &= \frac{Z^2 Pq}{\delta^2} \\
&= \frac{1.96^2 \times 0.548 \times (1 - 0.548)}{0.0025} \\
&= 380.62 \\
&= 381 \text{ participants.}
\end{align*}
\]
3.5 Sampling Technique

Purposive sampling technique was used to recruit participants. Those who presented with the symptoms and signs that were suggestive of ulcers or gastritis at the outpatient department. They were talked to about the study and those who were willing to participate gave their consent in writing or that of their parents/guardian until the required sample size was attained.

3.6 Sample Collection

Patients were given clean, dry, grease free stool containers without any preservatives and instructed to put stool sample for H. pylori testing. They were also instructed not to contaminate the stool specimen during the time of collection. The Stool samples were collected from the patients and taken directly to the laboratory where they were analysed. All of the study participants voluntarily produced stool samples for the analysis and detection of the presence of H. pylori antigens.

3.6.1 Laboratory analysis for H. pylori stool antigen test

The test was based on the principle of immunochromatography *invitro* for qualitative determination of H. pylori antigens in stool (Bio tracers™). The test used H. pylori specific monoclonal antibodies coated on the membrane of the test device. The cap of the sample extraction tube was opened by unscrewing the cap. Using the sample collection stick attached to the cap, a fresh stool sample (about 50mg), approximately the size of a peanut was collected from at least four different sites of the specimen. For liquid or watery stool specimen, 100µl (approximately two drops) of the sample was taken using a plastic disposable pipette. The sample collection stick was then inserted in to the sample extraction tube containing Phosphate buffer and the tube was tightly closed to secure it. The tube was then swirled and shaken well to dissolve the
stool sample. It was mixed homogenously with the phosphate buffer in the sample extraction tube as shown in the figure 3.1 below;

![Figure 3.1: Sample preparation for H. pylori stool antigen testing](image)

The testing device (cassette) was then taken out of the foil pouch and paced on a clean and flat surface, preferably on a bench. Then the dispenser cap of the sample tube was twisted off and by holding the tube vertically, five (5) drops of the mixture of the stool sample and buffer were dispensed into the sample well of the cassette test device as shown in figure 3.2 below. The results were read after 15 minutes.

![Figure 3.2: Testing Procedure for H. pylori stool antigen test](image)

### 3.6.1.1 Test outcome Information

The stool sample with no antigen (for negative test) did not react with the *H. pylori* antibody conjugate in the test device. The buffer and the antibody conjugate migrated
chromatographically on the membrane of the cassette and no coloured line was generated on the test window (T).

The *H. pylori* antigen in the stool sample (for positive test) reacted with the *H. pylori* antibody conjugate in the test device. The antibody - antigen mixture then migrated chromatographically on the membrane of the cassette and generated a red coloured line on the test window (T). An additional line in the control window (C) appeared irrespective of presence or absence of the specific *H. pylori* antigen in the stool sample. The test results were read and interpreted within 15 minutes.

A red colour band on test (T) and control (C) window, showed positive results (antigen detected) was indicative of *H. pylori* antigen. As shown in figure 3.2 below; in a negative result, a band appeared on the control (C) zone only, (antigen not detected).

![Figure 3.3: A positive *H. pylori* stool antigen test results](image-url)
3.6.2 Patients’ Age stratification

The occurrence of the *H. pylori* infection based on the age group of the participants was established. And the age groups were stratified accordingly to the score limits so that the prevalence of the bacteria among various age groups was achieved. This was done by getting the ages of the patients then classifying them into various age groups of equal units so as to know the age category with the highest positive cases. Considering that too few strata would lead to loss of accuracy and too many of the strata result to inaccuracy.

3.6.3 Questionnaires

The participants also filled the questionnaires by giving answers to crucial information (appendix 1). In the questionnaires, they indicated their ages which were used to categorize them in various age groups so as to know the occurrence of the infection in different age categories. The questionnaires were also used in the evaluation of risk factor associated the *H. pylori* infections among the patients with gastritis and ulcers. The questions involved in the questionnaires included; the age, gender, level of education of the participants, number of household members, source of water and the places where they got their meals. The questionnaires administered by the study participants voluntarily and then analysed accordingly.

