**PNEUMONIA AMONG PATIENTS ATTENDING MAKINDU SUB- FACTORS INFLUENCING THE HIGH OCCURRENCE OF COUNTY HOSPITAL**

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**CLINICAL MEDICINE DEPARTMENT**

**A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF CLINICAL MEDICINE IN FULFILMENT FOR THE AWARD OF DIPLOMA IN CLINICAL MEDICINE**

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**DECLARATION**

I CHARLES ODHIAMBO OGONGO declare that this research proposal is my own work and it has not been presented for the award of a degree or a diploma in any other college or university.

Presented by ………………………………….. Date…………………………………

**Supervisor’s Declaration**

This research proposal has been submitted for examination with my approval as the college supervisor

Approved by………………………………….. Date…………………………………..

Mr. KWINGA

LECTURER – Clinical Medicine Department

**DEDICATION**

I would like to dedicate this work to the Almighty God for the gift of life, knowledge, wisdom and grace. Secondly, I dedicate to my late wife Catherine Dudi Ogongo, my kid Aiden Blaine Ogongo, my sister Adhiambo Dourice Ogongo, my beloved Evangelyne Ogongo, Lawrence Ayodo, my supervisor Dr. Nicholas Kwinga and all staffs from Makindu sub county hospital for support and cooperation during my study.

**ACKNOWLEDGEMENT**

My sincere gratitude goes to all people who contributed of this study. First and foremost, I am grateful to my supervisor Nicholas Kwinga, for his tireless support, ideas, guidance and valuable feedback regarding the materials in this research. He was truly instrumental in the production of this document.

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**ABBREVIATIONS AND ACRONYMS**

**HIV :** Human Immunodeficiency Virus

**URTI :** Upper Respiratory Tract Infection

**WHO**  : World Health Organization

**Hib :** Haemophilus influenza type B

M.S.C.H: Makindu Sub county hospital.

**DEFINITION OF TERMS**

**Streptococcus pneumonia**: Is a bacterial strain causing pneumonia. It’s the main cause of bacterial pneumonia.

**Airborne diseases**: These are diseases which can easily be propelled through the air by forces thus causing infections.

**Aspiration:** This is the process of drawing breathing

**Body immune**: This is the state and system of the body to protect your body from disease causing organisms.

**Malnutrition:** The state of the body lacking sufficient and essential nutrients.

**Immunocompromised**: A state of the body having impaired immune system

**Population:** Number of people, plants or animals living in certain in a particular space.

**Limitations**: A limiting conditions to some actions.

**Socio-economic:** A state relating to interaction of the social and economic factors.

**Alcoholism:** A state of addiction to the consumption of alcohol.

**ABSTRACT.**

Pneumonia is one of the diseases that are frequently reported in hospitals. Its impact to health is critical and needs urgent medical attention. This research focuses mainly on factors that have led to high occurrence of pneumonia among patients attending Makindu sub county hospital. It aims deeper in to associated factors such as level of education, social economic status and environmental factors. The study aims to provide data and information that will help in reducing if not eliminating the high occurrence of pneumonia. And the information will create great awareness about pneumonia effects.

**CHAPTER ONE**

**1.0: Background information**

**1.1: Introduction**

Pneumonia is an infection causing inflammation of the air sacs in one or both lungs, which can be filled with pus or fluids.

Streptococcus pneumonia is the most common cause of the bacterial pneumonia and the infection can be life threatening to human beings particularly infants, children and people of age above 65 years. Other group of people who are at high risk include persons with chronic illnesses or immunocompromised persons, persons of low socio-economic status and people who live in over-crowded areas.

Bacterial pneumonia is the common causing complications of upper respiratory tracts infections (URTI) or the chronic cardio-pulmonary disease. It is a common disease and is one of the most frequent cause of deaths worldwide. Pneumonia accounts for 14% of all deaths all children under 5 years killing over 740,180 children in 2019 (WHO). Deaths caused by pneumonia worldwide are high in Southern Asia and Sub Sahara Africa. This is due to environmental factors and socio-economic status-WHO reveal that pneumonia was the leading cause of deaths and disabilities in the world in the year 2000-2009.

Most common causes of pneumonia are bacterial causes such as: Streptococcus pneumonia (most common cause in children), Haemophilus influenza type B (Hib)-second most common cause of bacterial pneumonia.

