

**ESTIMATES OF HUMAN CASES OF DOG BITES AND PUBLIC HEALTH  
BURDEN OF DOG BITES IN HOMA BAY COUNTY, KENYA.**

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**DECLARATION**

This thesis is my original work piece and has not been presented for a degree in any other university.

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## **DEDICATION**

This work is dedicated to my enabler, “The Almighty God”, as well as my entire family for the encouragement and moral support during this long struggle.

## **ACKNOWLEDGEMENTS**

I'm sincerely grateful to the Almighty God for the gift of life and health all through the study period. He salvaged me when I had virtually lost hope in continuing with this work by reminding me that it will always be hard if it is worth its salt.

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## LIST OF ABBREVIATIONS

CDC	Centres of Disease Control
CI	Confidence Interval
DALYs	Disability Adjusted Life Years
dRIT	Direct Rabies Immunohistochemical Test
FAT	Fluorescent Antibody Test
HH	House Hold
HRIG	Human Rabies Immune Globulins
KNBS	Kenya National Bureau of Statistics
PEP	Post Exposure Prophylaxis
PET	Post Exposure Treatment
RAT	Rapid Antigen Test
RT-PCR	Reverse Transcription and Polymerase Chain Reaction
WHO	World Health Organization
ZDU	Zoonotic Diseases Unit

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## ABSTRACT

Dog bite is a prevalent but, underreported problem in the developing world. It's almost always associated with rabies.

Rabies, a disease of ancient times, continues to cause untold suffering and death in most of the developing world. Control efforts of the disease have largely been unsuccessful. Part of the reason for control failure is lack of data to inform policy on control. The objectives of the present study were to 1) Estimate human cases of dog bites and 2) Assess the public health burden of dog bites in Homa Bay County, Kenya. The study was a survey of randomly selected households in three sub-counties of Homa Bay County. Within each selected sub-county, two wards were randomly selected. A transect walk was done within each ward and every 4<sup>th</sup> household selected until the required sample size was achieved. Two sets of data were collected:- retrospective study of hospital records from 2016 to 2018 and Survey (prospective study) of households in Homa Bay County in 2018. The latter method employed simple and systematic random sampling and data collected through questionnaires administered via personal interviews.

There were 291 dogs found in the 198 households visited converting to 1.5 dogs per household. The dog population in the county was large and estimated at 192,000 dogs. The dog to person ratio was 1:6. Dog ownership in the county was common with 71% of the surveyed households owning dogs.

The dog population in the county was inadequately protected from rabies through vaccination – only 27% of survey dogs were reportedly vaccinated against rabies. The annual animal bites of humans were 1,571/100,000 population i.e. 1.57% of the population. A large proportion (82%) of

bites were inflicted in the lower extremities (feet and legs). Children especially those under 15 years of age, were the most affected.

Compliance with the recommended five-dose vaccination regimen in humans was low. Only four of the 28 human bite cases reportedly completed the five doses of anti-rabies vaccinations. Reasons for non-compliance included, the prohibitive cost of antirabies vaccines, its non-availability at time of visit and the transport cost to health facility by the victim. The average cost of post exposure prophylaxis (vaccination) was estimated at KES. 3,450 with a range of KES 1200 to 6000. Further, transport cost to hospital was between KES60 and 500 with an average of KES 300. With the requirement of five hospital visits, the cost of transportation alone was approximated at KES 1500.

In conclusion, this study has shown that dog bites had an incidence of 1.57%, and is a major public health problem in Homa Bay County. Control of rabies in dogs has not been adequate as shown by the low vaccination levels of dogs in the county which was only 27% as revealed by the study. There is a need to scale up rabies control efforts in the county with public participation being a major component of those efforts. These efforts are essential if the ancient and terrible disease - rabies- is to be controlled and eradicated.



## CHAPTER ONE

### INTRODUCTION

#### **1.1 Background**

Dog bite and rabies are a major problem and burden to the rural poor worldwide though underreported and not well documented (Guatret *et al.*, 2013). Rabies is a disease which is inevitably followed by death when signs and symptoms appear. Most human rabies cases resulting from dog bites are reported in Asia particularly in Indonesia and India (Guatret *et al.*, 2013). In Africa, there is gross under-reporting of rabies in dogs (Kitala *et al.*, 2000) and in humans (Cleaveland *et al.*, 2002). Rabies, usually transmitted to man via bites by rabid animals remains an important zoonosis in many developing countries where an estimated 59,000 human deaths occur each year due to the disease, which is mainly a direct result of dog bites (Knobel *et al.*, 2005).

The rural poor encounter the problem of dog bites daily and strain to pay for the treatment of the bites as post-exposure prophylaxis (PEP) and/ or treatment of the cases (Nanyingi *et al.*, 2010). Over 7.5 million post-exposure human rabies vaccine doses are distributed annually to treat human cases of bites (Knobel *et al.*, 2005), with an economic burden of US\$ 1 billion worldwide (WHO, 2007). Apart from the burden of vaccines for post exposure treatment, the other costs incurred include transport costs to the health facilities which are often far off, time lost in repeated hospital visits, cost of wound treatment, litigation in case of court cases, psychological torture and cost of rabies control by the government (Berzon *et al.*, 1972)

Globally, rabies is considered to be a relatively insignificant human disease, accounting for only 1% of deaths attributable to infectious diseases (Meslin *et al.*, 1994). But, it is widely recognized that the number of deaths officially reported in much of Africa does not reflect the true incidence of the disease. For example, the 1996 World Survey of Rabies (WHO Report, 1998)

recorded a total of 33,212 cases of which 238 were in Africa and 32,772 in Asia. In Addis Ababa, Ethiopia, during the time period between 1992 and 1993, 464 cases of rabies were reported but, the official record for the whole country was 26 and 35 cases for the two years respectively (Fekadu, 1997). Thus, rabies cases are grossly under-reported in much of the developing world, where unfortunately rabies incidence is the highest.

A study by Louis revealed that there were discrepancies in data on rabies reported to WHO, OIE and Southern Eastern Africa Rabies Group (SEARG) by African countries. Some years did not have data from several countries. The discrepancies were a sign of poor surveillance and reporting as well as lack of cooperation among countries in their efforts to control rabies disease (Louis, 2013)

To manage and control rabies and dog bites, bite cases can be used as a source of epidemiological data to estimate the public health burden of rabies and to monitor epidemiological trends in developing countries (Cleaveland *et al.*, 2002). In addition, such data can be used to convince policy makers on the importance of rabies and therefore allocate resources for its control.

## **1.2 OBJECTIVES**

### **1.2.1 General objective:**

To estimate human cases of dog bites and the public health burden of the same in Homa Bay County, Kenya

### **1.2.2 Specific objectives:**

- To estimate human cases of dog bites in Homa Bay County, Kenya.
- To assess the public health burden of dog bites in Homa Bay County, Kenya.

## CHAPTER TWO

### LITERATURE REVIEW

#### **2.1 Rabies**

Rabies is an acute and fatal inflammation of nervous tissue that affects all warm blooded animals including human beings. It occurs worldwide, except countries that have eradicated it or prevented its entry through strict dog movement rules. It is a zoonosis caused by the Rabies virus of the genus Lyssavirus and Family of Rhabdoviridae (Kobayashi *et al.*, 2006)

Rabies can infect all mammals and 99% of human death cases due to rabies are transmitted by domestic dog through bites. This means that the main cause of rabies is bites by domestic dogs (WHO, 2013).