3.7 Ethical consideration and approval

All participants were informed about the objectives and purposes of the study, and that they were required to fill informed consent. The study involved humans, that is knowing the prevalence of *H. pylori* among individuals with ulcers and the pattern of infection based on the age categories as well as the risk factors associated with the infection. Participants were also informed of the sample collection procedures,
possible discomforts and the freedom to choose either to participate or decline to take part in the study (appendix 2). The study complied with International Committee for Harmonisation and Good Clinical Practice guidelines (ICH GCP) on research ethics and permission was sought from Kenyatta University Ethics Review Committee and also from Kenyatta National Hospital – University of Nairobi (KNH – UoN) ethical review committee (appendix 3). To maintain and uphold confidentiality in this study, the samples and questionnaires from the participants had no names, instead they were assigned numbers, sex and age details.

3.8 Data Management, analysis and Presentation

All the findings obtained from this research were captured in a notebook initially. The entire data was then checked for completeness, consistency and accuracy. Thereafter, the data was coded and exported to MS Excel spreadsheets. The data was then fed into a computer and subsequently analysed using statistical package for social sciences (SPSS, version 20.0) and Chi-square test for proportions. The data was summarized into frequency tables, pie charts and graphs. Out of the total number of participants, the positive cases were used to calculate and give the prevalence of the infections. Statistical significance was considered for probability values ($P$) less than 0.05. Depending on the ages of the participants, the infection pattern among the various age groups was also identified. The dully filled questionnaires also gave the possible risk factors that lead to the $H. pylori$ infection among the participants.
CHAPTER FOUR

Results

4.1 Demographics characteristics of the participants

The social demographics information of the respondents was studied. A total of three hundred and eighty one (381) participants who had consented and were recruited in this study, took part by correctly filling the questionnaires and they also successfully produced stool samples for detection of *H. pylori* antigen.

4.1.1 Age of respondents

The participants in this study were between the ages of 6 months and 90 years old and the age was stratified into nine (9) age groups, namely; 6 months – 10 years, 11 – 20 years, 21 – 30 years, 31 – 40 years, 41 – 50 years, 51 – 60 years, 61 – 70 years 71 - 80 years and 81 – 90 years. The Mean age was calculated to be 42.03 with Standard Deviation of 20.11.

Out of the 381 participants in this study, those who were in the age group between 81 to 90 years and 71 – 80 years had the lower numbers of participants of thirteen (13) and fourteen (14) respectively. Those participants who were in the age group between the ages of 31 to 40 years had the highest number of members who participated in the study at one hundred and eighteen (118), as shown in Table 4.1; representation of ages of the participants.
Table 4.1: Demographic representation of ages of the participants

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Total participants (N=381)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6months – 10 yrs</td>
<td>30</td>
</tr>
<tr>
<td>11– 20 yrs</td>
<td>36</td>
</tr>
<tr>
<td>21– 30 yrs</td>
<td>84</td>
</tr>
<tr>
<td>31– 40 yrs</td>
<td>118</td>
</tr>
<tr>
<td>41 - 50 yrs</td>
<td>33</td>
</tr>
<tr>
<td>51–60 yrs</td>
<td>27</td>
</tr>
<tr>
<td>61–70 yrs</td>
<td>26</td>
</tr>
<tr>
<td>71–80 yrs</td>
<td>14</td>
</tr>
<tr>
<td>81– 90 yrs</td>
<td>13</td>
</tr>
<tr>
<td>Total (N)</td>
<td>381</td>
</tr>
</tbody>
</table>