In people living with HIV, pneumocystic jiroveci is one of the most common causes of pneumonia. It’s responsible for at least one quarter of all pneumonia deaths in HIV infected people.

Apart from bacterial causes, pneumonia can also be caused by viruses, fungal and parasites. Pneumonia can spread through number of ways i.e. viruses, bacteria and air-borne droplets from a cough or sneeze. It can also be caused by aspiration of fluids into the lungs. Pneumonia presents differently according to the causative organisms. Viral symptoms may be more numerous than the symptoms of the bacterial pneumonia.

In children of age 5 years and below, they present with cough, difficulty in breathing with or without fever. And it’s diagnosed by the present of either fast breathing or the lower chest walls indrawing -intact during inhalation and wheezing is common in viral infection.

Some of the risk factors to pneumonia are: people of low body immune, mal-nutrition people, people of pre-existing illnesses such as HIV, lung conditions and diseases

**1.2: Problem statement**

Pneumonia is one of the dangerous diseases in our Country Kenya. It contributed to many deaths that has affected our Country economically. According to the low living standards amongst people, they tend to live congested areas in a poorly environment- this enhances chances of pneumonia spread and infect many people at a time

In the year 2019, the WHO revealed that pneumonia accounts for 14% of all deaths children. Pneumonia has been a threat to many lives especially children, malnourished people, old age people of 65 years and above and other people having preexisting illnesses such as HIV, Measles. ( K Djawe . 2013 ).

Other environmental factors also show a problem and risks to pneumonia. These factors are:

* Living in crowded homes.
* Parental smoking.
* Indoor air pollution caused by cooking and heating with biomass fuels.

This indoor cooking with biomass gases distress to the upper respiratory system hence making it susceptible to pneumonia.

Living in crowded areas give higher chances of bacterial transmissions from infected people to others.

Parental smoking also affects the respiratory system of the active smokers and passive smokers living in the same homes. This increases chances of susceptions

In Makindu sub-county hospital, cases of pneumonia have been rising day by day and the report showed that most people affected, were children of 5 years and below, people of low socio-economic backgrounds, immunocompromised people and those who had pre-existing diseases such as HIV, Chronic obstructive pulmonary disease, Asthma, Measles and any other lung diseases.

Even though the government has paced all mechanisms in fighting this condition, pneumonia still became a problem among the patients attending Makindu sub-county hospital.

**1.3: Justification of study**

It was true that the high prevalence of pneumonia affected the entire population. It also affected the economy of the entire population. Due to the fact that some of the factors enhancing high prevalence of pneumonia could be controlled, such as changing lifestyle, avoiding overcrowding areas, dieting in boosting immunity of the immunocompromised people. In relation to overcrowding as a factor, the research was placed to ensure people living in such areas got valid health education in relation to prevalence of pneumonia. The research was also to ensure that all mechanisms of dealing with that condition were estimated and well approximated to help government in budgeting and management of the affected patients.

**1.4: Limitations of the Study**

There were many factors which affected the process of finding out the right information about their health. These factors were as follows:

1. Limited time in gathering information among patients attending M.S.C.H
2. Lack of funds in carrying out my research
3. Language barriers since many patients uses local languages and it’s difficult in getting translator.

**1.5 Research question**

1. How did level of education affected the high occurrence of pneumonia among the patients who were attending Makindu sub county hospital?

2. How did socio economic status affected the high occurrence of pneumonia among the patients who were attending Makindu sub county hospital?

3. What were the environmental factors relating to high occurrence of the pneumonia among patient who were attending Makindu sub county hospital?

**1.6: Broad objective**

To determine factors influencing high occurrence of pneumonia among patients attending M.S.C.H.

**1.6.1: Specific objectives**

To determine how level of education affect the high occurrence of pneumonia among patients attending M.S.C.H.

To determine how socio-economic status affect the high occurrence of pneumonia among patients attending M.S.C.H.

To identify how environmental factors affect the high occurrence of pneumonia among the patients attending M.S.C.H.

