KNOWLEDGE, ATTITUDE AND PRACTICES ON RABIES IN KISUMU AND SIAYA COUNTIES, KENYA

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Declaration

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

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Dedication

To my parents Robert Muriuki and Elena Wanjira, who have always inspired my endevours.

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Abbreviations

ABC	Animal Birth Control
AIDS	Acquired Immune Deficiency Syndrome
CBPP	Contangious Bovine Pleural Pneumonia
CVIL	Central Veterinary Investigational Laboratories
DALYs	Disability Adjusted Life Years
DUVV	Duvenhage virus
ECF	East Coast Fever
FAT	Fluorescent Antibody Test
FGDs	Focus Group Discussions
FMD	Foot and Mouth Disease
FRDs	Free Roaming Dogs
HDCV	Human Diploid Cell Vaccine
HDR	Human: Dog Ratio
HEP	High Egg Passage
KAPs	Knowledge, Attittude and Practices
KES	Kenya Shillings
LBV	Lagos bat virus

LEP	Low Egg Passage
MIT	Mice Innoculation Test
MOKV	Mokola virus
PCEC	Purified Chick Embryo Cell Vaccine
PEP	Post-Exposure Prophylaxis
PVRV	Purified Vero Cell Rabies Vaccine
RABV	Rabies virus
RIG	Rabies Immune Globulin
SEARG	Southern and Eastern African Rabies Group
WHO	World Health Organization of the United Nations
ZDU	Zoonotic Disease Unit

Abstract

Rabies is a neglected viral zoonotic disease that is invariably fatal in humans and other mammals. It affects mainly the low and middle income countries. Domestic dogs are the main vectors of the disease causing 94% of human rabies through bites. The disease not only causes human mortalities and Disability Adjusted Life Years (DALYs) but also a high public health burden, productivity losses, high costs of Post-Exposure Prophylaxis (PEP) and other costs incurred from control and prevention programs. Reliable data on rabies are necessary to understand the epidemiology of the disease, its impact on human and animal populations, and to obtain commitment and support from national authorities in the implementation of preventive and control programs.

This study was therefore designed to determine the level of community knowledge, attittude and practices (KAPs) concerning rabies, owned and roaming dog demographics, the socio-cultural value of dog keeping and the number of animal bite cases in the preceeding 5 years in Kisumu and Siaya counties of Kenya.

A total of 183 and 168 questionnaires were administered in selected sub-counties of Kisumu and Siaya respectively to determine community KAPs, owned dog demographics and the socio-cultural value of dog keeping. Mark- recapture technique was used to determine roaming dog demographics while a five year retrospective data on dog/animal bite cases were obtained from the health information system.

Over 90% of the respondents were aware of rabies, its zoonotic nature and the importance of the domestic dog in its transmission. In both counties, over 75% of the respondents would seek medical attention in case a family member was bitten by a dog. However, a significant number of respondents (52.6% in Kisumu and 32.5% in Siaya) were not aware of the first line

of action at home level after a person is bitten by a dog. Despite a large proportion of the respondents (78.6% - Kisumu and 66.9% - Siaya) being aware of the importance of dog vaccination in prevention of rabies, only 20.4% and 19.1% of the households in Kisumu and Siaya respectively had up to date vaccination of their dogs.

A total of 259 and 299 household dogs were counted in Kisumu and Siaya respectively. In Kisumu, 68.6% of dogs were free to roam 24 hours a day while in Siaya, this proportion was lower at 28.6%. In the roaming population, 196 and 190 dogs were counted in Kisumu and Siaya respectively. In both counties, over 60% of the free roaming dogs were males.

The five-year data (2010-2014) revealed a total of 14058 and 17288 animal bite cases in Kisumu and Siaya respectively. The data indicated that the number of bites and their incidence were on the rise over the years, and were higher in Siaya than in Kisumu.

The knowledge gaps and negative practices identified by this study show the need to create public education and awareness programs in these counties in an effort to control the disease.

1 CHAPTER ONE

1.1 Introduction

Rabies is a neglected viral zoonotic disease that is invariably fatal in humans and other mammals. It affects mainly low and middle income countries. Domestic dogs are the main vectors of the disease causing 94% of human rabies through bites (Abbas *et al*., 2011). The prevalence of the disease is highly influenced by the density of unvaccinated dog populations (Appel and Carmichael, 1979). In addition to the mortalities and Disability Adjusted Life Years (DALYs), the public health burden of rabies extends to the cost of disease control. The fear of the disease and uncertainity of outcome cause psycological trauma on the victims of animal bites (Cleaveland *et al.*, 2001). Reliable data on rabies are necessary to understand the epidemiology of the disease, its impact on human and animal populations, and to obtain commitment and support from national authorities in the implementation of preventive and control programs (Balogh *et al.*, 2001). Such information is always lacking, especially in low-income countries and this has led to low prioritisation of the disease leading to neglect (Kitala*et al.*, 2000; Cleaveland *et al*, 2014).

Understanding dog ecology is essential for effective control of rabies. The global dog populationis estimated to be around 700 million (Hughes and Macdonald, 2013). Between 30% and 70% of dogs in Africa and Asia are "stray" or "ownerless" (Bögel and Joshi, 1990). Perry, (1993) estimated the dog population size of Kenya to be 2.3 to 3.2 million more than 2 decades ago. Little is known about the exact dog population figures and dynamics in Kenya. This is a big

setback in the efforts to ensure 70% vaccination of the dog population as it is difficult to gauge the coverage of the vaccination (Macharia *et al.*, 2001).

The Kenyan government together with other stake-holders have shown willingness and efforts to control rabies. A National Rabies Elimination Strategy has been developed with the aim of eliminating human dog-mediated rabies by the year 2030 in Kenya. Kisumu, Siaya, Machakos, Kitui and Makueni Counties have been selected as pilot areas to demonstrate success of the program before scaling up to the rest of the country (National Rabies Elimination Strategy, 2014). For any rabies control program to succeed, various aspects of the communities involved and dog populations must be considered. This study provides baseline data oncommunity knowledge, attitude and practices with regards to rabies, dog population demographics and animal bite cases in Kisumu and Siaya counties.

1.2 Objectives

1.2.1 General objective

The overall objective of the study was to establish the status of rabies-related attributes of communities in Kisumu and Siaya Counties, Kenya.

1.2.2 Specific objectives

i. To assess community knowledge, attitude and practices (KAPs) on rabies, and the socio-cultural value of dog keeping in selected areas of Kisumu and Siaya counties.
ii. To determine stray and owned dog population demographics in selected areas of Kisumu and Siaya counties.
iii. To quantify retrospectively the distribution of animal bites in Kisumu and Siaya counties.

2 CHAPTER TWO

2.1 Literature review

Rabies is one of the most neglected infectious diseases affecting mainly the low and middle income countries (Abbas *et al*., 2011). It is an acute encephalitis characterized by altered behaviour, aggressiveness, progressive paralysis and death in most species. The virus is present in the saliva of infected mammals. Natural transmission is by bite of rabid animals. The dog, cat, fox, skunk, racoon, bobcat, coyote, mongoose and other small carnivorous mammals are the most commonly affected animals and also the main vectors of the disease (Warrell and Warrell, 2015; Appel and Carmichael, 1979). Bats are also important vectors of the disease and causes hundreds of thousands of cattle deaths in Central and South America every year (Appel and Carmichael, 1979). It is regarded as a non-treatable disease, but preventable by immunization of animals and humans in high risk areas or occupations, and by PEP of humans (Warrell and Warrell, 2015; Swango, 1995).

Today, the major challenges in dog rabies control are economic and logistic rather than technical (Balogh *et al.*, 2001). African governments are using most of their resources on priority human and animal diseases such as Acquired Immune Deficiency Syndrome (AIDS), Malaria, Foot and Mouth Disease (FMD), Contangious Bovine Pleural Pneumonia (CBPP) and East Coast Fever (ECF), leaving hardly any means for rabies control (Balogh *et al.*, 2001).

The disease mainly affects the low and middle income countries. Globally it kills about 60,000 people a year, most of them (95%) in Africa and Asia (Abbas*et al.*, 2011). The estimated global annual cost of rabies is US $ 6bn and this includes productivity losses as a result of premature human deaths, Post-Exposure Prophylaxis (PEP) costs and other costs incurred from control and

prevention measures (WHO, 2013). The high cost of human PEP is a major economic burden which affects both government and household budgets (Cleaveland *et al.*, 2001). At the household level, costs of PEP arise directly from anti-rabies vaccines and indirectly from costs associated with travel, medical fees and income loss. The indirect household losses represent more than 50% of total costs (National Rabies Elimination Strategy, 2014). The total PEP costs have been estimated at US$40 per patient in Africa and US$ 49 in Asia, accounting for 6% and 4% of annual per capita Gross National Income, respectively (National Rabies Elimination Strategy, 2014). In Kenya, the direct medical cost associated with a complete regime of PEP is estimated at $85 per person (National Rabies Elimination Strategy, 2014).