#### **2.1.1 Epidemiology**

##### **2.1.1.1 Etiology**

Rabies disease is caused by the rabies virus. The virus is a member of the Lyssavirus genus of Rhabdoviridae family. It is a fatal viral infection of warm blooded animals (Ryan.,2004; Rodostits *et al.*, 2013)

Other Lyssaviruses involved include Makola virus of bats, Lagos bat virus, Duvenhage virus and Shimoni bat virus, Obodhiang virus, Kotonkan virus, Rochambeau virus, European bat Lyssavirus types 1 and 2 and Australian bat Lyssavirus (Kuzmin *et al.*, 2010)

##### **2.1.1.2 Occurrence and Distribution**

Rabies is endemic in all continents except Australia and Antarctica. Islands such as New Zealand, Cyprus and Hawaii and until recently Britain were free of the disease (Wanderler,1994). Rabies



follows certain patterns in the temperate countries where there is increased incidence of animal cases in the winter when there is increased animal contact for breeding among the wildlife. The spring and autumn show the highest number of exposure in human beings when the numbers are lowest in the animals. This may be due to increased mankind outdoor activity in the warm seasons increasing the risk of exposure. In the tropics and sub-tropics, the disease is prevalent throughout the year as there is constant contact between man and animals with little seasonal variation. (Held *et al.*, 1967).

### **2.1.2 Transmission and mode of infection**

Rabies is transmitted through bites by infected dogs and other canines and felines. Transmission to man is mainly through bites by infected dogs and cats (Wong and Derrek 2009). In rabies endemic areas or regions, 90% of the human rabies cases are attributed to bites inflicted by infected domestic dogs (Seligsohn, 2014). There exist two epidemiological forms of rabies (Carlos *et al.*, 1996)

- a) The urban type spread by the dog and cat- is common in Africa, Asia, Central and South Americas
- b) The wildlife (sylvatic) type - mainly seen in North America and Europe among foxes, wolves, jackals, coyotes, skunks, weasels, mongooses and bats.

The incubation period of rabies is on average 3 – 12 weeks but, the duration may be shorter or longer than the stated depending on a number of factors including the viral dose, how far the bite site is from the central nervous system, innervation of the inoculation site and virus strain (WHO, 2004; Cotran *et al.*, 2005).

In Africa, it has been shown that the animal mainly involved in rabies virus maintenance cycles is the domestic dog. However, other carnivores may be involved but not as maintenance

populations (Lembo *et al.*, 2010). Jackals in Zimbabwe and yellow mongoose in South Africa also act as maintenance population (Lembo *et al.*, 2010).

In Kenya, rabies has been diagnosed in domestic animals including cattle, sheep, goats, horses and donkeys. The disease has also been confirmed in a variety of wildlife species including hyenas, jackals, honey badgers and civet cats (Chong, 1993).

## **2.2 Diagnosis**

Tentative diagnosis in animals can be based on the clinical signs. These include restlessness and apprehension, then aggression, snapping or biting at any moving object, attacking any animal, humans and even inanimate objects. There is also constant licking, chewing and biting at the bite sites, drooling saliva and making noises (Cotran *et al.*, 2005).

Laboratory tests include the Fluorescent Antibody Test (FAT) which is the standard and recommended test by the WHO (2005) for rabies. Histopathology is also used to demonstrate the presence of Negri bodies which are intracytoplasmic inclusion bodies pathognomonic for rabies but may be absent in 25% of the cases (Ryan *et al.*, 2004).

For antemortem diagnosis several samples can be obtained for tests in humans including saliva, serum, spinal fluid and skin biopsies of hair follicles at the nape of the neck. For virus isolation, saliva is used and the tests performed are reverse transcription followed by polymerase chain reaction (RT-PCR). Test for rabies antibodies uses serum and spinal fluid while rabies antigen can be demonstrated by using skin biopsy specimens (Dacheus *et al.*, 2008).

Other rabies tests include Rapid Antigen Test (RAT) and Direct Rabies Immunohistochemical Test (dRIT) (CDC.gov 2011), <https://www.gov>rabies>diagnosis, 2011>)

## **2.3 Prevention and Control**

Rabies is a preventable disease through efficient vaccination of the animal reservoirs and vectors. The threshold density of 5 – 6 or more dogs per Km<sup>2</sup> is necessary for persistence of rabies in a locality. This shows that density and transmission are directly proportionate and in normal circumstances rabies control efforts should target high dog density areas (Kitala, *et al.*, 2002).

Control can be done by (Rupprecht, 2019);

1. Dog registration and certification after proof for importation of dogs.
2. Notifying the authorized government agency of suspected cases and euthanasia of dogs and other animals with clinical signs of rabies and animals bitten by them.
3. Application of leash laws and dog movement control to reduce contact between dogs that have not been vaccinated i.e. susceptible dogs.
4. Mass vaccination of dogs through campaigns and ensuring vaccination of young dogs at the right age. The vaccination should cover 70-75% of the dog population within a short time (i.e. within 2 months) (Martin *et al.* 2000).
5. Restriction of dogs within the owner's premises
6. Public education on disease of rabies.
7. Cooperation of the public in rabies control should be enlisted.

## **2.4 Dog bites**

Dog bites are a serious problem with great public health importance and concern though underreported in the developing countries (Guatret *et al.*, 2013). Dog bites result into physical harm and injury, severe psychological impacts and are also commonly complicated by infections including rabies which has the highest case fatality rate among all infectious diseases.

There has been increased cases of dog bites in large urban areas of the world e.g. in Marseille, France where nuisance dogs belong to street beggars (Guatret *et al.*, 2013). In Machakos and Makueni counties, Kitala *et al.*, (2000) estimated a human dog bite incidence of 234 per 100,000 population

In Bhutan, India, Media has frequently reported an increase in stray dog populations, resulting in dogs biting humans and risks of rabies outbreaks (Tenzin *et al.*, 2011). The study by Tenzin *et al.*, (2011) revealed that men (62%) were more at risk than women. Children aged five to nine years were at more risk of bites than other age groups. Most of the bites were inflicted by stray dogs, (Tenzin *et al.*, 2011).

In the United States of America 279 human deaths related to dog bites were recorded between 1979 and 1994. This led to a reevaluation of existing laws on dog adoption and handling those dogs deemed dangerous both in the local and state jurisdiction (Sacks *et al.*, 1996). Up to 1.5% of the USA population is affected by dog bites per year (Gilchrist *et al.*, 2008).

In 1998, Switzerland reported 325 cases of bites per 100,000 human population and scratch incidences of which 60% were caused by dogs and 25% by cats (Matter *et al.*, 1998). Most cases were in persons below the age of 20 years. In this study more females than males were bitten but, in children below 10 years of age, more males were affected (Matter *et al.*, 1998).

There has been an increase in incidence of rabies in the sub-Saharan region, a sign that dog bite cases are increasing despite presence of effective vaccines to control the disease (Cleaveland *et al.*, 2003). In the study by Cleaveland *et al.*, (2003), it was shown that intensive vaccination of dogs against rabies greatly reduces incidence of the disease in dogs as well as humans. In addition, it was reported that information on dog bites provides valuable data which can be used for surveillance where rabies case incidence information cannot be found (Cleaveland *et al.*, 2003 and Ngugi *et al.* 2016).

In Kenya, canine rabies is endemic. It often emerges in many places but, remains a neglected infectious zoonosis that is commonly underestimated and underrated in the country. It, however, still remains a public health concern and economic burden in the poor areas. One needs to understand the transmission dynamics and distribution of dog bites over specified time period to assist in the assessment of risk factors, design interventions to exposure and the estimation of rabies burden (Nanyingi *et al.*, 2010). In a study in Western Kenya, it was documented that 148 bite incidents occurred annually and treated in a local hospital, with children below 10 years of age being the most affected. Most of the bites affected the lower extremities (83.8%) and 1.0% ended up in rabies and death even after post exposure treatment (Nanyingi *et al.*, 2010).

Rabies weighs heavily on the economic ability of the underdeveloped countries (Knoble *et al.*, 2005). Human deaths from canine rabies was estimated to be 59,000 per year. Deaths resulting from rabies are responsible for 1.74 million disability adjusted life years (DALYs) lost each year. In addition to this, 0.04 million life years are also lost through morbidity and mortality due to side effects of nerve tissue vaccine (Fevre *et al.*, 2004).