Mean age 42.03
Std. deviation 20.11

4.2 Prevalence of *H. pylori* infection among patients with gastric ulcers attending Mbagathi level V Hospital

A univariate analysis of *H. pylori* stool antigen test was done to establish the occurrence of the bacteria among the participants. Prevalence refers to the percentage of the individuals found to have the condition in a study population. This was achieved by dividing the number of people found to be positive for the case by the
total number of study population, and is usually expressed as a fraction, as a percentage. The results showed that, out of the total 381 participants, 176 of them (46.2%) were reactive (positive) for *H. pylori* antigen stool test. Those participants who were non-reactive (negative) for the *H. pylori* antigen stool test comprised 205, (53.8%). The results showed that, the prevalence of *H. pylori* infection in patients with ulcers at Mbagathi level V Hospital was 46.2% (P = 0.015). These were the patients who were positive for *H. pylori* stool antigen test. As shown in the figure 4.1;

![Figure 4.1](image)

**Figure 4.1; Showing the prevalence of *H. pylori* infection among the participants**

4.3 *H. pylori* infection pattern among various age groups in the study population

The study results showed that, those participants who were between the ages of 31 - 40 years had the highest number of positive cases of *H. pylori* infection, which was fifty seven (57) cases, translating to 32.4% (P = 0.031). Table 4.2 below shows the prevalence of *H. pylori* infection based on various age groups of the participants.
Table 4.2 Occurrence of *H. pylori* in various age groups

<table>
<thead>
<tr>
<th>Age groups (years)</th>
<th>Positive</th>
<th>Total</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>6months–10</td>
<td>05</td>
<td>07</td>
<td>12</td>
</tr>
<tr>
<td>11–20</td>
<td>08</td>
<td>06</td>
<td>14</td>
</tr>
<tr>
<td>21–30</td>
<td>13</td>
<td>20</td>
<td>33</td>
</tr>
<tr>
<td>31–40</td>
<td>21</td>
<td>36</td>
<td>57</td>
</tr>
<tr>
<td>41–50</td>
<td>09</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>51–60</td>
<td>06</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>61–70</td>
<td>04</td>
<td>07</td>
<td>11</td>
</tr>
<tr>
<td>71–80</td>
<td>02</td>
<td>05</td>
<td>07</td>
</tr>
<tr>
<td>81–90</td>
<td>04</td>
<td>02</td>
<td>06</td>
</tr>
<tr>
<td>Total</td>
<td>72</td>
<td>104</td>
<td>176</td>
</tr>
</tbody>
</table>

4.4 Risk factors associated with *H. pylori* infection

The risk factors which were looked up in this study, were basically those that were found to be applying in almost in every house hold, they included, gender, level of education, source of drinking water, waste disposal, number of household members and the places where they got their meals.

4.4.1 Gender of respondents and occurrence of *H. pylori* infection

Out of the total 381 study participants, 206 (54.1%) of the respondents were female while 175 (45.9%) participants were male. This represented a ratio of male to female participants of 1:1.2, as shown in figure 4.2 below;
Out of the two hundred and six (206) female participants, one hundred and four (104) were positive for the *H. pylori* stool antigen test, translating to 59.1%. The male participants were one hundred and seventy five (175) and 72 (40.9%) were positive for the *H. pylori* antigen test. A Pearson product-moment correlation coefficient was computed to assess the relationship between the participant's gender and occurrence of *H. pylori* antigen. Results show that there was a positive correlation between the study participants gender and occurrence of *H. pylori* antigen (P = 0.003). Female had the higher number of infected individual in the study population compared to the male counterparts, as shown in the table 4.3;

**Table 4.3: Occurrence of *H. pylori* based on gender of participants (P = 0.003)**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>104 (59.1%)</td>
<td>102</td>
<td>206</td>
</tr>
<tr>
<td>Male</td>
<td>72 (40.9%)</td>
<td>103</td>
<td>175</td>
</tr>
<tr>
<td>Total</td>
<td>176</td>
<td>205</td>
<td>381</td>
</tr>
</tbody>
</table>
4.4.2 Level of education and Occurrence of H. pylori antigen

One hundred and forty five (145), representing 38.1% of total participants had attained midlevel college education and twenty six (26) representing 6.8%, had (kindergarten) pre-primary education by the time of carrying out the study. Others, one hundred and sixteen (116), representing 30.4% and fifty seven (57) representing 15.0%, had attained Secondary and Primary education level respectively. Thirty four (34) representing 8.9%, had attained University level education by the time of the study and only three (3) representing 0.8% had not attained any formal minimum education.