2.1.1 Etiology

Rabies virus is a Lyssavirus in the family Rhabdoviridae (WHO, 2007; Radostits *et al.*, 2000). Members in this family are rod-shaped (Swango, 1995). In Kenya, five genotypes of the lyssavirus have been reported. The most common is Genotype 1 (Rabies virus, RABV). Others are Genotype 2 (Lagos bat virus, LBV), Genotype 3 (Mokola virus, MOKV), Genotype 4 (Duvenhage virus, DUVV), and the Shimoni bat lyssavirus (WHO, 2014). The Lagos bat virus and the Mokola virus are antigenically related to rabies virus and may cause rabies-like signs in dogs (Appel and Carmichael, 1979). Lagos bat virus and the Mokola virus are found mainly in small veterbrates and are limited to the African region, unlike rabies virus that is globally distributed (Radostits *et al.*, 1994,Swango, 1995). Human infections are mostly due to the canine biotype of RABV (WHO, 2014).

The virus is labile and does not survive in the environment as sunlight, warm temperatures, drying, heat and common disinfectants destroys it (Swango, 1995). The virus is present in the saliva and salivary gland, nerve tissue, and pancrease of infected mammals. It is less often found in urine and lymph, and rarely in blood (Appel and Carmichael, 1979).

Virus isolated from natural cases of rabies is called "street" virus while the one isolated after serial passage in laboratory animals is called "fixed" virus. When passed through several experiments, the incubation period keeps on shortening until there is a fixed number of days (Appel and Carmichael, 1979).

2.1.2 Epidemiology

2.1.2.1 Occurence

Rabies is present in all continents except Antarctica. It is endemic in Africa, Asia and South America. The only countries without rabies are Switzerland, Netherlands, United Kingdom, Ireland, Sweden, Norway, Iceland, Japan, Australia, New Zealand, Singapore, most of Malaysia, Papua New Guinea, the Pacific Islands and some Indonesian islands (Center for Food Security and Public Health, 2012; WHO, 2014a). Island countries have managed to exclude it by quarantine or prohibition of entry of dogs. Australia and Newzealand have never had the disease (Radostits *et al.,* 1994). A country is considered to be free of rabies if there have been no indigenously acquired cases in humans or animals during the previous 2 years, in the presence of adequate surveillance and import regulations (Center for Food Security and Public Health, 2012). The reservoirs comprises mammalian species in the Orders Carnivora (dogs, racoons, skunks, foxes, jackals) and Chiroptera bats (Lembo *et al.,* 2010), although all warm-blooded animals are

susceptible to the virus. Opposums and birds are the most resistant species. Skunks, wild canids/foxes, racoons, bats and cattle are the most susceptible while dogs, cats, horses, sheep, goats, nonhuman primates and humans are of intermediate susceptibility (Swango, 1995). Young dogs are more susceptible than adults. This is the case also for all other species (Appel and Carmichael, 1979).

The domestic dog is the main vector and reservoir of rabies with 94% of human rabies caused by dog bites (Abbas*et al.*, 2011). Elimination of dog rabies through vaccination and environmental control is the most cost-effective strategy for preventing human rabies (WHO, 2004). Vaccinating 70% of the dog population will eliminate dog rabies and hence human rabies (Cleaveland *et al*., 2014). However, the necessary level of coverage is influenced by dog population demographics and dynamics and disease transmission dynamics (Cleaveland *et al*., 2010). Therefore, establishing dog population demographics and dynamics is a vital initial step in any rabies control program.

There has been marked efforts to control canine rabies in the last three decades with recent successes being reported in Central and South America (Belotto *et al.*, 2005). Developing countries like Philipines, Mexico and Indonesia have successfully eliminated human rabies through mass vaccination of dogs, dog population control, dog bite management, public education and improved diagnosis, surveillance and monitoring (National Rabies Elimination Strategy, 2014). This led to a decline in dog rabies and human rabies cases and deaths in these countries (Schneider *et al.*, 2007). Unfortunately, the situation in most African and Asian countries is completely different as the incidence of dog rabies and human rabies deaths continue to escalate and new outbreaks are reported in areas previously free of the disease such as the

islands of Flores and Bali in Indonesia (Lembo *et al.*, 2010). Rabies control interventions are underway in Tanzania and Kwa-Zulu Natal, South Africa, while in Kenya an elimination strategy has been launched but yet to be operationalised (National Rabies Elimination Strategy, 2014).

Among the challenges that hamper rabies control, especially in Africa, is unavailability of acurate data on the public health impact of the disease, thus leading to a very high level of under-reporting and neglect (Cleaveland *et al.*, 2001). Reasons for under-reporting includes lack of laboratory confirmation, inability of medical staff to recognize the disease, patients with clinical disease staying at home or seeking help from local healers, cause of death recorded locally but not forwarded to the central authorities and some people perceiving it as bewitchment requiring exorcism rather than medical treatment (Cleaveland *et al.*, 2001).

The many misperceptions about the disease are other major challenges in rabies control efforts (Lembo *et al*., 2010). These include the misperception that rabies is relatively insignificant as a disease of public health concern; that rabies is a problem of 'stray' dogs that are not accessible for parenteral vaccination; that rabies can only be controlled through culling or reduction in the dog population density; and that wildlife play a major role in sustaining rabies cycles in Africa (Cleaveland *et al.*, 2014). These misperceptions drive a cycle of neglect, adoption and implementation of the wrong control measures, demotivation of policy-makers and veterinary field staff and the erroneous impression that rabies control is futile (Cleaveland *et al.*, 2014).

Lembo *et al*., (2010) identified four common reasons for the lack of effective canine rabies control in Africa. These are (a) a low priority given for disease control as a result of lack of awareness of the rabies burden; (b) epidemiological constraints such as uncertainties about the required levels of vaccination coverage and the possibility of sustained cycles of infection in

wildlife; (c) operational constraints including accessibility of dogs for vaccination and insufficient knowledge of dog population sizes for planning of vaccination campaigns; and (d) limited resources for implementation of rabies surveillance and control. A major factor in the low level of political commitment to rabies control is a lack of accurate data on the true public health impact of the disease.

The poorest communities in the world are the main recipients of the physical, psychological and economic consequences of rabies. These consequences are preventable if the veterinary and medical professions and governments direct their efforts in correcting the misperceptions, providing acurate data and delivering existing solutions (Cleaveland *et al.*, 2014).

2.1.2.1.1 Rabies situation in Kenya

Animal rabies is a notifiable disease in Kenya under the Disease Control Act and Rabies Act (WHO, 2014). Based on the confirmed cases at the Central Veterinary Investigational Laboratories (CVIL) in Kabete, rabies in Kenya is most prevalent in dogs, followed by cattle, cats, goats, sheep, pigs, wildlife and man in that order (Macharia *et al.*, 2001). Though vaccination, killing by baiting of roaming dogs, treatment of wounds and vaccination of people are the main approaches of rabies control in Kenya (Kagira and Kanyari, 2012), mass vaccination of dogs is the most feasible way of rabies control (Lembo *et al.*, 2010). Human rabies cases are commonly diagnosed by history of animal bite and the presenting symptoms. Human animal bites and PEP statistics provides vital data that can be used to detect trends on disease incidence, burden and impact of human rabies, improve allocation of medical and veterinary resources and assess impacts of rabies control measures (Cleaveland *et al.*, 2014; Kagira and Kanyari, 2012; Kitala*et al.*, 2000).

The first report of rabies in Kenya was in South Nyanza in 1902, but the first confirmed case was in1912 in a dog which was previously involved in a fight with a jackal in Nairobi (Hudson,1944). In 1928, the first case of human rabies was documented in a woman from the Lake Victoria basin region in Western Kenya (National Rabies Elimination Strategy, 2014). In the 1930s and 1940s there were a number of rabies epizootics which triggered systematic andsustained vaccination of dogs in mid-1950s and 1960s that virtually eliminated the disease by 1973 (National Rabies Elimination Strategy, 2014). However, two outbreaks in Taita/Taveta (1974) and Transmara (1979) districts led to widespread distribution of the disease in the country (Kariuki, 1998). The incidence increased after 1980 which may be attributed to the collapse of the vaccination program in the 1970s (National Rabies Elimination Strategy, 2014), although it may also mean increased level of surveillance and improved diagnostic capabilities (Perry, 1992). The reported incidence decreased after 1987 and this may mean either improved control strategies or deteriorating surveillance (Macharia *et al.*, 2003). Today, rabies is morewidespread in the country than at any time in its history (National Rabies Elimination Strategy, 2014) with an average of 82 confirmed animal cases each year (Macharia *et al.*, 2001) and an estimated annual incidence of 1000 to 2000 human rabies deaths in the whole country (National Rabies Elimination Strategy, 2014). However, data in OIE World Animal Health Information System indicated that there were 3 human rabies cases in 2012, and 3 in 2013 in Kenya (OIE, 2014). Kitala *et al*. (2000) estimated a rabies incidence of 2.5 rabies deaths per 100,000 people and 232 bites per 100,000 people during an active surveillance in Machakos district only. As is common with reports submitted to various authorities in Africa, the number of dog rabies cases varies. For example, Kenya reported 21 dog rabies cases in 2011, 42 in 2012, and 38 in 2013 to the OIE (OIE, 2014). In another report

submitted to Southern and Eastern African Rabies Group (SEARG), 35 positive rabies cases in dogs were confirmed in 2011, and 50 in 2012 (Kiambi, 2013). These variations show that there are gross errors of either omission, miss-reporting or under-reporting. It is expected that human and animal rabies could be higher than officially reported. Poor surveillance and diagnostic capacity has led to scarce data and underestimation of the reported burden of rabies in Kenya by about 70 times in animals and 200 times in humans (National Rabies Elimination Strategy, 2014). Consequently, this has led to low prioritisation of the disease leading to neglect (Cleaveland *et al.*, 2014; Kitala*et al.*, 2000).