The burden of rabies can be roughly said to be evenly distributed across all sectors of society but is influenced by age and socio-economic factors the world over (Knoble *et al.*, 2005). The total cost of post exposure prophylaxis after bites per patient is estimated at USD 39.57 in Africa and USD 49.41 in Asia. This converts to huge amounts of money expended by the governments and coupled with the many life years lost due to mortality and morbidity, it ends up being a huge economic loss (Knoble *et al.*, 2005).

In Asia and Africa, there is disparity in affordability and accessibility of post exposure prophylaxis while risks of exposure to rabid dogs is high resulting in skewed distribution of disease burden across the societies of the two continents with the major impact falling on the poor rural communities and in particular children (Knoble *et al.*, 2005).

## **2.5 Post-exposure treatment**

This is the treatment instituted to a human bite case after exposure to bite of any nature from a presumed rabid animal or not. Post exposure treatment (PET) involves Post exposure prophylaxis (PEP) and wound treatment. The prophylaxis involves the injection of patients with human rabies immune globulins (HRIG) and Rabies Vaccine. The HRIG is highly recommended for cases that have not been previously vaccinated against rabies. The vaccination regimen consists of injections on day 0 (zero), 3,7,14 and finally day 28, (WHO, 2014; CDC.gov, 2019)

As a first aid, the wound needs immediate washing with plenty of water and mild disinfectant to reduce the viral load. This reduces the chances of rabies infection. The wound is then assessed for extent of damage. The injuries may at times involve nerves and tendons. The clinician decides on the manner of wound treatment to undertake. Tetanus toxoid administration is done especially for cases that have not been vaccinated against tetanus in the last 10 years. (WHO, 2014; CDC.gov, 2019)

CHAPTER THREE  
MATERIALS AND METHODS

**3.1 Study area**

The study was conducted in Homa Bay County. The area was selected because of observed huge population of roaming dogs and reported high prevalence of dog bites. The study area also had no data or information about dog bites and by extension rabies to guide policy development on rabies and dog bite control and management.

Homa Bay County has a size of 4,183.3 Km<sup>2</sup> made up of land and water masses. It is located along the shores of Lake Victoria in South Western Kenya (Fig. 3.1)

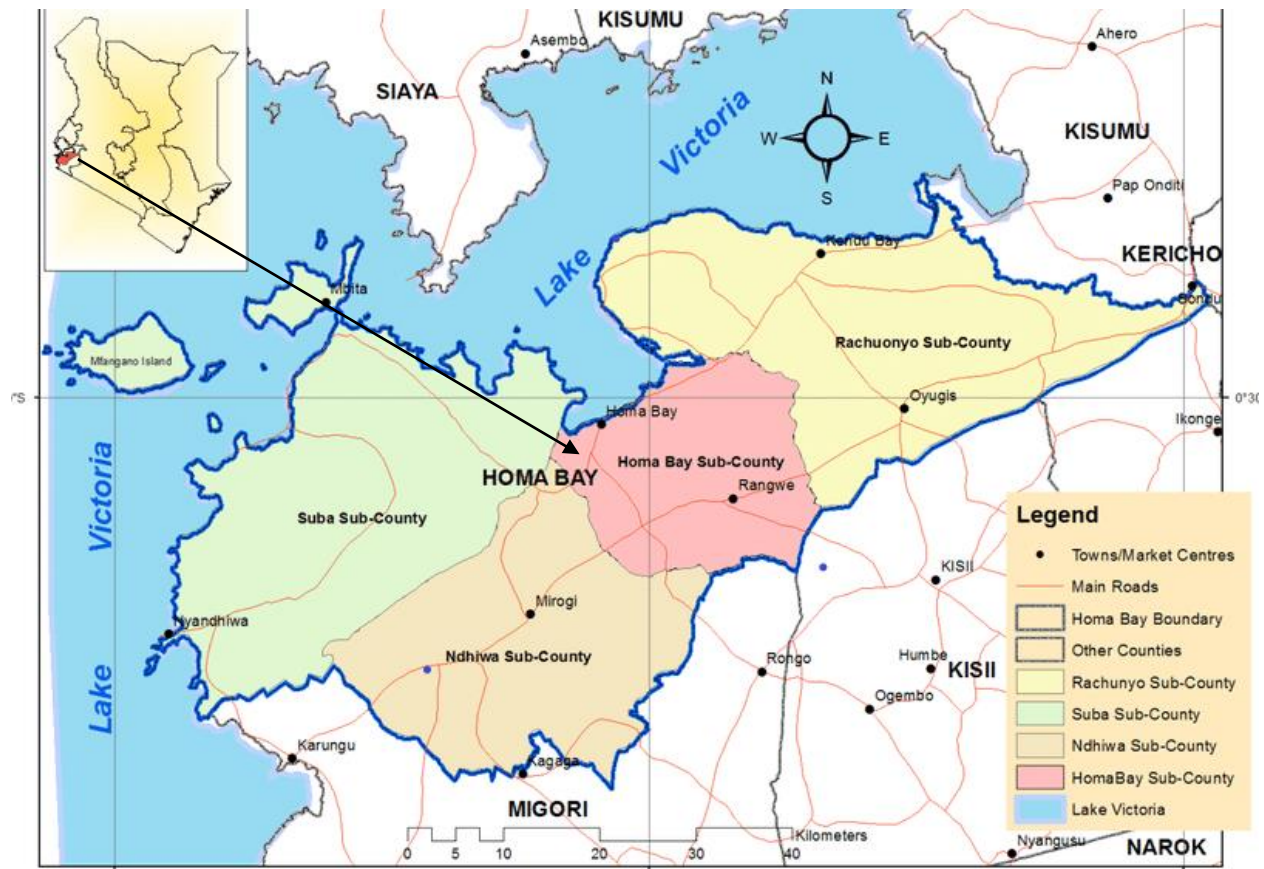


Figure 3.1 Map of Homa Bay County

It has a semi – arid climate, a hilly terrain and lies 4000 ft above sea level. There is a relatively high number of roaming dogs in the county. The dogs also roam along the beaches on the mainland and the islands of Lake Victoria in search of fish from fishermen and fish mongers in relatively large numbers.

The study area is moderately populated with a density of 303 persons per Km<sup>2</sup>. The human population was reported to be 963,794 persons as per the National Census of 2009, (KNBS, 2010).

It is also a typical rural set up lacking adequate health facilities.

The county is divided into eight administrative units called Sub-counties. These are Suba North (Mbita), Suba South, Ndhiwa, Rangwe, Homa Bay Town, Rarachuonyo North (Karachuonyo), Rarachuonyo South (Kasipul), Rarachuonyo East (Kabondo/Kasipul) (Figure 3.1).

The people of Homa Bay County are mainly members of the Luo and Suba ethnic groups.

## **3.2 Study Design**

The study was a survey of households to get information on human cases of dog bites and public health aspects of dog bites in Homa Bay County

## **3.3 Sampling**

### **3.3.1 Sampling Method**

Two sets of data were collected:- retrospective study of hospital records from 2016 to 2018 and a Survey (prospective study) of households in Homa Bay County in 2018. The latter method employed multi-stage sampling technique. Three out of the eight sub-counties were randomly selected. The 3 selected sub-counties were Homa Bay Town, Ndhiwa and Suba North (Mbita) with a population of 110,466, 210,340 and 136,075, respectively. This added up to a human population of 456,881 persons in the three sub-counties (KNBS, 2017). Then, within each selected sub-



county, two (2) wards were randomly selected for a total of 6 wards. Selection of the households within the wards was by systematic random sampling technique. A transect route through the ward was identified and every fourth homestead on either side of the route was picked and households sampled until the required sample size was achieved.

### 3.3.2 Sample size determination

The sample size of households was determined according to Dohoo *et al.*, (2003):

$$n = \frac{Z_{\alpha}^2 P(1-P)}{L^2}$$

Where, n is the sample size required,

P - *priori* estimate of the prevalence of bites estimated at 0.15

$Z_{\alpha}$  = The value of the normal deviation that provides 95% confidence interval

$$(Z_{\alpha} = 1.96),$$

L = Level of precision - 0.05.