The overall results showed that, there was no notable relationship between the two variables as the pattern of infection across all education levels was not well defined (P = 0.205). As shown in the figure 4.3 below;

Figure 4.3: Respondents’ level of education and occurrence of H. pylori infection
4.4.3 Source of drinking water and occurrence of *H. pylori* infection

Thirty two (32) participants, translating to 8.4% and three hundred and seventeen (317) translating to 83.2% of the participants, used bottled and tap water respectively. The others, twenty nine (29), translating to 7.6% and three (3) representing 0.8% of the participants used borehole and water from the river as their sources of water respectively.

To establish the relationship between source of drinking water and occurrence of *H. pylori* antigen among study participants, a bivariate Pearson's correlation was done. The results of this study indicated that there was a positive correlation between the source of water used for drinking and other home usage and the occurrence of *H. pylori* infection among the participants (P = 0.007), as shown in figure 4.4;

![Figure 4.4: Respondent's source of drinking water and other domestic use](image)
4.4.4 Place of waste disposal and Occurrence of *H. pylori* antigen

Two hundred and ninety nine (299) representing 78.5% of the participants were using flash toilets as a way of disposing human waste, during the study period. The other eighty two (82) participants representing 21.5% were using pit latrines. A bivariate Pearson's correlation was done to establish the relationship between participant’s place of waste disposal and occurrence of *H. pylori* antigen. The results show that there is no notable relationship between place of waste disposal and prevalence of the *H. pylori* infection among study subjects \((P = 0.28)\), as shown in the figure 4.5;

![Image of bar chart showing waste disposal methods and occurrence of *H. pylori* infection](image)

**Figure 4.5: Waste disposal methods and the occurrence of *H. pylori* infection**

4.4.5 Number of household members and occurrence of *H. pylori* infection

A Correlation analysis \((r)\) was done to establish existence of any relationship between number of household members and occurrence of *H. pylori* among the study participants. Results from this study indicate that there is no relationship between the occurrence of *H. pylori* infection and the number of members in a household, \((r = \)
0.145). The number of house hold members do not determine occurrence of \textit{H. pylori} infection which then may subsequently result to gastritis and gastric ulcers.

### 4.4.6 Place of meals and occurrence of \textit{H. pylori} infection

Three hundred and forty nine (349) of the participants representing 91.6% of the total had their meals at their respective home and thirty two (32) representing 8.4% had their meals in ‘vibanda’ and other eating places mostly. To establish existence of any relationship between the places where study participants ate their food and occurrence of \textit{H. pylori} infection, a Chi-Square was done. Results showed that the occurrence of \textit{H. pylori} infection among participants had no relationship (no significance) with the places of taking meals. ($X^2 = 0.296, P= 0.69$). That is, the place of taking meals had no impact and did not have any effect on the prevalence of \textit{H. pylori} infection. As shown in the figure 4.6 below;

![Figure 4.6: Places where participants take their meals](image-url)
CHAPTER FIVE

Discussion, Conclusions and Recommendations

5.1 Discussion

The results of this study determined the prevalence of *H. pylori* infection in patients with gastric ulcers who were attending Mbagathi level V hospital, to be 46.2%. This study favourably compares the finding with a study done in Beue and Limbe districts of Cameroon Ndip *et al.*, (2004) where the prevalence was found to be 52.27%. The study having been carried out in Nairobi County within a developing country, Kenya, the results proves the phenomenon that the prevalence of the *H. pylori* is usually high on developing countries and low in developed countries.

In the study, *H. pylori* stool antigen test was used as the diagnostic test of choice. According to Kenneth (2012), prevalence refers to the percentage of the individuals found to have the condition in a study population. It may be achieved by dividing the number of people found to be positive for the case with the total number of study population, and is usually expressed as a fraction, as a percentage (Gerstman, 2013).