Legislations are available in Kenya to enforce the fight against rabies and includes the Rabies Act (Cap 365), the Rabies Ordinance (Cap 214) and the Animal Diseases Act (Cap 364). For example, dog registration and vaccination against rabies is a legal requirement and compulsory especially for dogs kept in urban areas under the Rabies Act Chapter 365 (Laws of Kenya, 2012). These laws need strict enforcement to support the control of the disease.

Apart from the occasional vaccination campaigns, no major steps have been taken by the government to promote awareness, responsible dog ownership and appropriate health seeking behavior in the event of dog bites in communities in the past (Mucheru *et al.*, 2014). Fortunately, the Kenyan government together with other stake holders have shown willingness and efforts to control rabies. A National Rabies Elimination Strategy by the Ministry of Agriculture, Livestock and Fisheries and Ministry of Health through the Zoonotic Disease Unit in collaboration with stakeholders aimed at eliminating human dog-mediated rabies by the year 2030 in Kenyawas launched in 2014. The strategy provides a guide for systematic reduction of rabies risk through

sustained mass dog vaccinations, pre and post-exposure prophylaxis and public education. Kisumu, Siaya, Machakos, Kitui and Makueni Counties have been selected as the pilot areas to demonstrate success before scaling up to the rest of the country (National Rabies Elimination Strategy, 2014). However, no major steps have been undertaken since the launch of the strategy. Lack of baseline data on knowledge, attitudes and practices regarding rabies could possibly be one of the reasons for delayed action (Mucheru *et al.*, 2014).

2.1.2.2 Methods of transmission

The main route of transmission is by bites of infected animals. Other methods include oral (milk, cannibalism, scavenging and predation), aerosol (in bat caves or when a susceptible host is in close proximity with a rabid animal), trans-placental, tissue transplants and skin wound or mucous membrane contamination with fresh virus-laden saliva (WHO, 2007; Swango, 1995; Radostits *et al.*, 1994). In the olfactory end organ in the nares, the neuroepithelial cells are in direct contact with the body surface. These cells extend directly to the olfactory bulb in the brain and thus provide a route by which the virus reaches the central nervous system after aerosol exposure (Radostits *et al.*, 1994).

After a bite, the virus replicates locally in muscle cells and remains around the wound for weeks or months (Appel and Carmichael, 1979). The virus then reaches neuromuscular spindles, and then the peripheral and central nervous system centripetally at which point the disease develops rapidly. In the brain, the virus multiplys in neurons and then migrates along nerves centrifugally to the salivary glands and is shed in saliva (Warrell and Warrell, 2015; Appel and Carmichael, 1979).

The incubation period of rabies in dogs is 3 to 8 weeks, but may vary from 1 week to a year (Swango, 1995). This incubation period is highly dependent on the location of the bite and the amount of the virus present at exposure. Bites on the head, face and neck carry shorter incubation periods (Swango, 1995). In humans, rabid-dog bites close to the brain carry more risk of developing rabies with a mortality of 30- 60% while those far located have a mortality of 15-40% if left untreated (Cleaveland *et al*., 2001).

A few dogs have been reported to survive clinical rabies (Appel and Carmichael, 1979). A few dogs, foxes and racoons have been found to have serological evidence of infection without showing any clinical disease (Appel and Carmichael, 1979). This is common in bats (Appel and Carmichael, 1979) where the virus multiplies in fatty tissues without invading the nervous tissues. This makes them symptomless reservoirs of the virus (Radostits *et al.,* 1994,Swango, 1995).

2.1.2.3 Zoonotic implications

Rabies is transmissible to humans mainly by animal bites. Veterinarians are at a higher risk of exposure due to their occupation. Most human exposures are caused by domestic animals and not wild animals. Thus, wild animlas play a minor role in rabies transmission to humans compared to domestic animals (Radostits *et al.,* 1994). Globally, rabies kills up to 60,000 people a year, most of them (95%) in Africa and Asia (Abbas*et al.,* 2011). There are estimated 2000 human rabies deaths in Kenya every year (National Rabies Elimination Strategy, 2014). However, incidence of human rabies in Kenya cannot be estimated accurately due to under-reporting and lack of laboratory confirmation. In most hospitals, a patient is suspected to have rabies only on the basis of animal bite history and presenting symptoms (Macharia *et al.*, 2001).

From 1982 to 1987, 5264 human animal bites and 11 human rabies deaths were reported in Machakos district of Kenya (Kitala *et al.,* 1993). The same study reported an estimated annual human dog bite prevalence of 40 per 100000 people in the same district of Machakos. With the current human population in Kenya, this prevalence is expected to be high (Macharia *et al.,* 2001). Controlling canine rabies through vaccination is by far the most effective method of controlling human rabies (Radostits *et al.,* 1994).

2.1.3 Clinical presentation

The incubation period of rabies in dogs is 3 to 8 weeks, but may vary from 1 week to a year depending on the innoculated viral dose, site of bite and the ease of the virus reaching nerve endings (Swango, 1995). After reaching nerve endings, the disease develops within days or weeks. Older animals have longer incubation periods than younger ones (Appel and Carmichael, 1979). Local treatment with hyperimmune serum or cutting of nerves up to 48 hours after infection prevents development of the disease (Appel and Carmichael, 1979).

Clinically, rabies presents in three defined stages namely the prodromal, excitative and paralytic stages (Swango, 1995; Radostits *et al.,* 1994). The prodromal stage is the initial stage of rabies and is characterised by change in behavior. Friendly pets become agressive and hide out of fear while wild animals lose their fear of humans or nocturnal animals are seen during the day and in locations where they would normally be afraid to go. This stage in wild animals has been described by the term “friendly foxes” (Swango, 1995). This stage lasts 1 to 3 days. This is then followed by the excitative or hyperactive stage. Animals in this stage are easily excited by external stimuli and would bite on anything in their vicinity including stones, metal and wood, and snap at imaginary objects (Radostits *et al.,* 1994). The dog produces abnormal sounds. Thus

this stage is explained by the term “mad dog”. If the hyperactivity is prominent, the dog is described as having “furious rabies” (Swango, 1995). However, some animals show hyperactivity for a very short duration, or the hyperactivity is not prominent. Such animals are oblivious of their environment and appear to be in a state of stupor. These animals are described as having “dumb rabies”. This stage may be absent as in dumb rabies or it may last 3 or 4 days (Swango, 1995).

During the excitative stage, dogs may run as far as 20 miles in a day and attack any animal they encounter. Self mutilation is common in this stage. After several days of disappearance, dogs return with paralytic rabies (Appel and Carmichael, 1979).

Paralytic rabies is the last stage of the disease. The virus damages motor neurons resulting to paralysis, usually ascending ataxia of hind limbs and incordination. Animals with unexplained paralysis should be handled as rabies suspects (Swango, 1995). Paralysis of muscles of deglutition causes inability to swallow and drooling of saliva. The mouth remains open and the tongue is protruded (Radostits *et al.,* 1994). This stage lasts 1 to 2 days and is followed by death due to respiratory paralysis. Death occurs 2 to 7 days after onset of clinical signs (Swango, 1995).

Source of the virus may influence the clinical syndrome seen in animals. It has been demonstrated that “fixed” virus causes paralytic form while “street” virus causes the furious form. There is also a geographical influence on presentation with most animals infected in the Americas showing paralytic form while those in Africa and India showing mainly the furious form (Radostits *et al.*, 1994).

Drooling saliva, open mouth and protruded tongue leads to suspicion of poisoning or foreign body stuck in the mouth and owners get exposed to infected saliva while trying to help their dogs.

Salivation, indigestion, pica, bladder and anal paralysis, and increased libido associated with rabies are signs that suggest involvement of the autonomic nervous system and endocrine glands (Radostits *et al.*, 1994). There is lack of reliable antemortem methods of diagnosing rabies, and therefore caution is advised when dealing with suspect cases to avoid human exposure (Swango, 1995).

2.1.4 Diagnosis

Rabies should be suspected based on the clinical presentation although confirmation is done by postmortem Fluorescent Antibody Test (FAT) on impression smears of fresh brain and brain stem tissues (Macharia *et al.*, 2003). Other tests are mice intracerebral innoculation test and histological search for Negri bodies in neurons (Radostits *et al.*, 2000). Fresh tissues give best results, although frozen and glycerinated ones may also give satisfactory results (Appel and Carmichael, 1979). At least 2 of the mentioned tests should be used on all specimens before making conclusions (Radostits *et al.*, 1994). Rapid diagnosis of rabies *intra vitam* in humansis possible by PCR on saliva, cerebrospinal fluid, respiratory secretions, tears and skin biopsies and by immunofluorescent staining of skin sections and corneal impressions (WHO, 2015; Warrell and Warrell, 2015).