Therefore, the sample size was,  $n = \frac{1.96^2 * 0.15 * 0.85}{(0.05)^2} = 195.9$ ; hence, 196 households were selected

### 3.4 Data Collection

Household data were collected by administration of a questionnaire (Appendix 1), to the household heads or any other adult in the household via personal interviews. The information collected included demographic information, dog ownership and care, cases of dog bites and their management, knowledge of rabies and financial cost of dog bites and rabies. Additional information collected include; knowledge, attitude and practices related to rabies and dog bites. Secondary data were obtained from hospital records (Homa Bay County and Mbita Sub-county hospitals). Data collected at the hospitals included human cases of dog bites vaccinations in case

of bites, the biting animal, site of bite, sex and age of the bite cases and ownership of the biting animal.

As at 2014 there were 144 health facilities in Homa Bay County, all publicly owned, including 1 level 5, 11 level 4, 31 level 3, and 101 level 2. In addition, there were privately owned 3 Mission hospitals, 36 health centres and 23 dispensaries (Department of Health, County Government of Homa Bay 2017 report) from among these, two public hospitals were the source of the secondary data

### **3.5 Data handling and analysis**

Data collected were entered into excel spreadsheet and then transferred to SPSS (IBM 20) for statistical analysis after thorough data arrangement and cleaning. Descriptive statistics were generated (i.e. proportions, means, e.t.c) for the variables such as demographic information, dog ownership and care, dog bite and its management, knowledge of rabies and financial cost of dog bites. The animal bite incidence of humans was calculated as the number of bites in the previous one year in the households visited divided by the number of people in the household and multiplied by 100,000.

The burden of dog bites was measured by prevalence (estimate of the bites) and assessing the direct and indirect costs incurred in the event of a bite. These costs included that for post exposure prophylaxis, transport to the point of treatment and wound treatment. Transport cost was estimated by obtaining the average of fares paid by the patients to reach the health facilities.

## CHAPTER FOUR

### RESULTS

#### 4.1 Retrospective/passive study results (from hospital records) (Secondary data)

##### 4.1.1 Human cases animal bites (2016 – 2018)

For the three years (2016-2018) animal bite data were collected, a total of 157 bite cases were reported to Homa Bay and Mbita sub-county hospitals. Figure 4.1 shows the temporal trend of the bite cases for the three years. The least cases were recorded for the year 2018 and the most in 2017 then a slightly lower number in 2016. The overwhelming majority of the bite cases were inflicted by dogs i.e. 143 cases (91%), others by cat -10 cases (6.4%) the donkey –1 case (0.6%) and snake bites - 3 cases (2.4 %). The majority, 113 animals (71.7%) of the biting animals had identified owners while 29.3% had no identified owners.

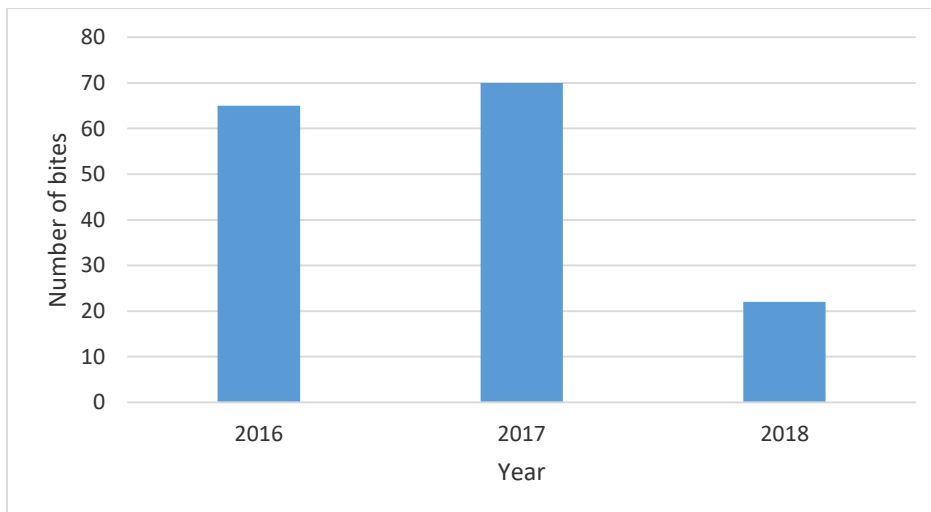


Figure 4.1 Frequency of human cases of animal-bites reported at the Homa Bay and Mbita Sub-county hospitals in Homa Bay County, 2016-2018.

#### 4.1.2 Age-sex distribution of animal bite cases (2016-2018)

The hospital data showed that children aged <15 years were the most bitten by dog in both sexes. In this category more males (46 cases) than females (33cases) were bitten. This was followed by those aged over 15 to 30 years. However, in this category more females suffered dog bites than males. But, more males were affected among those aged above 45 years. The least affected group was aged 30 years up to 45 years. Generally, males were most affected at 51.6% (81cases) against 48.4% female cases (76 cases).

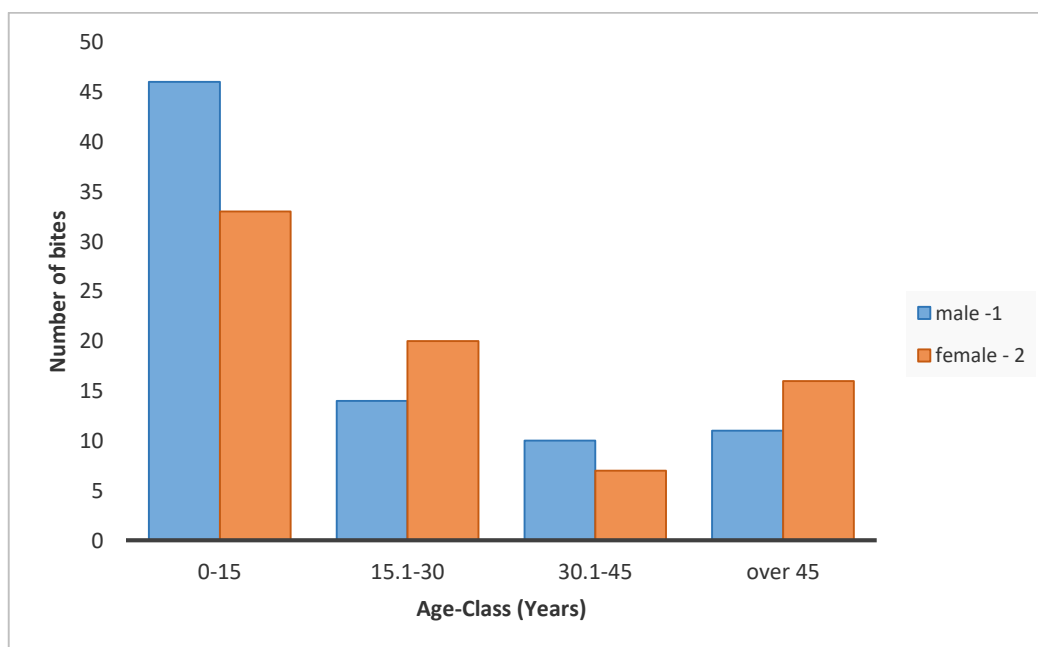


Figure 4.2: Age-sex distribution of human animal-bite cases reported in two hospitals in Homa Bay County

#### 4.1.3 Distribution of bites on the body

Bites were spread in different parts of the body where 70% (110 cases) of the cases were inflicted on the legs and feet of the victims. About a quarter (26.2% i.e. 41 cases) were effected on the arms and hands while 3.8% (6 cases) had injuries inflicted on the head and face (Figure 4.3)