**CHAPTER TWO**

**2.0: LITERATURE REVIEW**

**2.1: Introduction**

Pneumonia is a complex fatal infection and inflammation of upper respiratory tract in persons with compromised immunity complicated by resistance against multiple antibiotics and assisted by advanced in medication such as better diagnostic techniques and stronger treatment therapy. This has increased the survival of about all patients, despite this disease is still the most invasive in fection in patients with compromised immunity, younger ages, children below 5 years and the elderly patients and the lower socio-economic people. ( NJ Alvis – Zakzuk).

**2.2 Level of education**

Research done showed that number of patients don’t know how to detect that they have the disease or they are in danger to seek for medication. They tend to wait for so long without attending the facility when the condition has worsen. ( JE Zack . 2002).

This shows that patients who have no information about pneumonia tend to assume the clinical presentations of pneumonia and the same people get strong attacks which sometimes lead to death. This shows that lack of information about pneumonia and knowledge affect great number of people within the area.

The research was to ensure that the awareness and education to low class population about pneumonia were well taken to ensure that all people had information and knowledge about the attack of pneumonia, effects and how to be managed.

**2.3 Socio economic status**

The influence of socio economic status, disparities on adults with pneumonia is not well understood. The national center for technology information reveals that in the study the incidence of pneumonia was 80 percent higher in areas with deprived socio economic conditions compared to areas of higher socio-economic status. (2011)

Low financial status were other factors which contributed to occurrence of pneumonia, they delayed the rate of people attending the facility for treatment. This contributed to high risk of the disease. ( TL Wienken - 2020, S Stelianides – 1999 ).

**2.3.1 Alcoholism**

Alcoholism affect most of people living within the area and this has been found contributing to majority of people attending Makindu sub county Hospital. They are the same patients presenting with signs and symptoms of pneumonia. Alcohol intake affects the body immune and makes the body appear weak to defend against the bacteria causing pneumonia and other diseases. Alcohol affects major body organs such as liver, lungs and other respiratory organs plus their perfusions. This compromises the state of the body functions hence making the body susceptible to pneumonia agents. ( SM Simet – 2015 ).

**2.3.2 Immunocompromised**

These are the state of the body, not able to fight against any pathogens or disease causing organism. Body becomes weak and cannot withstand the effect of the disease causing organism. It is found that immunocompromised people are majorly affected by pneumonia since their body cannot resist these infections.

These immunocompromised people are either people living with HIV, old age patients of above 65 years and young children of below 5 years. ( D Schnell – 2010 ).

My research was to ensure awareness about pneumonia among the patients who were attending MSCH. Also tried to educate the patients on the infections, clinical manifestations and how it could be done away with through medication. That intervention was to promote living standard, reduce mortality rate and also boosting social economic status of people living within the area.

**2.4 Environmental factors.**

Environmental hazards have been seen to have high contributing factors to high prevalence of pneumonia.

Environmental factors affected people directly and indirectly contributing to prevalence of high occurrence of pneumonia among the patients who were attending M.S.C.H.

Some environmental factors that affected people who were attending MSCH were:

* Indoor air pollution caused by cooking firewood and biomass.
* Living in crowded homes.
* Parental smoking.

**2.4.1 Indoor air pollution**

Air pollutions producing smoke which affects respiratory cells and organs. These pollutions make peoples living in such homes become susceptible to pneumonia agents due to compromise cells and organs. This pollution risk factor to pneumonia. Air pollution affects respiratory system and breathing becomes a problem and in return, the patients become susceptible to pneumonia causing organism. ( EE Adaji – 2019 ).

**2.4.2 Living in overcrowded homes**

People living in overcrowded homes find it difficult in breathing fresh air. And should therefore be any infection amongst the crowd, the spread become faster and mortality rates rise due to poor intervention. Pneumonia agents in an overcrowded areas spread faster since people are living in a congested homes and disease can spread easily from one person to another. ( NJ Alvis – Zakzuk 2020 ).

**2.4.3 Parental smoking**

According to the research done earlier, it’s clear that smoking cigarettes contribute to risk factors of pneumonia. Smoking affects upper respiratory system of the active smokers and passive smokers. Children and family members living with become passive smokers and they are affected too. They then become susceptible to pneumonia since their respiratory systems are compromised. My work up was therefore aimed towards creating awareness about smoking and how to live with smokers socially. Was also tried to educate them on the effects of smoking and how they could do away with habits of cigarette smoking.