Fluorescent Antibody Test is 99% acurate in diagnosing rabies and gives results in 2 hours (Radostits *et al.*, 2000). If the virus is found in the brain, there is possibility of finding it in the saliva and salivary glands. If a suspected rabid animal had bitten a human being or another animal and its FAT results are negative, its specimens are subjected to intracerebral mice innoculation test. This test takes about 2 to 3 weeks to give conclussive results (Radostits *et al.*, 1994; Swango, 1995). After innoculation of mice with suspect brain material, the incubation

period is 4 to 18 days and death occurs in 7 to 21 days. After rabies signs appear in the mice, the brain tissue is harvested and subjected to FAT (Radostits *et al.,* 1994).

The presence of intracytoplasmic inclusions (Negri bodies) in neurons as observed in histological slides is pathognomonic for rabies in dogs. However, the inclusions are not always present, and their absence does not rule out rabies (Swango, 1995). Histological search for Negri bodies in neurons should give results in 48 hours (Radostits *et al.,* 1994). The inclusions are usually found in the cytoplasm of neurons of the hippocampus and Purkinje cells in the cerebellum. These inclusions are found in the axons and in the dendrites and never in glial cells. This is the difference between Negri bodies and Canine Distemper (CD) inclusions. CD inclusions are found in neurons as well as in glial cells, and in the nucleus as well as in the cytoplasm. Many neurons contain viral antigen and not negri bodies, thus FAT is more reliable (Appel and Carmichael, 1979). In Kenya, the Central Veterinary Investigational Laboratories (CVIL) carry out animal and occasionally human rabies diagnostics (WHO, 2014).

2.1.5 Treatment and prevention

There is no documented treatment for rabies. Rabid animals should be placed in strict isolation or euthanised and their brain examined to confirm rabies (Swango, 1995).

Immunization of dogs and cats, and control of stray animals prevents rabies infections. Mass vaccination of dogs has been accepted as the most effective method of controlling human and animal rabies (Radostits *et al.,* 2000). Dogs and cats should be vaccinated at 3 or 4 months of age. This is then boosted 1 year later and then annually or triennially thereafter depending on whether a 1-year or 3-year vaccine was used. A 3-year vaccine is the best to use since it increases the percentage of immunized animals. Most of the vaccines contains inactivated rabies virus of

tissue culture origin (Swango, 1995). Low Egg Passage (LEP) vaccine is only safe in dogs. It is recommended to use the High Egg Passage (HEP) vaccine in all species so as to avoid mortalities associated with LEP vaccine (Radostits *et al.,* 1994). Intramuscular innoculation is more effective than subcutaneuos inoculation (Appel and Carmichael, 1979).

Reduction of wild animal population by trapping has been attempted in efforts to control rabies. Trapping is safer than poisoning. Oral vaccination of wild canids with virus-containing baits has been used successfully in limited areas (Appel and Carmichael, 1979).

Washing bite wounds and animal scratches with soap or detergent and water immediately and thoroughly after exposure prevents establishment of infection. This is the most effective home level measure to prevent rabies after an animal bite for both animals and humans andtherefore should be a very important part of public education programs for rabies control (Radostits *et al.,* 1994; Balogh *et al.,* 2001). After carefully rinsing the soap or detergent, 70% alcohol, a tincture or aqueous solution of iodine or a 0.1% quaternary ammonium compound should be applied to the wound to inactivate any virus present (Appel and Carmichael, 1979). Antirabies serum should be innoculated deep and around the bite wound to neutralise the rabies virus (Appel and Carmichael, 1979).

Post-exposure vaccination of animals is of no value in preventing rabies as death usually occurs before establishment of immunity (Radostits *et al.,* 1994). Furthermore, antirabies serum is not available for use in animals (Radostits *et al.,* 1994). Suspect animals that have bitten humans should not be euthanised immediately. Such animals should be isolated and observed for development of rabies to aid diagnosis (Radostits *et al.,* 1994).

Livestock bitten by rabid animals should be slaughtered immediately. Its meat can be eaten without risk within 7 days after the bite. If the owner is unwilling to have this done, the animal should be vaccinated and confined for 6 months. No products from clinically rabid animal should be used for animal or human consumption (Appel and Carmichael, 1979).

2.1.6 Human rabies vaccination

The human diploid cell vaccine (HDCV) that contains inactivated rabies virus is available for both pre and post-exposure vaccination using 1.0ml intramuscular dose. Pre-exposure vaccination may also be done with a smaller dose of 0.1ml intradermally (Warrell and Warrell, 2015; WHO, 2007; Swango, 1995). Other types of vaccines include Purified Chick Embryo Cell Vaccine (PCEC), Purified Vero Cell Rabies Vaccine (PVRV) and Purified Duck Embryo Vaccine. Post-exposure treatment with HDCV is recommended for people with known or probable exposure to rabies virus (WHO, 2007).Immeditae post-exposure use of modern vaccines combined with proper wound care and Rabies Immune Globulin (RIG) is almost 100% effective in preventing rabies, even following high-risk exposure (WHO, 2007).

Vaccination protocols are defined by categories of risk of exposure which are continuous, frequent, infrequent and rare. The rare-risk category includes the entire human population. Pre-exposure vaccination is not recommended for this category. Pre-exposure vaccination is recommended for people in the other three categories. People in the continuous-risk category are laboratory workers in research and biologics production who work with virulent rabies virus in high concentrations on a regular basis. People in the frequent-risk category includes rabies diagnostic laboratory workers, spelunkers, veterinarians, veterinary technicians, and animal control and wildlife workers in areas with epizootic rabies. The infrequent-risk category includes

people in the frequent-risk category but in areas of low rabies endemicity, in addition to travellers or workers in foreign countries with epizootic rabies (WHO, 2007).

The primary pre-exposure vaccination consists of three doses on day 0, 7 and 21 or 28 (Warrell and Warrell, 2015;WHO, 2007). People in the continuous and frequent risk categories should have their rabies antibody titres periofically monitored and have a single boster dose of HDCV when titres are below significant levels. Routine boosters are recommended every 2 or more years. Booster doses are not recommended for people in the infrequent-risk category (WHO, 2007).

For people who have had pre-exposure vaccination, only 2 doses of post-exposure vaccine are needed 3 days apart regardless of the time since the vaccination (Warrell and Warrell, 2015). For those without pre-exposure vaccination, 5 doses of post-exposure vaccine are needed, on days 0, 3, 7, 14 and 28, in combination with one dose of rabies immune globulin at a dosage of 20 IU/ kg on day 0 (Warrell and Warrell, 2015; WHO, 2007). Since twentieth century B.C., the owner of a mad dog whose bite caused human death faced strict penalties. Today, dog owners whose dog bites a person are charged with the responsibility of providing PEP (Swango, 1995; Balogh *et al.*, 2001).

Most often than not, PEP is not available in government hospitals in African countries and victims of dog bites have to get them from private clinics at high costs. Victims are also forced to travel long distances to look for PEP. Since such victims ends up not receiving the appropriate PEP, wound washing with soap and water should be emphasized so as to reduce the risk of developing rabies (Balogh *et al.*, 2001).

Community surveys shows high level of negligence by both the victim and the health care providers as most victims of dog bites do not get PEP (Abbas *et al.*, 2011). Poor households can not afford the PEP, and this affects its delivery. Moreover, many remote health facilities in Africa do not stock PEP. Victims of animal bites are therfore forced to travel long distances to obtain treatment, further increasing the costs (National Rabies Elimination Strategy, 2014).

2.1.7 Public education and control strategies

The aim of any rabies control program should be to protect people from the disease. Rabies in dogs and that reported in humans are closely related (Appel and Carmichael, 1979). Vaccination and environmental control is the most cost-effective strategy to eliminate dog rabies and thus human rabies (WHO, 2004). Recent successes of rabies control through mass vaccination of dogs have been reported in South America and Asia (Abbas *et al*., 2011). When rabies is controlled in dogs, human rabies cases and PEP drops correspondingly (Appel and Carmichael, 1979).

The domestic dog is the main vector of rabies as 94% of human rabies are caused by dog bites (Abbas*et al*., 2011). Elimination of dog rabies through vaccination and environmental control is the most cost-effective strategy for preventing human rabies (WHO, 2004).Vaccinating 70% of the dog pupulation will eliminate dog rabies and hence human rabies (Cleaveland *et al*., 2014). However, the necessary level of coverage will be influenced by dog population demographics and dynamics and disease transmission dynamics (Cleaveland *et al*., 2010). Animal Birth Control (ABC) and habitat modification, for example by reducing the amount of food available for strays, will reduce dog population and maintain it at the new level. Sterilising 80% of the dog population disrupts rabies transmission (Cleaveland *et al*., 2010). Human attitude is a very important

determinant of dog population size. For example, cultural tolerance will prevent complete elimination of stray dogs (Cleaveland *et al*., 2010).

Government and community support are important factors in any rabies control program to ensure success. Reliable data will help win commitment and support of the relevant stakeholders (Balogh *et al.*, 2001).

In addition to controlling the number of susceptible domestic and wild animals, rapid and reliable diagnosis, surveillance and reporting are essential in rabies control (Appel and Carmichael, 1979). Collaboration between the veterinary department, the public health department and municipalities is an important factor in rabies control. Such intersectoral efforts are not common in Africa (Abbas *et al*., 2011).