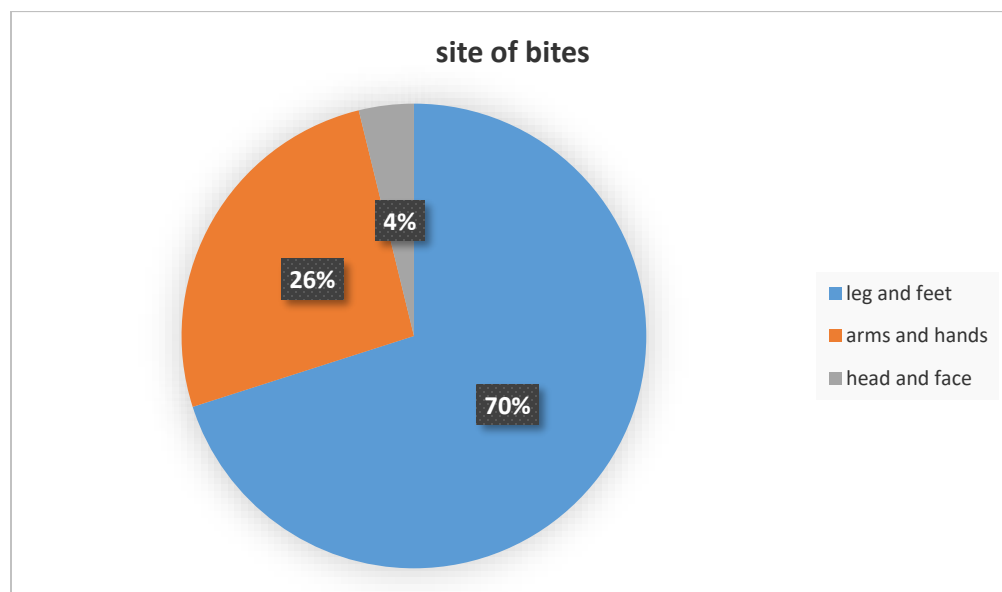


Figure 4.3: Distribution of animal bite wounds on body of human dog-bite cases

## 4.2 Household survey (Prospective study results (as carried-out in year 2018))

### 4.2.1 Response rate

Of the 198 respondents contacted, all agreed to participate in the study for a response rate of 100%.

### 4.2.2 Characteristics of survey households

#### 4.2.2.1 Age

Age of the respondents in this study was a very significant variable as the study targeted the bracket that could give meaningful response of a household; that is 15 years and above.

The majority (42.9%) of the respondents belonged to the age class 31-45 years (Table 4.3). Twenty seven percent of the respondents belonged to the age class 15 -30 years. Only 3 of the respondents were above 75 years of age.

**Table 4.1: Age of respondents in households surveyed in Homa Bay County, 2018**

Age	No.	(%)
15-30	53	26.8
31-45	85	42.9
46-60	32	16.2
61-75	25	12.6
76-90	3	1.5

#### **4.2.2.2 Education level**

Over half (53%) of the respondents had reportedly attained primary level of education and 29% secondary school level of education (Table 4.4). only 17% of the respondents had tertiary (university, college) level of education.

Table 4.2: Education level of respondents interviewed in **Homa Bay County**, 2018

<b>Education level</b>	<b>No.</b>	<b>(%)</b>
None formal education	3	1.5
Primary level	104	52.5
Secondary level	58	29.3
Tertiary level	33	16.7

### 4.2.2.3 Occupation of respondents

The occupation of the respondents varied from farming (69%) (including fishing in Lake Victoria, in the informal sector (artisans) (24%) and a few in offices within the county and further a field. This implies that Homabay County is mainly a rural setup.

## 4.3 Knowledge of rabies

### 4.3.1 Signs of Rabies

Almost 97% (192/198) of the respondents reportedly knew about rabies. The signs of rabies in dogs listed by the respondents are displayed in Table 4.3. The most common signs cited included nervous signs (paralysis, aggression) at 40%, drooling of saliva (17%), hoarseness of voice (14%) and behaviour change (14%)

**Table 4.3 Clinical signs of rabies in dogs according to the respondents**

Clinical signs	No.	Proportion(%)
Change of behaviour (strange)	27	13.6
Strange barking	28	14.1
Nervous signs	80	40.4
Drooling saliva and mouth wide open	33	16.7
Loss of appetite and thinning	15	7.6
Die eventually	2	1
Don't know	13	6.6

### 4.3.2 Susceptibility to rabies

The respondents also reported that human beings were the most susceptible to rabies virus at (55.6%) while 32.9% indicated that human beings and other animals were equally susceptible as shown in Table 4.4.

**Table 4.4 Species susceptible to rabies virus as reported by respondents in Homa Bay County**

<b>Species</b>	<b>No.</b>	<b>Proportion(%)</b>
Domesticated animals	10	5.1
Human beings	110	55.6
Both human and domesticated animals	34	17.2
Human, domestic and game animals	31	15.7
Dog and human	7	3.5
Don't know	6	3

### 4.3.3 Mode of transmission of rabies to humans

The majority (62%) of the respondents cited dog bites as the mode of transmission of rabies virus to man (Table 4.5). About a third (28%) cited bites by any rabid animal as the major mode of transmission of the virus to man.

**Table 4.5: Mode of transmission of rabies as reported by respondents in Homa Bay county**

<b>Mode</b>	<b>No.</b>	<b>Proportio(%)</b>
Through wound contact with saliva of infected animal	13	6.6
Through dog bite	122	61.6
Bite by any rabid animal	56	28.3
Don't know	7	3.5



#### **4.4 Dog population**

There were 291 dogs found among the 198 surveyed households converting to 1.5 dogs per household. Using the dog to human ratio of 1:8 estimated for Africa (Perry, 1993) and human population of Homa Bay county of 1,176,010 (KNBS, 2010), the dog population for the county was estimated at 147,000 dogs. However, according to the survey, there were 1782 people in the 198 households sampled translating to a dog:human ratio of 1:6. This ratio translated to 192,042 dogs in Homa Bay County. Ownership of dogs was common with 141 of the 198 households (71.2%) owning dogs. Only 51 of the 291 dogs (26.8%) were reportedly vaccinated against rabies.

The surveyed households kept dogs for various purposes but, predominantly as guard animals. 57% (113 households), kept the dogs as guards while 3% kept them as pets. 10.6% use them as hunting animals. The remaining 57 household i.e. 29% did not own any dog.

One hundred and twenty four (62.%) of all households, (or 88.6% of households that kept dogs), fed their dogs on food left overs. Only 16 households fed their dogs on commercial food or that which was specially cooked for the dogs.

#### **4.5 Bite information**

##### **4.5.1 Cases of human bites (2018)**

In the previous one year before the study begun, 28 cases of human animal bites were reported in the 198 survey households – all caused by dogs. The number of household members in the 198 households visited was 1782 giving an average household size in the study area as 9 persons per household. This gave a bite incidence rate of  $28/1782 = 0.01571$  in the study area. This converts to an annual dog bite incidence of 1571/100,000 population (95% C.I. of 970 - 2100). Of the 28

bites, 29% were provoked attacks by dogs and 71% unprovoked attacks. There were no cases of human deaths due to rabies a year to the study.

#### 4.5.2 Age and sex distribution of bites

The age and sex distribution of the 28 human cases of dog bites is shown in Figure 4.4. More females (8 cases) than males (5 cases) were bitten by dogs in the age class 0-15 years. However, in the age class 16-30 years, more males than females were bitten. Very few cases of bites were reported in the age class of 31-45 years with no cases of females in this age class. Generally, the study established that more males were bitten than females i.e. 53.6% versus 46.4%.