**2.5 Conceptual frameworks**.

**Independent variable Intervention Dependent variable**

Level of education:

* Health actions
* Education background

|  |
| --- |
| Health education  Health promotion  Advertisement about pneumonia |

Socio-economic status:

* House population
* Smokers in the house
* Income
* Source of cooking fuels
* Nutritional status

|  |
| --- |
| Reduce cases of pneumonia.  Reduce cases of mortality.  Appropriate prevention and control of occurrence of pneumonia. |

|  |
| --- |
| Avoid overcrowding  Avoid smoking  Use modern cooking fuels |

Environmental factors:

* Domestic pets
* Allergens
* Industrial dust
* House ventilation

|  |
| --- |
| Avoid domestic pets  Avoid industrial dust  Ensure well ventilations |

**CHAPTER THREE**

**3.1 Study location**

My study was conducted at Makindu sub-county hospital which is located along Nairobi Mombasa highway. It is found within makueni county, kibwezi west sub-county and it is about 65 kilometers from the county headquarter (Wote town). Makindu sub-county hospital draws patients within kibwezi sub-county and some other patients from neighboring counties.

**3.2 Research design**

Cross-sectional descriptive study was used in conducting the study. It was cheap and less time consuming. Data was collected all at once, so participants were less likely to quit the study because data was to be collected by asking questions in the study area.

**3.3 Study area**

My study area was at Makindu sub-county hospital, situated in Makueni County, Kibwezi west sub-county. Most patient attending Makindu sub-county hospital comes from Kibwezi west sub-county which has a population of more than ten thousand people. Most of people get their treatment services at Makindu sub-county hospital when they are sick.

**3.4 Study population and Target population**

The study population was targeting a population of patients that is, children under five years, adolescents and elderly patients attending Makindu sub county hospital with pneumonia. The approximate population of the patients attending Makindu sub-county hospital is about 600 patients.

**3.5 Sample technique**

I used systematic random sampling method because it was simple and quick. I determined my statistical interval (Kth number) by using formula K=N/n, where; N=my estimated study population and n= my sample size.

**3.6 Variables**

**3.6.1 Dependent variables**

Reduced cases of pneumonia, reduced cases of mortality rates and appropriate prevention and control of occurrence of pneumonia.

**3.6.2 Independent Variable**

* Level of education
* Socio-economic status
* Environmental factors

**3.7 Sampling Procedure**

Pneumonia patients were chosen randomly. The respondents who were willing to participate were used to conduct the study. Systematic random sampling was used to identify the sample in the hospital setting. Sampling was done on a daily basis until the sample size targeted was met.

**3.8 Sample Size Determination**

The study sample size was determined using Fisher’s et al (1999) formula

N=Z2PQ

Q2

N= Minimum sample size.

Z= standard normal deviation 1.96 (Corresponding to 96% confidential level)

P= proportion of the desired with desired characteristic 0.50

Q= the levels of statistical significant set ( 0.05 )

N=Z2PQ

Q2

N= 1.962×0.5[1-0.5]

0.052

=38416×0.5 ×0.5

0.00125

=0.9604

=0.0025

N f = n

1 + n

N

=384/1+384/600

=384/600

=0.64

=1+0.64

=1.64

=384/1.64

=234 respondents

**3.9 Data collection tool**

Data collection for the study was collected through use of questionnaires both open and closed ended.

**3.10. Data collection process**.

It was achieved through distribution of questionnaires to the pneumonia patients attending Makindu sub county hospital and asking questions.

**3.11 Pre-testing**

Pre-testing was done with different questionnaires in out-patient department, maternity ward and M.C.H department at Kambu Sub County Hospital. I assessed whether the questions in the questionnaires were understood or not understood, I redesigned them again.

**3**.**12 Data analysis and presentation.**

Data was analyzed using descriptive statistical methods. Data presentation was done using figures, charts and tables.

**3**.**13 Ethical consideration**.

The nature and purpose of the study was explained to the population who participating in the study to enable them make an informed consent. All participants were allowed to decide on their own whether to participate in the study or not. No one was coarse or intimidated.

And those who were choose to participate were given freedom of withdrawing from the study at any point. No potential harm expected or experienced to the participants.

Volunteers were instructed not to write their names or leave any personal details in the semi structured questionnaires to preserve anonymity.

My research and study was only collecting relevant information from the participants.