2.1.8 Management of dogs that have bitten a human

A dog showing neurological signs at the time it bit someone, or stray dog that bites a human should be euthanised immediately and its brain submitted to a diagnostic laboratory for rabies diagnosis. If rabies virus is not detected in the brain of the dog, the bitten person is considered unexposed. If the virus is detected, the bitten human should be given PEP immediately (Swango, 1995).

If the dog that bit a human is healthy and owned, it should be confined for 10 days and observed for signs of rabies. This 10 day observation period helps to determine whether the bitten person is exposed to rabies. This determination is based on the fact that dogs shed rabies virus in saliva only for a few days before development of clinical rabies (Swango, 1995). Six (6) days before onset of clinical signs is the earliest that rabies virus has been detected in saliva of dogs and

therefore, if the dog remains healthy for 10 days after biting a human, such people are considered unexposed (Swango, 1995).

2.1.9 Management of exposed or suspected dogs

A vaccinated dog bitten by a proven rabid animal or by a wild animal in a rabies endemic area should be revaccinated immediately and observed for 90 days (Swango, 1995). Unvaccinated dogs exposed to rabies virus should be euthanised or isolated for 6 months and vaccinated on the 5^{th} month of isolation. If still healthy, the dog is released back to the owner at the end of 6 months (Swango, 1995).

All animals suspected to be rabid should be isolated for at least 72 hours to allow development of signs to aid diagnosis. Such animals should not be euthanised early before clinical signs have developed as this may cause false negative laboratory diagnosis (Appel and Carmichael, 1979).

2.1.10 Free roaming dogs and rabies

Free roaming dogs (FRDs) are those dogs that are on public areas and not currently underdirect control. They are also reffered to as ‘free ranging’ or ‘stray’ dogs and include both owned and unowned dogs (www.wspa-international.org).

There is an enduring misperception that a large proportion of dogs in Africa are ownerless or ‘stray’ dogs that are not accessible for vaccination (Lembo *et al.*,2010). This has led to policy makers being reluctant to invest in dog vaccination campaigns and are directing resources towards ineffective strategies, such as culling (Cleavaland *et al.*, 2014). Dog ecology studies shows that, although most dogs in Africa are free-roaming, the number of ownerless dogs remains very low as majority are owned, and at least one household claims some responsibility,

including presentation for vaccination (Lembo *et al.*, 2010; www.wspa-international.org).Thus the level of dog ownership and accessibility is sufficient to enable control of rabies through mass vaccination of dogs (Cleavaland *et al.*, 2014).

Human behavior and attitude facilitates the existence of unowned dogs, and, in reality, "stray dogs" belong to the community (Ratsitorahina *et al.*, 2009). In mostof the African comminities, the issue of roaming dogs seems not to be one of a lack of ownership, but rather an inability or unwillingness by owners to confine their dogs (Lembo *et al.*, 2010).

Roaming dogs suffer welfare problems and also presents a human health risk, most notably rabies (Hiby *et al.*, 2011). Increase in the number of stray dogs leads to an increase in dog bites and rabies cases in humans (Abbass *et al.*, 2011). Advocating for responsible dog ownership and immunisation of all dogs are important areas that rabies control efforts should target.

3 CHAPTER THREE

3.1 Materials and methods

3.1.1 Study areas: Kisumu and Siaya counties, Kenya

Kisumu County is one of the new developed counties of Kenya. Its borders follow those of the original Kisumu District, one of the former administrative districts of the former Nyanza Province in Western Kenya (Fig 3.1). Its headquarters are in Kisumu City. It has a human population of 968,909 (National Census, 2009). The land area of Kisumu County totals 2,085.9 km² and lies between latitude 0° 20’ South to 0° 50’ South and longitude 33° 20’ East and 35° 20’ East. The county has 7 sub-counties namely Kisumu West, Kisumu Central, Kisumu East, Seme, Muhoroni, Nyando and Nyakach.

Siaya County is one of the counties in the former Nyanza Province in the Southwest part of Kenya. It is bordered by Busia County to the North, Kakamega County and Vihiga County's to the Northeast and Kisumu County to the Southeast (Fig. 3.1). It shares a water border with Homa Bay County which is located South of Siaya County. It has a human population of 842, 304 (National Census, 2009). The total area of the county is approximately 2,530 km². The county lies between latitude 0° 26’ South to 0° 18’ North and longitude 33° 58’ East and 34° 33’ East. Siaya has six subcounties namely Alego, Bondo, Gem, Rarienda, Ugenya and Ugunja.

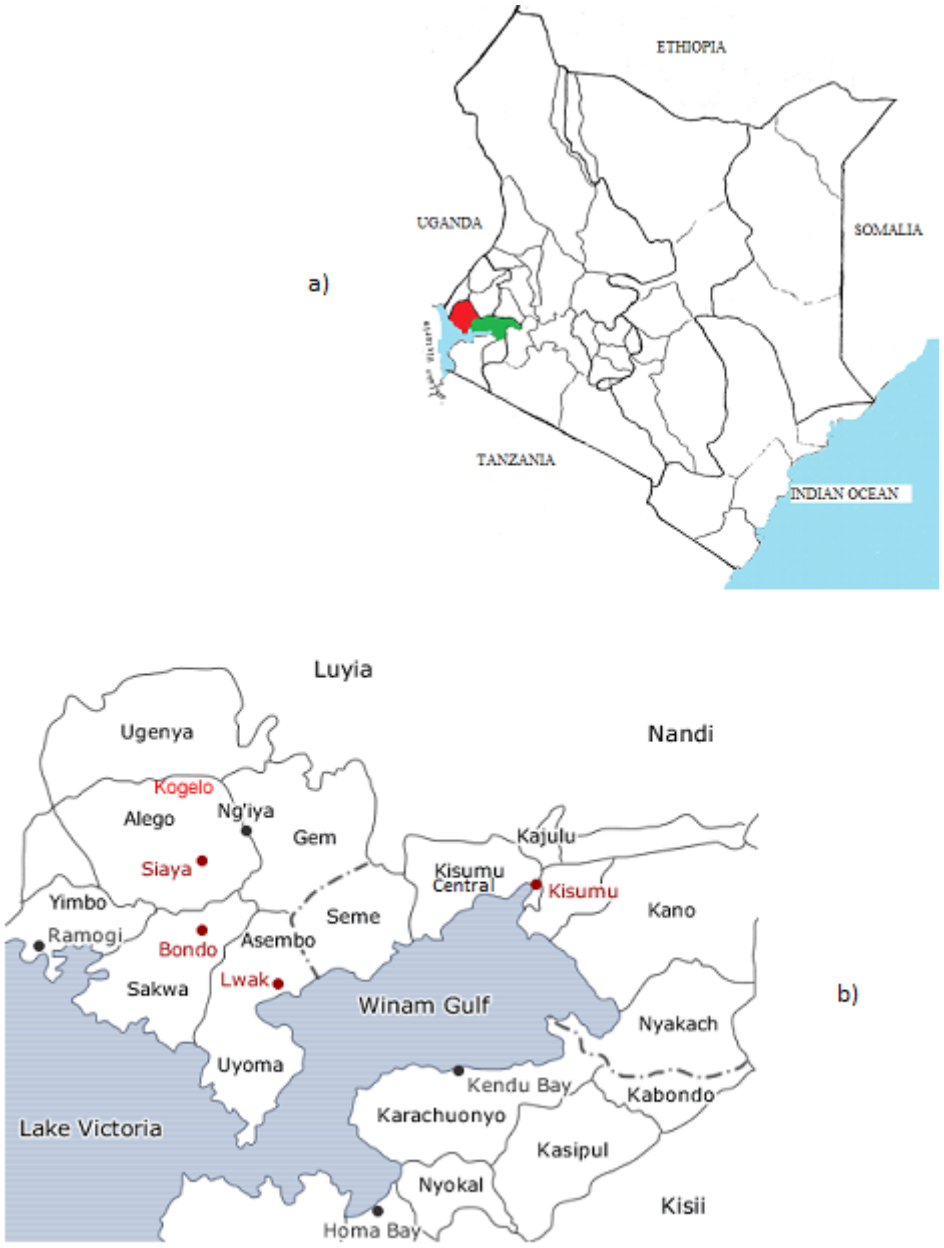

Figure 3.1: a) Map of Kenya showing the location of Kisumu (green) and Siaya (red) counties in relation to the rest of the country; b) Blown up map of study locations.

Both counties are characterized by large numbers of free roaming dogs and have reported high numbers of cases of human rabies. The two counties have also been selected as the pilot areas for the national rabies elimination strategy by the Ministry of Agriculture, Livestock and Fisheries and Ministry of Health through the Zoonotic Disease Unit to eliminate human dog-mediated rabies by the year 2030 in Kenya.

In consultation with the veterinary departments, two sub-counties from each county were purposively selected based on their reported high numbers of animal rabies cases and dog bites. Kisumu Central and Seme subcounties were selected in Kisumu County while Gem and Alego subcounties were selected in Siaya County. Households were randomly selected using a road transect and every third home was included in the study.

Mark-recapture studies were performed in the chosen areas that reflect different habitat types found in rural and urban centres (e.g. residential areas, market places, fishing grounds, slaughter houses, etc.). The study areas, within the selected urban centres, were purposively selected based on their dog populations, incidence of animal rabies, animal bites and existence of free roaming dogs.