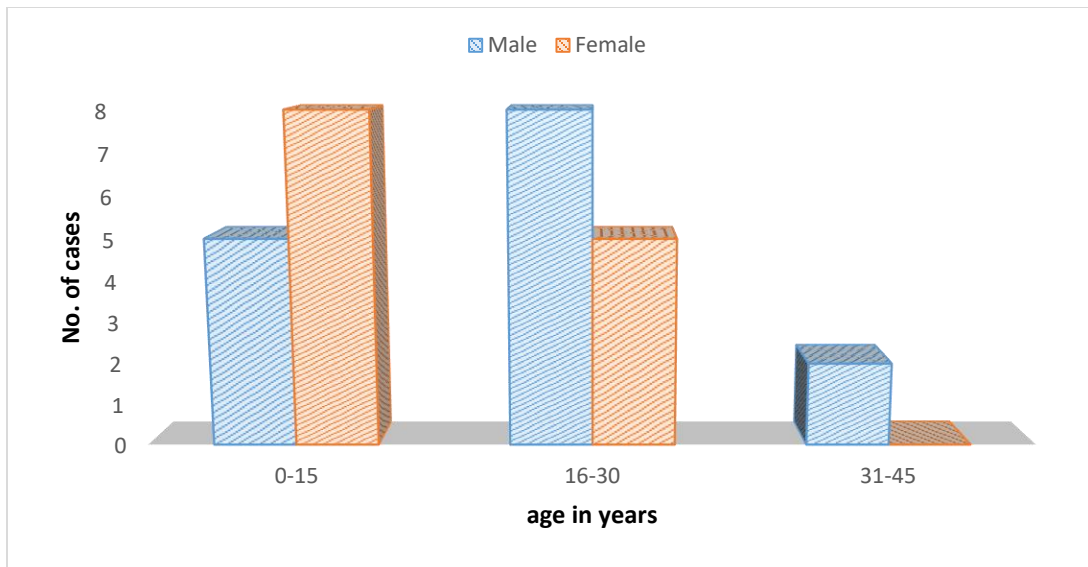


Figure 4.4: Age and sex distribution of human cases of dog bites in Homa Bay County, 2018.

#### 4.5.3 Sites of bites

Of the 28 bite cases the vast majority (82.1%; 23/28) were inflicted on the lower extremities- legs and feet (Fig.4.5). Only a few of the bites were on the upper extremities (hands and arms) and a single one on the head.

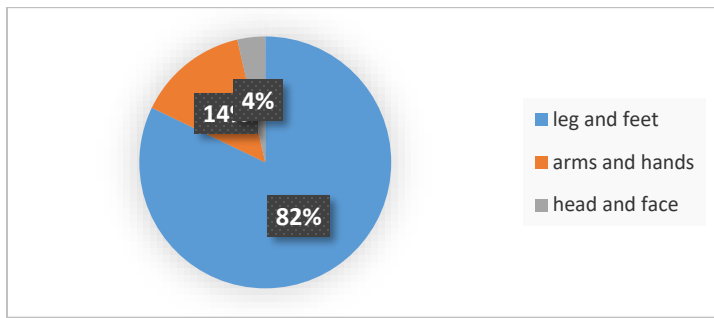


Figure 4.5: Sites of dog bites

#### 4.5.4 Spatial distribution of bites

As shown in Figure 4.6, most of the reported bites occurred to the north and central of the county. A few cases occurred to the south. These reported bite cases occurred in areas that were in close proximity to the lake shore. Generally there are many roaming dogs in the beaches along the shores of Lake Victoria. These dogs scavenge for food, especially fish on the beaches, an event that causes conflict with humans hence rampant bites in such area

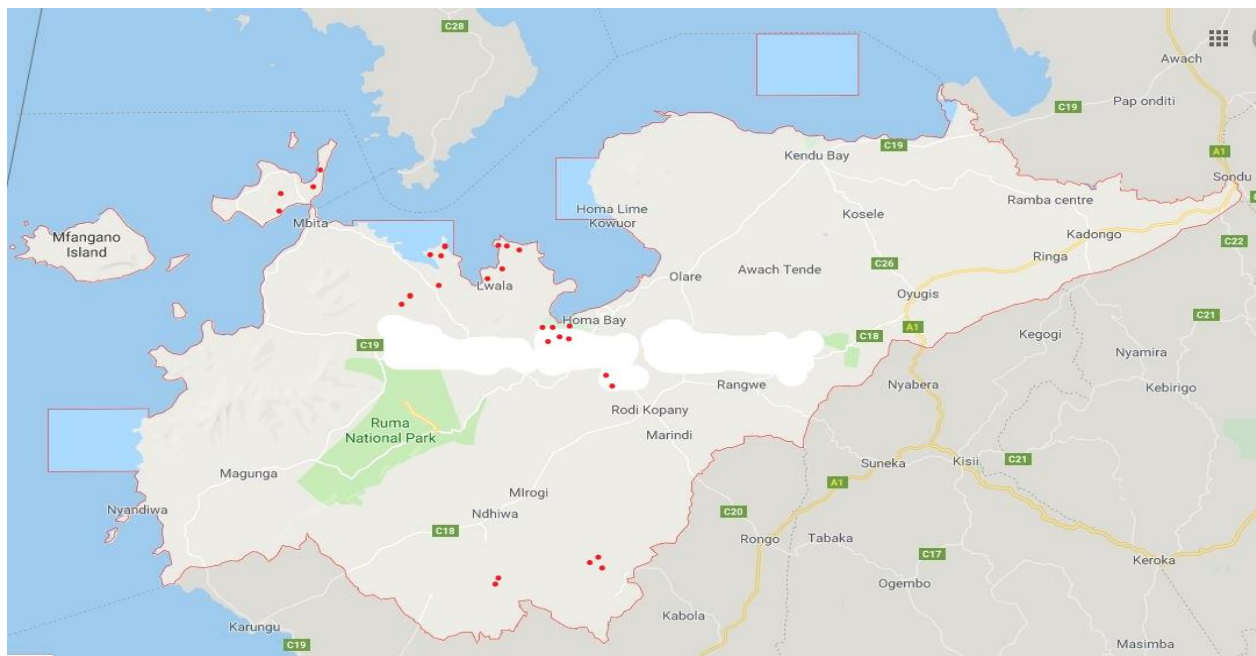
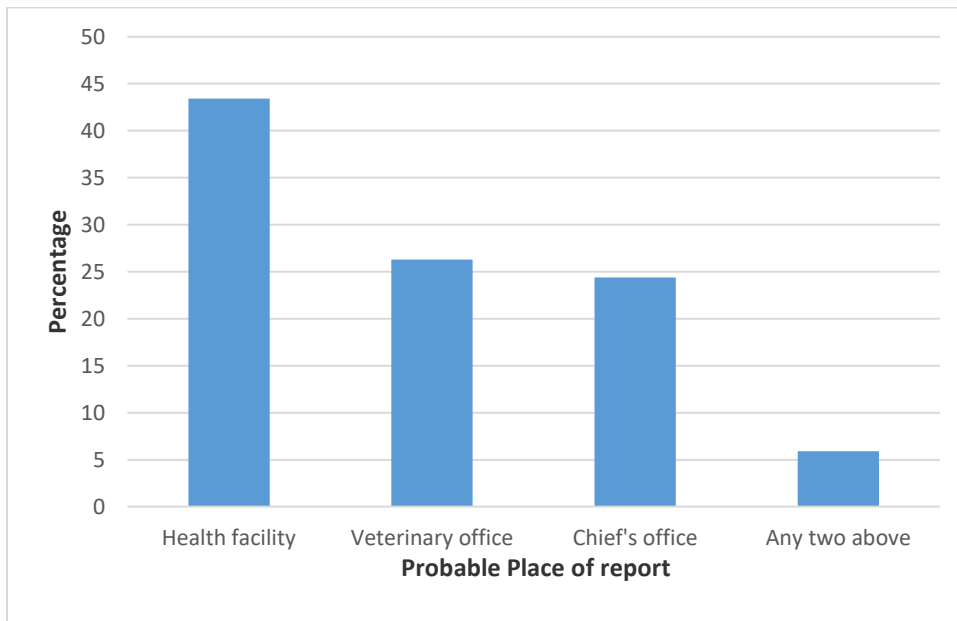


Figure 4.6: Map of Homa Bay County showing where dog bites occurred.