**CHAPTER FOUR: DATA ANALYSIS**

**4.0: Introductions To Data Analysis**

This chapter described the findings and data collected by word description, charts and graphs. The interpretations of data findings are also included here.

**4.1: Different age groups**

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Age of people affected by pneumonia in age brackets of 15-29 years, 30-39 years and above 40 years having response of 85 people, 79 people and 70 people respectively.

**4.2: Religion of the pneumonia patients attending M.S.C.H.**

The figure above showed that the greater percentage of patients attending M.S.C.H. are Christians with 80% and Muslims with 20% which represented 187 patients and 47 patients respectively.

**4.3: Employment Status**

The figure above represented the number of people in percentage who were unemployed, self employed and permanent employed. It was a clear indication that large number of patients were in class of unemployment.

**4.4: Level of education**

The figure above shows the level of education of people attending M.S.C.H. with pneumonia cases. It’s approved

**4.5: Number of family members.**

The figure above shows the number of family members living in the same house. It indicated that the high percentage 41% of patients lived in congested homes which remained a factor to worry about.

**4.6: Smoking of family member/ Members**

The figure above shows that most of the families experienced smoking challenges in their homes. Smoking of either one or more family members got a higher percentage of 69% with the least percentage of none smokers with a percentage of 31% of the 234 patients responded to the research questionnaire.

**4.7: Source Of Cooking Fuels.**

The Figure above shows the number of people using different types of cooking fuels. It shows that higher populations used firewood as source of cooking fuels. The use of cow dung as source of fuel reported the least number.

4.8: Source of cooking fuels

The figure above represent different percentage of people using different types of cooking fuels in pie chart form. It shows that, people who were using firewood as source of fuels reported high percentage 50% of the total represented population.

**4.9: Presence of Allergens**

The figure above shows 64% of the people attending M.S.C.H. are exposed to respiratory allergens. It’s clear that these allergens predisposed them to respiratory diseases like pneumonia.

**V**

**4.10: Feeding Pattern**

The figure above shows the pattern of feeding among people who were attending M.S.C.H for treatment. It was clear that higher percentage reported by people who were feeding once a day with 40% of the total population of 234 people.

**4.11: History of Skipping Meals**

The figure above shows how often the targeted population could find meals in a day or going throughout the day without meal. It shows that majority of families went on skipping meals with a percentage of 55% of sample group.

**4.12: History of chronic illnesses such as Asthma, HIV AIDS, Diabetes, and Hypertenson.**

The figure above shows the gap between people having history of chronic illnesses. It confirmed that most the patients attending M.S.C.H. were suffering from chroni diseases.

**CHAPTER FIVE: SUMMARY OF THE STUDY**

On the demographic data, the study found that, among the participants, 39% were having age of between 15-29 years, 34% were between the age of 30-39 years and above 40 years recorded 30%. These showed that the young ages were more affected by the pneumonia condition. It was confirmed by the level of education where majority of the reports were primary school drop outs. Primary school drop outs recorded the highest with 42% followed by college levels which had 35%. This confirmed that there were no enough knowledge about the living standards which could have protected them from acquiring such a disease. Health education was the way out to save the families and creating awareness about the disease.

On socio-economic status, 41% of the data collected reported large number of family members, more than 8 members living in one house/ under one roof. One to three numbers in a family recorded the least percentage of 30%. This confirmed that most of people in the area lived in a congested families and this became a risk factor to respiratory conditions. It promoted respiratory infections, pneumonia being one of them. I advised the families on family planning and to have a desirable size of families or having a spacious houses which could accommodate the population.

Regarding employment status, 68% of the data represented people who were not employed and lived from their farming activities which also did not bring a lot to their tables. The employed members remained the least of all with 4% enlarging the gap between the poor and rich. Economically, the low class levels were affected more and also recorded the highest level of food skipping with 55% of the total population. This largely affected the health status and body immune hence their health became weak and prone to diseases.

On environmental factors, presence of allergens recorded higher with 64% which represented 150 respondents. Presence of people with history of smoking cigarettes recorded 69% of the data collected. And also source of cooking fuels, use of firewood as source of fuel appeared as the leading with 60% compared to other sources. All these affected environment, air around and smokes affected respiratory system hence their health became weak and could not withstand any attack of diseases like pneumonia. Regarding chronic illnesses such as asthma, hiv aids, diabetes and hypertension, people with chronic illnesses or having relatives with chronic illnesses recorded a higher percentage of 62% which represented 145 people within the total respondents.