3.1.2 Project target groups

The project was implemented in Kisumu Central, Seme, Alego and Gem subcounties. The target groups in this study were dogs (both owned-restricted and free roaming dogs), dog owners, community, municipality workers, public health officers and veterinary officers.

3.1.3 Objective one: To assess community knowledge, attitude and practices (KAPs) on rabies, and the socio-cultural value of dog keeping in selected areas of Kisumu and Siaya counties.

Participatory techniques and questionnaires were used to generate information on the level of the community knowledge, attitude and practice on rabies incidence and human exposure in the study areas. A semi-structured questionnaire (Appendix I) was prepared and pretested before the study commenced. The questionnaire had both open and closed-ended questions, and captured details of individual and household characteristics that were used to assess socioeconomic status and education levels. Additional questions covered (a) knowledge of rabies, including a description of the disease, mode of transmission, outcome, range of species affected and means of prevention and control; and (b) attitudes and practices in relation to rabies prevention strategies and actions towards suspect rabid animals. Further questions were administered to respondents who owned dogs to assess attitudes and practices relevant to rabies control and frequency of vaccination.

Sample size was calculated based on the proportion of knowledge on rabies reported in a previous study (Mucheru *et al.,* 2014) and computed using the formula for estimation of proportions and means (Dohoo *et al.,* 2009) at 95% confindence level and 5% precision as described by Zafar *et al.* (2014). At least 138 respondents from each county were required for the study.

Research personnel were accompanied by sub-village leaders to identify household heads. Questions were asked to household heads or other household members of at least 15 years of age

in the absence of the household head. The interviews were conducted in Swahili and translated in to local language by sub-village leaders as needed.

Participatory focus group discussions (FGD) were done with selected potential key informants who included women group leaders, village elders/ chiefs, public health officers and field veterinary officers/ technicians.

3.1.4 Objective two: To determine stray and owned dog population demographics in selected areas of Kisumu and Siaya counties.

The aim of this assessment was to estimate the size and composition of the dog population in the study areas (both roaming and confined dogs). For the owned dog population, households were randomly selected using a road transect and every third home was included in the study. All houses having dogs were asked to identify and catch their dogs for marking. At the same time, every dog was identified (including those unable to be caught by their owners and free roaming). The age and sex of the dogs were recorded.

Counting of free roaming dogs was undertaken in the selected sub-counties. The exercise was done from 8:00 a.m. to 10:00 a.m. on each counting day as this is the recommended time to conduct mark-recapture (Cleaveland*et al.,* 2010) when stray dogs are most active and visible. Permanent marking material was used to mark counted dogs and avoid repeat counting. The survey consisted of two related elements; a direct observation and counting of roaming dogs.The study was carried out on a daily basis to minimize the disappearance of the mark since the length of time the marks persisted on the dog were unknown. Dogs were marked withpaint usingan automatic spray (Appendix II).Digital photographs were taken to aid in identifying roaming dogs

that were difficult to mark (Appendix III). Dogs were classified as either adults or puppies using visual criteria of body size and allometry, head size and leg length relative to body size. The marking team recorded the total number, sex and estimated age of each dog they marked.

3.1.5 Objective three: To quantify retrospectively the distribution of animal bites in Kisumu and Siaya counties.

A five year retrospective data on animal bites was retrieved from the Kenya Health Information System (www.hiskenya.org) and the Zoontic Disease Unit (www.zdukenya.org). The information was collected and analyzed to understand the trend of the disease in humans based on number of animal bites and their incidence. Incidence of animal bites was calculated using the number of animal bites and the total human population in each of the two counties.

3.1.6 Data management

Data was coded and entered into Microsoft Excel spreadsheet program (Excel, Microsoft Corp 2010, Redmond WA), double checked with the questionnaire information to avoid errors in input and then exported in to STATA satatistical software version 12.0 (STATA Corp., College Station, USA) for cleaning and analysis.

Descriptive tables were generated and descriptive statistics computed from the questionnaires. Answers that contained continuous variables were summarized as means with their 95% confidence intervals. Pearson Chi square test was used to test for association between categorical variables at $p<0.05$ significance level. Student's t test was used to test for difference in various means of continuous variables. The two proportion Z test was used to test for differences in proportions by county. All tests were done at 95% confidence interval. The data was also

summarized as graphs and pie- charts where applicable. All analyses were done for the overall results as well as at the county level where applicable.

4 CHAPTER FOUR

4.1 Results

4.1.1 Respondents' demographics and household sizes

A total of 183 and 168 residents were interviewed in Kisumu and Siaya Counties respectively.In both Kisumu and Siaya, the number of male and female respondents was proportional. Most of the respondents were above 40 years of age and had primary and secondary education levels. The number of people in households ranged from 1 to 22 in Kisumu and 2 to 22 in Siaya with an average 5.8 and 6.4respectively (Table 4.1).The mean number of people per household was significantly higher in Siaya than in Kisumu (p= 0.0285).

Table 4.1: Respondents' demographic data and household sizes

	Kisumu	Siaya
Gender	%	%
Male	50.27	53.57
Female	49.73	46.43
Education status	%	%
Illiterate	13.11	5.95
Primary	34.97	36.90
Secondary	32.79	48.81
Tertiary	19.13	8.33
Number of households	183	168
Average number of people	5.8	6.4
Range	1 – 22	2 – 22

4.1.2 Type of homestead fencing

Only 7.1% and 14.9% of the homesteads in Kisumu and Siaya respectively had a full fence capable of restraining dogs in the compound (Fig 4.1). A significantly higher proportion of households in Kisumu than in Siaya (p= 0.0002) did not have a fence (Table 4.2).

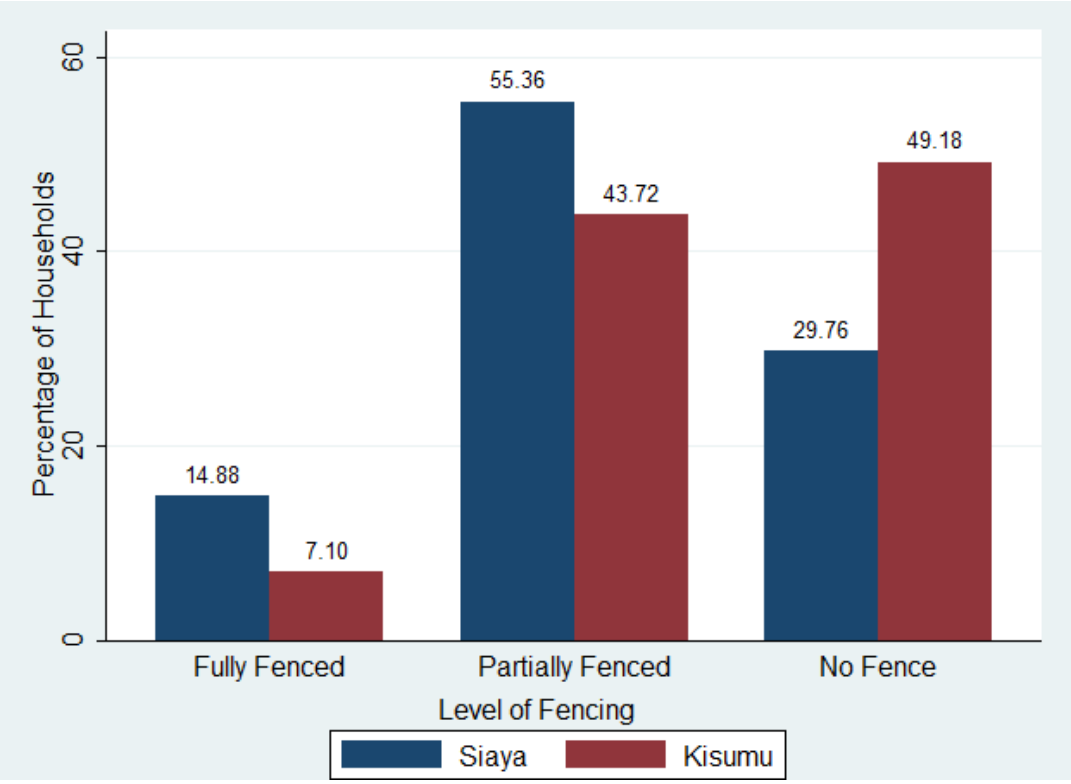

Figure 4.1: Level of homestead fencing in Kisumu and Siaya

Table 4.2:Two-sample Z test of different types of homestead fencing in Kisumu and Siaya

Type of Fencing	P Value	Remarks
No fence	0.0002	Kisumu had a significantly higher proportion
Partially fenced	0.0293	Siaya had a significantly higher proportion
Fully fenced	0.0192	Siaya had a significantly higher proportion

4.1.3 Knowledge, attitude and practices concerning dog ownership

4.1.3.1 Existence of dogsin households

In Kisumu and Siaya, 61.8% and 71.4% of the respondents interviewed had at least one dog respectively. A total of 259 and 299 dogs were counted in Kisumu and Siaya respectively. Most of the dogs were males giving a male: female ratio of 1.4:1 in Kisumu and 1.7:1 in Siaya. Over 70% of owned dogs in both counties were adults giving an adult: puppy ratio of 2.6:1 and 2.8:1 in Kisumu and Siaya respectively. In Kisumu, the average number of dogs per household was 2.3 with a range of 1-6, while that in Siaya was 2.5 with a range of 1-11 (Table 4.3). There was no significant difference (p= 0.3446) between the mean number of dogs kept in the two counties.