This study has also established that, the occurrences of *H. pylori* infection among the various age groups was high, at thirty two point four per cent (32.4%) in the age bracket between 31 to 40 years and it was lower at three point four per cent (3.4%) in the age group between 81 years to 90 years old. A study in Kenyan school going children from the age of 3 to 15 years in various hospitals within Nairobi, by Nabwera *et al.*, in 2000, found a prevalence rate of *H. pylori* infection to be 80.7%. Another study still done in Kenya by Kimang’a *et al.*, in 2010, also found the prevalence of *H. pylori* to be 73.3% in children and 54.8% in adults, similar to the findings by Shmuely *et al.*, in 2013 in India, who documented prevalence rate of 60 to
73% in all age groups in patients with gastritis and dyspepsia. In contrast, a study done in the United States, which is among the developed countries, found that the occurrence of *H. pylori* infection was much lower with the prevalence of 5% (Everhart *et al.*, 2000). Most of the studies on the prevalence of *H. pylori* infections in African countries including Nigeria, Tanzania, Egypt and Gambia, were done on children at the school going age, at the age group of between 1 to 15 years and the results showed a prevalence of an average percentage.

Even though previous studies have shown that *H. pylori* infection is linked with age, sex, and the state of the social economy (Aguemon *et al.*, 2005), the main risk factors for the infection vary from population to population by countries (Allaker *et al.*, 2002). From this study, majority of the participants found positive for *H. pylori* were between the age group between 31 to 40 years. They had the highest prevalence of thirty two point four (32.4%) ($P = 0.004$), and the group which was found to have the lowest prevalence was the age between 81 to 90 years, which was found to be three point four (3.4%). This was in similar to the study by Everhart *et al*, in 2000, where the study showed prevalence in various age groups varying from 16.7% for person 20 years and increasing to 56.9% for persons less than 70 years. This could have been attributed to fact that, *H. pylori* is acquired during young age as normal flora but in absence of treatment, the infection would persist throughout life time and manifest later in life (Naficy *et al* 2000). The outcome of the study was similar to the results of other studies done in most other developing countries. Moreover, results of 40% Seroprevalence in children less than 6 years of age from a low income population was reported (Braga *et al*, 2007).
The study also revealed that *H. pylori* infection is dependent upon some predisposing factors. Among the risk factors observed under this study, it was mainly water for consumption and other home usage that seemed to contribute to *H. pylori* infection. The same factors were also studied and described by Ertem *et al*, in 2003 with the addition of dietary habits. The factors included; age, gender, source of drinking water, level of education, place of waste disposal, number of household members and eating place. There may be a strong relation between these variables and when put in a logistic regression model (multivariate analysis), the level of education, where the participants ate meals and where they resided had no influence neither did they had relationship with *H. pylori* infection.

Several studies investigated putative risk factors for *H. pylori* infection. Gender and age do not seem to be associated with an increased risk of infection. Indeed, most studies reported no significant difference of *H. pylori* infection between men and women, both in adults and in children. No significant relationship was found between infection and the age in the adult population. The age-specific gradient in *H. pylori* prevalence reported by some studies seems to be related to a birth cohort effect (Eusebi *et al*., 2015).

Gender has not been identified as a relevant characteristic for *H. pylori* infection acquisition. In this study population, female gender had higher positive cases of 104, *H. pylori* infection than the male counterparts at 72 positive cases. According to Hunt *et al*., 2011, women usually consult their general practitioners more often than men and this trend applies across all gender-common ailments. These results were also similar to those of Nurgalieva *et al* (2002), who found that the source of drinking water had a strong effect on the prevalence of *H. pylori* infection. This showed that
water can be a source of *H. pylori* infection and to avoid these infections, availability of adequate clean water should be in place.