It is therefore confirmed that low level of education, low socio-economic status and harsh environmental states promoted the high prevalence of pneumonia around Makindu sub-county hospital.

**APPENDICES.**

**APPENDIX I : QUESTIONNAIRES**

The questionnaire was aiming at obtaining informations about th

e factors influencing the high occurrence of pneumonia in Makindu sub-county hospital. The information attained was only bind for purpose of the study and therefore was held confidential (please do not write your name).

**Instructions**

Tick only the appropriate answer provided and where applicable. Write the required answers in the spaces provided.

**SECTION A: Bio Data**

1. How old are you?
2. 15 – 29 years [ ]
3. 30 – 39 years [ ]
4. Above 40 years [ ]
5. Which religion do you belong to?
6. Christian [ ]
7. Muslim [ ]
8. Others ( specify )…………………………………………………………………………………
9. Employment status
10. Unemployment [ ]
11. Self-employed [ ]
12. Permanent employment [ ]
13. Level of education
14. Primary level [ ]
15. Secondary school level [ ]
16. College level or University level [ ]
17. None of the above [ ]
18. Marital status
19. Married [ ]
20. Separated [ ]
21. Single [ ]
22. Widow/ Widower [ ]
23. Divorced [ ]

**SECTION B: Level of Education**

1. Are you aware of pneumonia attack ?
2. Yes [ ]
3. No [ ]
4. Have you been infected with pneumonia?
5. Yes [ ]
6. No [ ]

If yes, what intervention did you take………..

1. Are you aware of the predisposing factors of pneumonia?
2. Yes [ ]
3. No [ ]

If yes what are the intervention taken towards all these?

**SECTION C: Socio-economic status**

1. Do you skip meals?
2. Yes [ ]
3. No [ ]
4. What is your occupation?
5. Self-employed [ ]
6. Permanent employed [ ]
7. How many children do you have? [ ] children.
8. How many are you in your house? [ ]
9. What is your religion?
10. Christian [ ]
11. Muslims [ ]
12. Others ( Specify )
13. In your family, is there any history of chronic illnesses/
14. Yes [ ]
15. No [ ]

**SECTION D: Environmental status**

1. In your family is there anyone who smokes?
2. Yes [ ]
3. No [ ]

If yes, specify

1. Sources of cooking fuels
2. Biomass [ ]
3. Firewood [ ]
4. Charcoal [ ]
5. Cow dung [ ]
6. Is there any Industry near your residence?
7. Yes [ ]
8. No [ ]

If yes, what type of Industry?

1. In your residence, do you have specific allergens that cause respiratory infections?
2. Yes [ ]
3. No [ ]

If yes, specify

**APPENDIX II: Budget**

|  |  |  |  |
| --- | --- | --- | --- |
| **ITEMS** | **QUANTITY** | **UNIT PRICE** | **AMOUNT** |
| Notebook | 1 | 200 | 200 |
| Bullpens | 6 | 20 | 120 |
| Ruler | 1 | 20 | 20 |
| Internet | 1 | 500 | 500 |
| Typing/printing | 234 | 50 | 11,700 |
| Binding | 3 | 50 | 150 |
| Data collection assistance | 10 days | 500 | 5,000 |
| Statistician fee |  | 10000 | 10,000 |
| Sub total |  |  | 27,690 |
| Miscellaneous 10% |  |  | 2769 |
| Grand total |  |  | 30,459 |

**APPENDIX III: Work plan**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Activity/ month 2022 – 2023** | **June**  **2022** | **July – Dec**  **2022** | **Jan**  **2023** | **Feb**  **2023** | **March**  **2023** | **April**  **2023** |
| **Identification of research topic** |  |  |  |  |  |  |
| **Proposal description** |  |  |  |  |  |  |
| **Proposal submission** |  |  |  |  |  |  |
| **Data collection, analysis and interpretation** |  |  |  |  |  |  |
| **Discussion of findings** |  |  |  |  |  |  |
| **Finding dissemination and project submission** |  |  |  |  |  |  |

**APPENDIX IV: Map of study area**