Table 4.3: Existence of dogs in households

Existence of dogs	Kisumu	Siaya
Yes	61.75%	71.43%
No	38.25%	28.57%
Number of dogs counted	259	299
Averange number of dogs	2.3	2.5
Range	1 – 6	1 – 11
Males	57.92%	62.54%
Females	42.08%	37.46%
Adults	71.81%	73.91%
Puppies	28.19%	26.09%

4.1.3.2 Reasons for dog keeping

In both counties, dogs were mainly kept for home guarding (Table 4.4).

Table 4.4: Reasons for dog keeping

Reason for dog keeping	Kisumu (%)	Siaya (%)
Home guard	98.11	100.00
Salon pet	1.89	0.00

4.1.3.3 Dog confinement

In Siaya, 65.6% of the respondents indicated that they restrict movement of their dogs while in Kisumu 68.6% said they don't (Fig. 4.2). A significantly ($p < 0.001$) higher proportion of owned dogs in Kisumu were free to roam than that in Siaya (Table 4.5).

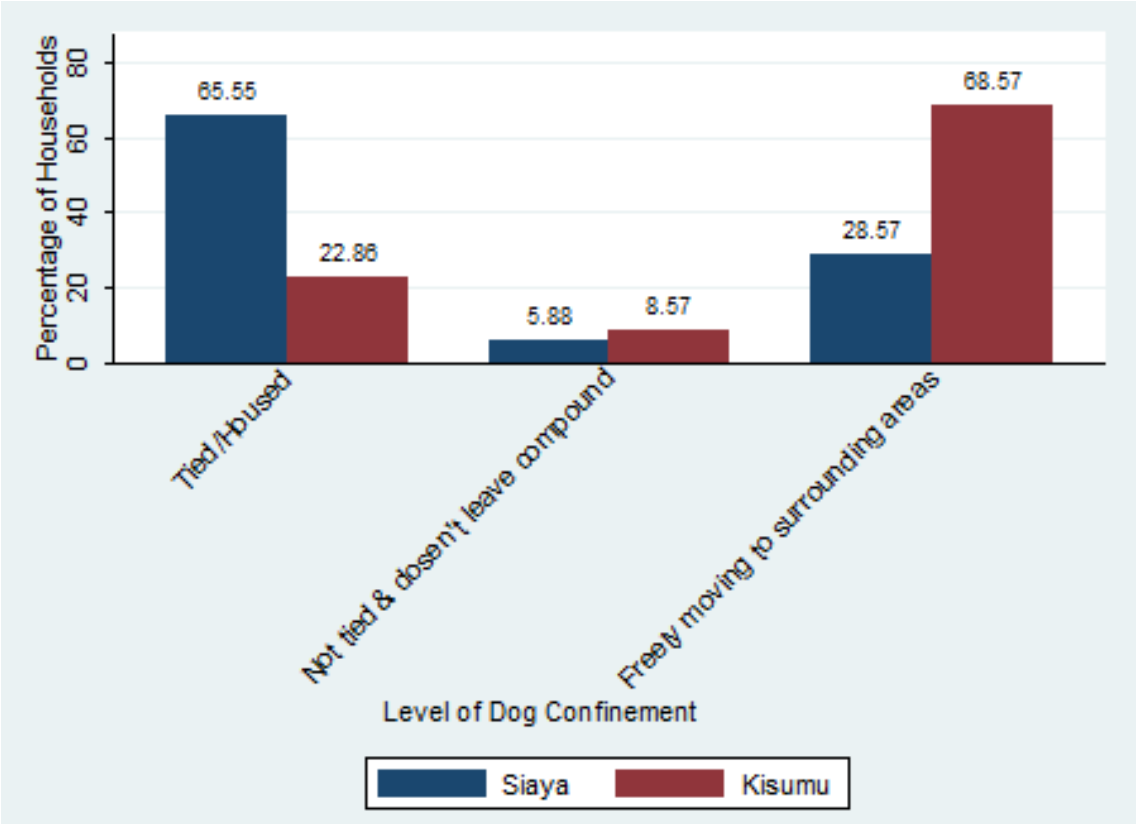

Figure 4.2: Level of owned dog confinement in Kisumu and Siaya

Table 4.5: Two-sample Z test of level of dog movement restriction in Kisumu and Siaya

Level of dog restraint	P Value	Remarks
Freely moving to surrounding areas	< 0.001	Kisumu had a significantly higher proportion
Not tied but dosen't leave compound	0.5203	No significant difference between the counties
Tied/Housed	< 0.001	Siaya had a significantly higher proportion

4.1.3.4 Types of dog feed

In both counties, most of the households fed their dogs on kitchen leftovers (Fig.4.3). However, the proportion of owned dogs that depended on scavenging in Kisumu (36.3%) was significantly higher ($p < 0.001$) than that in Siaya(13.6%) (Table 4.6).

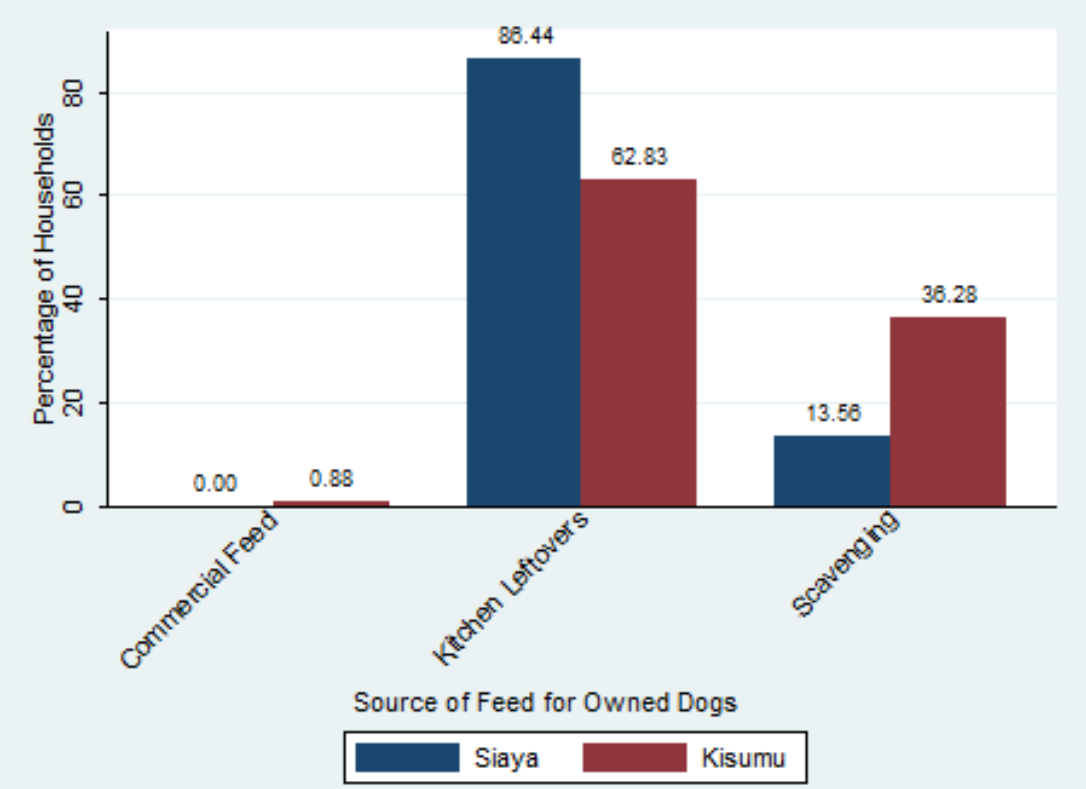

Figure 4.3: Source of feed for owned dogs in Kisumu and Siaya

Table 4.6: Two-sample Z test of different types of dog feed in Kisumu and Siaya

Level of dog restraint	P Value	Remarks
Scavenging	< 0.001	Kisumu had a significantly higher proportion
Kitchen leftovers	0.0001	Siaya had a significantly higher proportion
Commercial feed	0.3017	No significant difference between the counties

4.1.3.5 Value attached to dogs

Other animals kept in the study areas included cattle, sheep, goats, cats and chicken. Qualitatively, a higher socio- economic value was attached to cattle, goats and sheep than dogs. This was evidenced by the little care given to dogs than to livestock in terms of provision for housing, food and veterinary care. Most of the respondents considered dogs a responsibility of young boys, unlike livestock that was owned by the head of the household. Cats and chicken were the least valued.

4.1.3.6 Owned dog population

The human: dog ratio was 4.1:1 in Kisumu and 3.6:1 in Siaya. Using these ratios and the 2009 national census statistics of 968,909 and 842,304 human populations, then the owned dog population in Kisumu and Siaya counties could be approximated to 236,319 and 233,973 dogs respectively.

4.1.4 Free roaming dog population demographics

A total of 386 free roaming dogs were counted in both counties; 196 in Kisumu and 190 in Siaya. Over 60% of these dogs were males giving a male to female ratio of 1.5: 1 in both counties. Most

of these dogs, 86.73% in Kisumu and 81.05% in Siaya, were adults. The adult to puppy ratio was 7:1 and 4:1 in Kisumu and Siaya respectively (Table 4.7). Most of the roaming dogs were in poor body condition with various illnesses. The most common illnesses were mange and physical injuries, most of which were inflicted by the local people who considered roaming dogs a nuisance (Figures 4.4 and 4.5).