It is generally considered that among the risk factors for *H. pylori* infection includes, more siblings or infected family members (Wang and Wang, 2003) (Farrell *et al.*, 2005). This study found that the prevalence of *H. pylori* infection in this study was not associated with more family members, and that the prevalence tended to be more in the persons between the ages of 11 years to 30 years. The number of house hold members do not determine occurrence of gastritis and gastric ulcers. An association between bed sharing and the *H. pylori* infection was demonstrated by Danesh *et al.*, (2000). A comparison was made between two eating places, the participants who ate in their homes and those who mostly used to eat in hotels and other eating places away from their homes, to ascertain if the eating place could also play a role in transmission of *H. pylori* infection. This was in line with a study done in Bolivia which also found that, the place of food consumption was not significant in the transmission of *H. pylori* infection (Kathleen *et al.*, 2002).

### 5.2 Conclusions

i. This study established that the prevalence of *H. pylori* among the patients with gastritis and gastric ulcers attending Mbagathi level V hospital was at 46.2%.

ii. The participants with the age group between 31 - 40 years had the highest prevalence of *H. pylori* infection at 32.4% and the lowest prevalence was found in the age group between 81 years and 90 years (3.4%). The occurrence of the *H. pylori* infection in various age groups was also found to be high in the ages between 31 years to 40 years old.
iii. From the results, it also concludes that the major predisposing factors for the establishment of *H. pylori* infection among the patients with ulcers in Mbagathi level V Hospital was found to be water for consumption and other domestic usages and female gender.

5.3 Recommendations

i. This study recommends that the national and county governments should improve on the supply of clean, treated water among the individuals in their residential areas and also look up on other environmental sanitation which would generally help in the reduction of *H. pylori* infection among the community. Similarly, those diagnosed and found positive for the infection, should be treated on time and be followed up so as to curb the disease transmission.

ii. There should be frequent testing for *H. Pylori* of individuals which should be done routinely. This will allow for better and promptly management of those found positive so as to avoid transmission of the infection from one person to another.

5.4 Recommendations for further studies

i. This study also recommends that more research studies on *H. pylori* should be done and they should incorporate the aspects of drug resistance. This is because very minimal research studies on drug resistance of *H. pylori* have been done in Kenya, while there is an emergent of the diseases associated with the bacterial infection even after treatment.

ii. This study also recommends that more research studies on *Helicobacter* species should be done which should involve molecular characterization of the
bacterial genome. This will enable complete understanding of the gene involved in various mutations.
References


biofilms. *Application Environmental Microbiology*, 74(19), 5898-5904.


Go, M. F. (2002). Natural history and epidemiology of *H. pylori* infection. *Alimentary pharmacology and therapeutics*, 16(s1), 3-15.


Appendix I: A map of Mbagathi level V Hospital
APPENDIX II: QUESTIONNAIRE

A questionnaire to collect information about the research participants.

1. Age ............................................................................................................................................

2. Gender ........................................................................................................................................

3. How many are you in the family ..............................................................................................

4. What is your highest level of education (tick appropriately)

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
</tr>
<tr>
<td>Midlevel college</td>
<td></td>
</tr>
<tr>
<td>University</td>
<td></td>
</tr>
</tbody>
</table>

5. Where do you eat,

(a) Home

<table>
<thead>
<tr>
<th>Always</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Often</td>
<td></td>
</tr>
</tbody>
</table>

(b) Hotel

<table>
<thead>
<tr>
<th>Always</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Often</td>
<td></td>
</tr>
</tbody>
</table>

6. Where do you stay..........................................................................................................................
7. Are you a permanent resident there

Yes [ ] No [ ]

8. If no,
How long have you been staying there?

<table>
<thead>
<tr>
<th>Less than a month ago</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Between one and six months</td>
<td></td>
</tr>
<tr>
<td>Between seven months and one year</td>
<td></td>
</tr>
<tr>
<td>More than a year ago</td>
<td></td>
</tr>
</tbody>
</table>

9. Do you have toilet in your home stand?

Yes [ ] No [ ]

10. Do you wash hands with soap after visiting the toilet?

<table>
<thead>
<tr>
<th>Always</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Often</td>
<td></td>
</tr>
<tr>
<td>Seldom</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
</tr>
</tbody>
</table>

11. Where do you get water for home usage and drinking?
12. a) Have you ever been to a camp

| Yes | No |

b) If yes, when was it?