#### 4.6 Reporting of dog bites

Majority (43.4%) of the 198 respondents said that they reported bite cases to the local health centre. Nearly a quarter (26.3%) and a further 24.4% indicated that they reported to the nearby veterinary office and chief's office respectively (Figure 4.7). A small proportion (6.1%) said they reported to any of the offices which was nearest to them. The dog bite patients that reported to veterinary office were mostly seeking assistance to lodge a court case for compensation from the dog owners

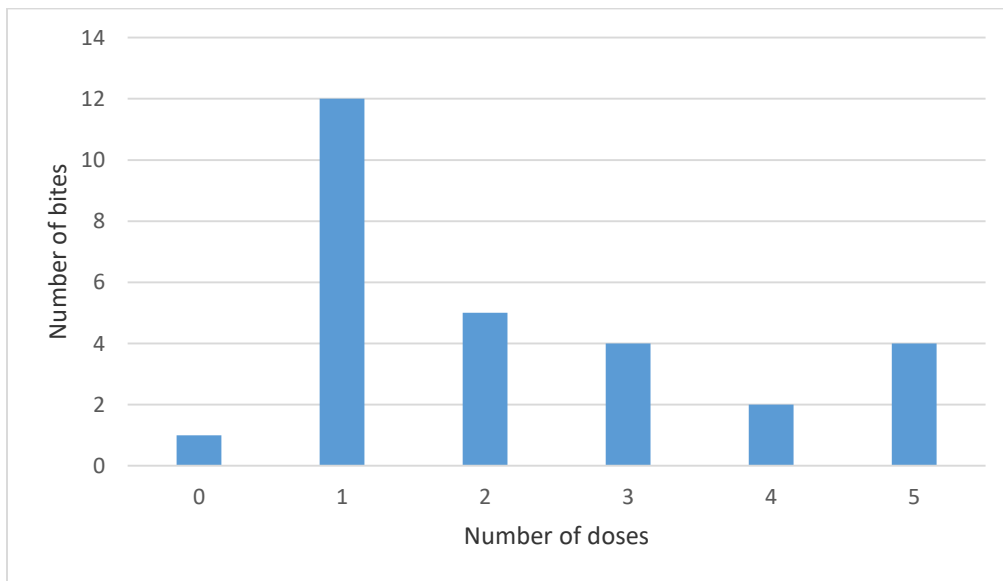


**Figure 4.6** Places where respondents would report cases of human dog bites

#### 4.7 Post-exposure prophylaxis

Only 4 persons out of the 28 cases of dog bites (14.2%) completed the recommended five dose vaccine regimen for dog bites. The number of doses received dropped drastically from 12 (42.9%) as those who received only the first dose to four (those who received five doses - 14.2%). The non-completion of the vaccination doses was a reflection of the cost of PEP where twelve cases (42.9%) indicated that the vaccine was quite expensive. The remaining 16 cases indicated high transport cost

and inavailability of the vaccine at time of visit to the health facility. Indeed, one of the persons bitten opted not to undergo PEP.



**Figure 4.7: Doses of antirabies vaccine received by 28 human cases of dog bites in Homa Bay County.**

Most of the dog bite cases reported high cost of the antirabies vaccine coupled with bus fare to the health facilities as contributory factors to not completing PEP. The cost of a single dose of vaccine was going for between Kshs. 1,000-1,200 (Verorab<sup>®</sup>). For the recommended 5 doses, PEP would cost between Kshs. 5000-6000. This together with the bus fare would be far out of reach of the majority rural poor who live below the poverty line. A check with the health facilities revealed that the antirabies vaccines were rarely in stock thereby forcing people reporting with dog bite wounds to seek for the vaccine at the local pharmacies at exorbitant prices.

## CHAPTER FIVE

### 5.0 DISCUSSION

The current study was a survey of dog bites incidence and public health burden of dog bites and by extension rabies in Homa Bay county. It describes some demographics of dog population, factors that determine dog bites in humans and financial implication of dog bite and rabies in the study area.

Rabies was well known in Homa Bay County. Most of the residents were able to correctly point out the clinical signs of the disease, and species susceptible to rabies virus. Indeed, the first case of human rabies in Kenya occurred in the then South Kavirondo (Homa Bay, Migori and Kuria) in a woman who had been attacked and bitten by a rabid dog (Green, 1928; Hudson, 1944) since then rabies has been continuously reported in the area (Bitek *et al.*, 2019).

Like in most parts of the developing world (particularly Asia and Africa) the domestic dog was the most important animal species causing bites in humans. The proportion (91%) of animals causing bites being dogs in this study from the secondary data from hospital records was similar but slightly higher than that estimated in Machakos and Makueni Counties of 81%. Similar estimates have been in other low income countries including Ethiopia (97%) (Ngugi *et al.*, 2015), India (96%) (Domple *et al.*, 2015; Beyene *et al.*, 2018). However, the primary data is based on 100% dog bites as this was the main focus. Thus, control efforts towards rabies should always be targeted at dog populations. Unfortunately, only 27% of the dog population of Homa Bay County was reportedly vaccinated as indicated by the data collected in this study. This proportion is much less than the recommended 70-75% cover required to halt rabies spread (WHO, 2005). A similar vaccination cover of 29% was estimated in Machakos and Makueni Counties (Kitala *et al.*, 2000). In Kenya, dog vaccinations are not carried out regularly, but as a one off exercise usually in

response to outbreaks (Perry, 1993). This is a dangerous practice because theoretical studies have shown that inadequate vaccination of dog populations make rabies to establish itself endemically with only minor fluctuations in incidence (Kitala *et al.*, 2002). However, all is not lost because of the initiative by the Zoonotic Diseases Unit (ZDU) to eliminate dog-mediated rabies in Kenya by year 2030. ZDU developed a strategic plan spanning from 2014 – 2030. The strategic plan enabled establishment of rabies control committees from the sub-counties to the National level. The plan recognises that 98% of human rabies cases are dog mediated and thus control of the disease in dogs will drastically reduce or eliminate human rabies.

The control strategy envisages a sustained dog vaccination and human pre and post exposure prophylaxis to eliminate rabies disease in Kenya. Part of this initiative is the enhanced dog vaccination coverage to a high percentage of 70% and above and not only at times of disease outbreak, (ZDU 2014).

The dog population in Homa Bay County was large compared to other similar rural settings in Kenya. The proportion of households found with dogs of 71% is higher than the proportion (63%) estimated for rural Machakos and Makueni counties (Kitala *et al.*, 2001), and much higher than the estimate of 58% in the neighbouring Siaya County (Kwoba *et al.*, 2019). The dog density per household of 1.5 in Homa Bay County, was also higher than that estimated in Machakos / Makueni Counties of one (1) dog per household. However, the dog to human ratio (1:6) estimated in this study was quite close to that estimated for Africa (1:8) and similar to estimates in Siaya County and in Machakos/Makueni Counties (1:7) (Kitala *et al.*, 2001). The high dog density in Homa Bay County could be attributed to the readily available food (fish) found along the beaches of Lake Victoria and lack of control of roaming dog population in the county. The households of Homa Bay kept dogs mainly for use as guard in their homesteads

The dog bite incidence of 1.57% (1571/100,000 population) estimated in this study was much higher than that in Machakos/ Makueni Counties of 234/ 100,000 population (Kitala *et al.*, 2000), and 440/100,000 population in Nigeria (Nwaho and Ugueze, 2017). A study by Gugsa *et al.*, 2018 showed that Siaya and Kisumu counties in the period of year 2010 to 2014, reported 3441 and 4997 dog bites cases respectively. This gave a yearly average of 688 and 999 bites for Siaya and Kisumu respectively for five years of the study (Gugsa *et al.*, 2018).

The rate was however, lower than estimates of 2520/ 100,000 population and 1960/ 100,000 population in urban and rural areas of India respectively (Sharma *et al.*, 2016). The high dog bite incidence may have been due to a high human/ dog interaction as a result of high dog density.