<table>
<thead>
<tr>
<th>Less than a month ago</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Between one and six months</td>
<td></td>
</tr>
<tr>
<td>Between seven months and one year</td>
<td></td>
</tr>
<tr>
<td>More than a year ago</td>
<td></td>
</tr>
</tbody>
</table>

13. Has any one of your family members been treated for ulcers?

| Yes | No |

14. If yes, When was that

<table>
<thead>
<tr>
<th>Less than a month ago</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Between one and six months</td>
<td></td>
</tr>
<tr>
<td>Between seven months and one year</td>
<td></td>
</tr>
<tr>
<td>More than a year ago</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX III: Informed Consent form

A. Information sheet

The research study is carried out by a student undertaking Masters Degree in infectious diseases, Mr. Mwareso Khamisi, from Kenyatta University. The study is about, determination of the prevalence of *H. pylori* infection in patient with symptoms of gastritis and gastric ulcers and also to determine the predisposing factors that lead to the infection.

B. Procedure to be followed

You will be requested to assist with some information by filling the questionnaire, which will be used to ascertain the risk factors of the infection. The questions asked in the questionnaire will include your personal details about your demographic background. Participation in this research study is voluntarily and you have the right to refuse to participate or withdraw your participation from the study. You will also be requested to give stool sample for diagnosis and analysis of *H. pylori* infection. You have the right to refuse to participate in the study. You will get the same care and medical treatment whether you agree to join the study or not and you decision will not change the care you will receive from the hospital today or that you will get from any other hospital at any other time.

C. Confidentiality

All information provided will remain confidential and will only be reported as group data with no identifying information. All data, including questionnaire will be kept in a secure location and only those directly involved with the study will have access to them.
D. Benefit

No payments or any other direct benefits are provided to the participants. However, preventive measures can be recommended if the predisposing factors are known.

E. Participant of assent

I have read the information/it has been read to me. I ASSENT voluntarily or on behalf of the subject as participate in this research study.

Signature/Thumbprint......................................... Date.................................................

Relationship to the participant........................................

F. Participant’s refusal to participate.

I read carefully and I understand the nature of this study and the risks involved and the expected results as described above but I REFUSE to participate in this study.

Signature/Thumbprint......................................... Date.................................................

Relationship to the participant........................................

G. Contact Information

If you have any question you may contact Khamisi Mwaleso on 0722 445130, Dr. Daniel Okun on 0725 991515 or Dr. Scholastica Mathenge on 0722 936884. You may also contact Kenyatta University Ethical Review Committee secretariat on secretary.kuerc@ku.ac.ke or Kenyatta National Hospital - University of Nairobi Ethical Review Committee on uonknh_erc@uonbi.ac.ke in case you have any ethical issues.
Appendix IV: Authorization and approval letters

KENYATTA UNIVERSITY
GRADUATE SCHOOL

Email: kubs@yahoo.com
Website: www.ku.ac.ke
P.O. Box 43844, 00100
NAIROBI, KENYA
Tel: 0105901 Ext.27230

Internal Memo

FROM: Dean, Graduate School
TO: Mwangi M. Said
C/o Medical Laboratory Science Dept.
Kenya University

DATE: 29th September, 2015

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

We acknowledge the receipt of your revised Research Proposal as per recommendations raised by the Graduate School Board of 16th September, 2015 entitled “Determination of Prevalence of Helicobacter Pylori in Infection in Patients with Gastric Ulcers and the Associated Risk Factors in Migaa Hospital”.

You may now proceed with your data collection, subject to clearance with the Director General, National Commission for Science, Technology & Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed supervision tracking forms per semester. The form has been developed to replace the progress report forms. The supervision tracking forms are available at the University’s website under Graduate School subpage downloads.

Attachment:

RESIGNED

FOR DEPARTMENT OF GRADUATE SCHOOL

C.C.: Chairman, Medical Laboratory Science Dept.

Sponsor

1. Dr. Daniel Okun
Biochemistry & Biotechnology Dept.
Kenya University

2. Dr. Scholastika Matherge
Medical Laboratory Science Dept.
Kenya University

RAU/asc

Committed to Creativity, Excellence & Self-Reliance
E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

OUR REF: P150/CE/23142/12

The Director-General,
National Commission for Science, Technology & Innovation
P.O. Box 30623,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MWALESO K. SAID REG NO: P150/CE/23142/12

I write to introduce Mr. Said who is a Postgraduate Student of this University. He is registered for M.Sc. Degree programme in the Department of Medical Laboratory Science in the School of Medicine.

Mr. Said intends to conduct research for M.Sc Thesis entitled, “Determination of Prevalence of Helicobacter Pylori in Infection in Patients with Gastric Ulcers and the Associated Risk factors in Mbagathi Hospital”.

Any assistance given will be highly appreciated.

Your faithfully,

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL

EM/cao

Committed to Creativity, Excellence & Self-Reliance
KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Email: chairman@ku.ac.ke
secretary@ku.ac.ke
ero@ku.ac.ke
Website: www.ku.ac.ke

Our Ref: KU/R/COMM/51/621

Date: 19th February, 2016

Mwaleo Khamisi Said
Kenyatta University,
P.O Box 43844,
Nairobi

Dear Mwaleo,

APPLICATION NUMBER KLU/421/1390 - DETERMINATION OF THE PREVALENCE OF HELICOBACTER PYLORI INFECTION IN PATIENTS WITH GASTRIC ULCERS AND THE ASSOCIATED RISK FACTORS IN MBAGATHI HOSPITAL, KENYA.

1. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic: “Determination of the prevalence of Helicobacter Pylori infection in patients with gastric ulcers and the associated risk factors in Mbagathi Hospital, Kenya”.

2. APPLICANT

Mwaleo Khamisi Said

3. STUDY SITE

Mbagathi Hospital, Kenya

4. DECISION

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines AND APPROVED that the research may proceed for a period of ONE year from 19th February, 2016.

5. ADVICE/CONDITIONS

i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.
iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.

If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

DR. TITUS KAIGGA
CHAIRMAN ETHICS REVIEW COMMITTEE

I hereby accept the advice given and will fulfill the conditions therein.

Signature........................................... Dated this day of...2/6/2016...

Vice-Chancellor
DVC: Research Innovation and outreach
Dear Mwaleso,

REVISED RESEARCH PROPOSAL - DETERMINATION OF THE PREVALENCE OF HELICOBACTER PYLORI INFECTION IN PATIENTS WITH GASTRIC ULCERS AND THE ASSOCIATED RISK FACTORS IN NBAGATHI HOSPITAL (P902/2016)

This is to inform you that the KNH-UoN Ethics & Research Committee (KNH-UoN ERC) has reviewed and approved your above proposal. The approval period is from 30th May 2016 – 29th May 2017.

This approval is subject to compliance with the following requirements:

- Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
- All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH-UoN ERC before implementation.
- Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
- Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH-UoN ERC within 72 hours.
- Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (Attach a comprehensive progress report to support the renewal).
- Clearance for export of biological specimens must be obtained from KNH-UoN ERC for each batch of shipment.
- Submission of an executive summary report within 90 days upon completion of the study.

This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

For more details consult the KNH-UoN ERC website [http://www.erc.uonbi.ac.ke](http://www.erc.uonbi.ac.ke)

Protect to discover
Yours sincerely,

PROF M.L. CHINDIA
SECRETARY, KNH-UoN ERC

c.c.: The Principal, College of Health Sciences, UoN
The Deputy Director, CS, KNH
The Assistant Director, Health Information, KNH
The Chair, KNH-UoN ERC
Supervisors: Dr. Daniel Okun, Dr. Scholastica Mathenge