Despite the many cases of human dog bites, no human death due to rabies was reported during the year just before this study begun. This was rather unexpected given that the five-dose vaccination regimen for dog bite cases was not complied with in Homa Bay. However, not all dog bites even by confirmed rabid dogs, result in contracting rabies. Indeed, rabies mortality in humans bitten by confirmed rabid animals is only 23% (Fekadu *et al.*, 1982). Alternatively, dog bite human cases may have contracted rabies and never reported to the hospital. This is a common practice in most African societies (Mallew *et al.*, 2007).

Most of the dog bites were inflicted on children less than 15 years of age. However, more girls than boys in this age class (0-15 years) were affected according to this study. This was contrary to what has been reported in other studies showing boys and not girls to be the most affected. The current study may have lacked the power to detect the real differences because of the small sample size. Children, especially boys, have a tendency of provoking dogs, even those unknown to them. In this way, they are at a high risk of dog bites and are likely to be bitten on the upper extremities and the head because of their short stature and inability to protect themselves from attacking dogs.



Almost all of the bites were on the lower extremities (feet and legs) presumably inflicted as people fled from the offending dogs (Mallew *et al.*, 2007). The current study found that 82.1% of the dog bite sites were at the lower limbs, 14.6% on arms and only one case 3.6% on the head and face. This was in accordance with a study conducted in selected counties in Kenya which documented dog bites occurring in the lower limbs with children being attacked on the head and face. (Ngugi *et al.*, 2016). Another study by Vijayan *et al.*, 2016 also showed similar results with the leading bite site being the lower limbs at (86.5%) followed by arms and hands (13%) and other parts being 0.5%, (Vijayan *et al.*, 2016).

This study showed that people in Homa Bay County were more likely to be bitten by dogs they know, probably a neighbour's dog, than those unknown to them. The latter category is the most dangerous because rabid dogs have a tendency to traverse large areas (random walking) biting anything in their paths, both living and non-living. Dogs that attack without provocation have the highest probability of being rabid.

There was a low compliance to post exposure prophylaxis (PEP) by the residents of Homa Bay County. Only four human dog bite cases completed the recommended five dose regimen. This observation has also been made in India (Vijayan *et al.*, 2016). In Homa Bay, the reasons cited for not completing PEP were high cost of the antirabies vaccine and bus fare to the health facilities. Other costs that may have not been apparent to the residents of Homa Bay are the working hours lost while visiting the clinics (5 visits), the uncostable human life lost through death and the psychological torture of those bitten and their families. Most residents of Homa Bay, like in other areas of Kenya, live below the poverty line and would thus find the costs of PEP to be prohibitively high.

The burden of dog bites and by extension rabies is likely to have been great in Homa Bay. Because of the design of the current study, it was not possible to estimate the Disability Adjusted Life Years (DALYs) which is a better estimate of disease burdens in populations. Such studies are recommended in Homa Bay County.

In conclusion, dog bite injuries are serious public health problems in the study area. The dog population in Homa Bay County is inadequately protected against rabies by vaccination posing a great danger to the animals as well as humans in the event of an outbreak of rabies disease. There is a need for the government to scale up rabies control activities in the area. Key in the programmes is to increase dog vaccination coverage to 70%. To achieve this, the cooperation, participation and sympathy of the public to the control efforts should be enlisted.

## CHAPTER SIX

### CONCLUSIONS AND RECOMENDATIONS

#### 6.1 Conclusions

The following conclusions can be drawn from this study:

1. The dog population of Homa Bay County is large estimated at 192, 042 dogs. Dog density per household was 1.5 and the dog to person ratio was 1:6. The annual human dog bite incidence was 1.57% (1571/100,000 population). The domestic dog was the most important animal species causing 91% of the reported bite cases from the secondary data. The dog population was inadequately protected against rabies through vaccination as only 27% of the surveyed dogs were reportedly vaccinated against the disease.
2. Compliance with post exposure prophylaxis regimen was low whereby only four persons out of the 28 (14.3%) bite cases completed the recommended five dose vaccination regimen. Reasons for not compliance with vaccination regimen included the prohibitive cost of the antirabies vaccine, high transport cost to the health facilities and non-availability of the vaccines in the health facilities at the time of visit by the victims of dog bites.
3. Despite the many bite cases, no death from rabies was reported from the surveyed households. Therefore dog bite menace stood out as a public health burden in Homa Bay County as indicated by the high incidence of 1.57%, high cost of treatment and transportation and inaccessibility of vaccines when needed.

## **6.2 Recommendations**

1. Dog bites and rabies are a major public health problem in Homa Bay County. There is therefore a need for the government to upscale rabies control in Homa Bay targeted at dog populations. To achieve higher vaccination coverage the cooperation and participation of the public should be enlisted.
2. Although it has been shown that a control strategy based on dog vaccination is more cost-effective in rabies control than one based on PEP, the government should strive to make available antirabies vaccine in the health facilities especially during this time of Universal Health Care policy enactment.
3. Public education on any rabies control strategy and bite prevention would be paramount. The public should be educated on the dangers of keeping unvaccinated dogs and untreated dog bite wounds.
4. Further studies should be conducted in Homa Bay to properly estimate the burden of rabies in Homa Bay county. Such studies would include Disability Adjusted Life Years (DALYs) as a parameter.

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## CHAPTER EIGHT

### 8.0 APPENDICES

#### APPENDIX 1: STUDY QUESTIONNAIRE

A Survey of Dog bite and the Public health burden of dog bites in Homa Bay County

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The information gathered during this survey will be treated confidentially and used in a similar manner.

Part A: General Information of interviewee

NO	ITEM/ QUESTION	LEVELS
1	Serial number of interviewee	Age
2	Residence:	Division Location Sub Location Village
3	Education level of interviewee:	1 Primary ( )

		2. Secondary ( ) 3. College ( )
4	Occupation	Farmer White collar worker Blue collar worker (Jua Kali)
5	Do you know rabies?	
6	What are signs of rabies	
7	Who can get rabies and how	
8	Which animal species is responsible for transmitting rabies to humans	
9	Have you or any member of the family ever suffered dog bite in the last one year?	1. Yes ( ) 2. No ( )
10	Age of the victim (years)	
11	Sex of the bite case	Male ( ) Female ( )
12	Site of injury	1. Head and face ( ) 2. Arms ( ) 3. Chest ( ) 4. Lower limbs ( )
13	If, yes, under what circumstances?	1. Provoked... ( ) 2. Unprovoked ( )
14	Do you own dog(s) and how many	1. Yes ( ) 2. No ( )

15	Has your dog ever been bitten by a stray dog?	1. Yes ( ) 2. No ( )
16	If the dog was bitten, how did it behave later on?	1. Still alive? ( ) 2. Dead (in 1-2 months). ( )
17	Do you vaccinate your dogs against rabies?	1. Yes... ( ) 2. No. ( )
18	Do you hunt wild game with your dogs	1. Yes ( ) 2. No ( )
19	How do you acquire the dogs that you keep?	1. Buy from market ( ) 2. Capture roaming ones ( ) 3. From friends ( ) 4. Offspring of own bitch ( )
20	Source of your dog food	1. Household leftovers 2. Commercial dog food 3. Other (specify)
21	How far are you from the nearest hospital	1. 500m -5km 2. 6-10 km 3. 11-20km 4. More than 20km
22	How easy or difficult is it to get post exposure treatment after a bite	Easily accessible ( ) Hard to access ( )
23	How much does it cost you to reach hospital?	

24	Was the rabies vaccine available at the health facility when you visited it?	Yes ( ) No ( )
25	If not where did you get the vaccine?	Chemist/ Pharmacy Veterinary office Hospital/ health centre
26	How much does it cost to treat a dog bite?	
27	Did you finish all the injections? If not, why?	
28	Where do you report cases of dog bites?	1. Health facility 2. Veterinary office 3. Chief's office