Table 4.7: Summarized free roaming dog population demographics

Roaming dog population structure	Kisumu	Siaya
Number of dogs counted	196	190
Males	60.20%	60.53%
Females	39.80%	39.47%
Adults	86.73%	81.05%
Puppies	13.27%	18.95%

Figure 4.4: A free roaming dog with eye injury inflicted by the local people

Figure 4.5: Free roaming dogs with wounds inflicted by the local people

4.1.5 Knowledge on rabies and its transmission

4.1.5.1 Rabies awareness

The main aim of the present study was to assess the knowledge of the communities with regards to rabies.The results indicated that over 90% of the respondents in the study areas had at least heard about the disease. Above 96% said that dogs are the primarily affected animals. However, about 58% of the respondents in both counties could not describe features of a rabid dog. Of the respondents involved in this study, 89% in Kisumu and 74% in Siaya were familiar about the importance of free roaming dogs (FRDs) in rabies transmission. Only 13.2% of respondents in Kisumu and 19.0% in Siaya were aware that rabies could affect livestock (Table 4.8).

Table 4.8: Knowledge on rabies and its transmission

	Kisumu (%)	Siaya (%)
Heard about Rabies		
Yes	91.26	97.02
No	8.74	2.98
Proportion aware that rabies can infect:		
Dogs	100.00	96.93
Cats	39.63	25.77
Livestock	13.17	19.02
FRDs important in rabies transmission		
Yes	89.22	74.23
No	10.78	25.77

4.1.5.2 Zoonotic importance of rabies

Over 90% of the respondents in both counties were aware that rabies is zoonotic. In Kisumu and Siaya, 89%and 95% of the respondents respectively saidthat people get the disease through bites of infected animals.

4.1.5.3 Source of information on rabies

In both counties, school/friends/neighbors were the major sources of information (Fig. 4.6) and there was a significant level of association between acquisition of formal education and knowledge about rabies (p= 0.010).

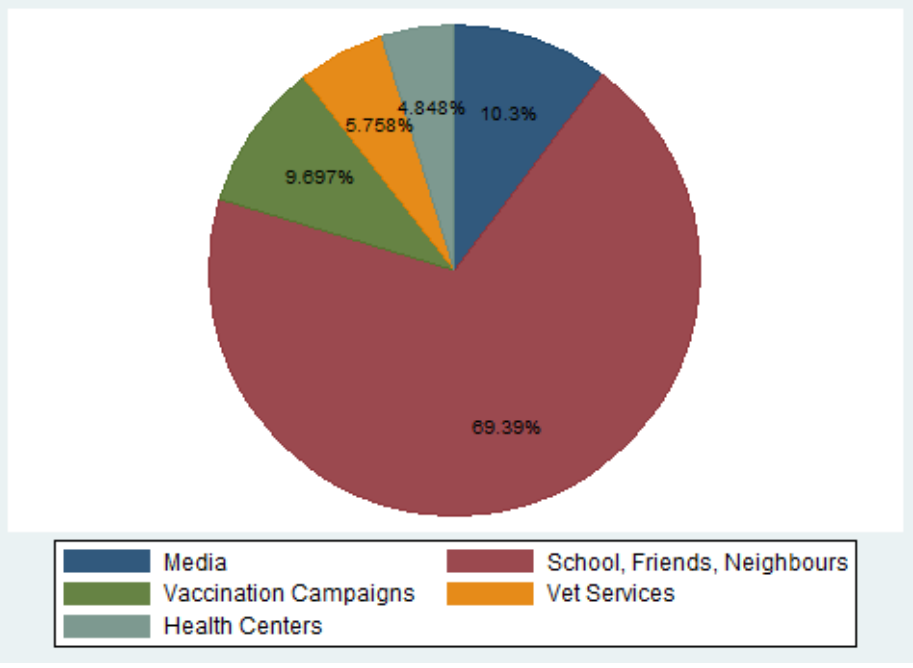

Figure 4.6: Different sources of information on rabies in Kisumu and Siaya

4.1.6 Knowledge, attitude and practices related to dog/animal bite management and prevention of rabies

4.1.6.1 Bite wound management at home level

In Kisumu and Siaya, 52.6% and 32.5% of respondents respectively were not aware of any home level action to take in case an animal or a person were bitten by a suspected rabid animal. Only 8.57% and 26.38% of the respondents in Kisumu and Siaya, respectively, would wash bite wounds with soap and water (Table 4.9).

Table 4.9: Bite wound management

	Kisumu	Siaya
Bite wound management	%	%
Wound wash with water	5.14	5.52
Wound wash with water and soap	8.57	26.38
Apply Alcohol	16.57	26.99
Apply irritants like lemon	0.57	6.75
Traditional treatment	16.57	1.84
No idea	52.57	32.52

4.1.6.2 Health seeking behaviours

Although over 75% of respondents in both counties would seek conventional medical treatment after an animal bite, a number of people in Kisumu (16.6%) considered traditional treatment as

their first line of action after an animal bite. A proportion of respondents, 11.5% in Kisumu and 15.2% in Siaya had at least one household member bitten by a dog in the previous 12 months.

4.1.6.3 Rabies prevention and control strategies

In Kisumu and Siaya, 78.6% and 66.9% respectively were aware of the importance of dog vaccination in prevention of rabies. However, only 20.4% and 19.1% of the respondents with dogs in Kisumu and Siaya respectively had vaccinated their dogs as proved by vaccination records. Of the respondents in Kisumu and Siaya, 71.0% and 78.0% respectively suggested eradication of free roaming dogs by baiting as a method of preventing rabies.However, 16.9% and 27.6% in Kisumu and Siaya respectively had no idea of any rabies prevention strategy (Table 4.10). Most of the respondents in both counties would kill any animal they suspected of having rabies and only about 20% of them would call a veterinarian for further action (Fig. 4.7).

Table 4.10: Rabies prevention/ control strategies

	Kisumu (%)	Siaya (%)
Rabies prevention strategies		
Vaccination of dogs	78.57	66.87
Prevent dogs from roaming	4.55	5.52
No idea	16.88	27.61
Households with vaccinated dogs		
Yes	20.35	19.12
No	79.65	80.88
Options for management of FRDs		
Eradication of free roaming dogs by baiting	70.95	77.98
Animal birth control method	13.97	9.52
No idea	15.08	12.50

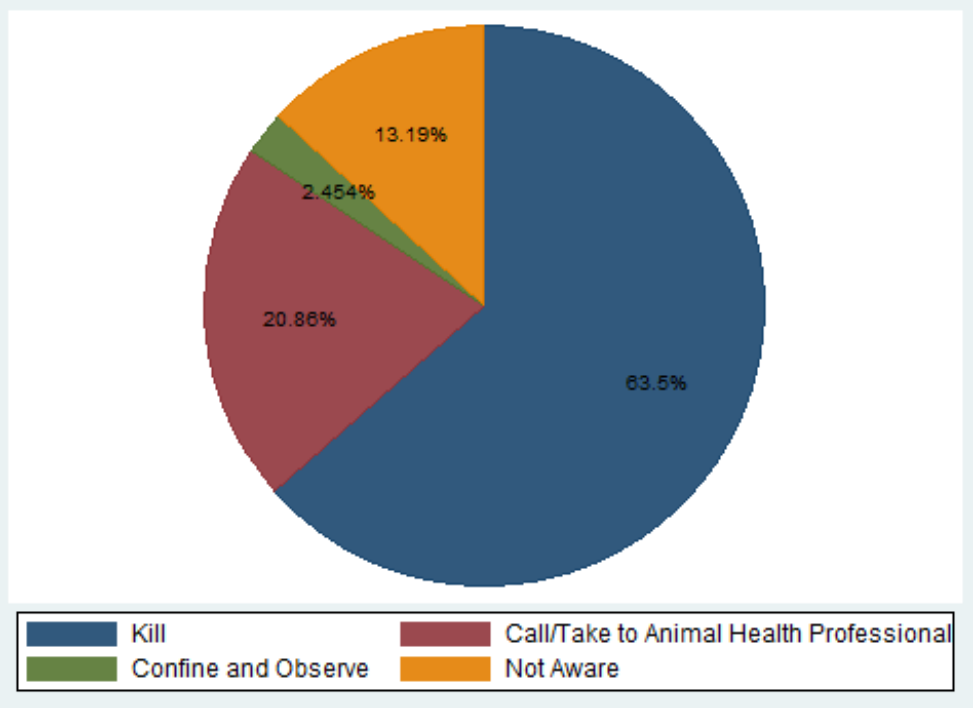

Figure 4.7: Actions taken by communities on suspect rabid animals

4.1.7 Animal bites in humans

In the period2010-2014, a total of 14058 and 17288 animal bite cases were reported in Kisumu and Siaya respectively (Table 4.11). There was a rise in the number of bites and their incidence over the years, and were higher in Siaya than in Kisumu (Figure 4.8).

Table 4.11: Animal bites in humans as recorded in Health Information System

County		2010	2011	2012	2013	2014	Remarks
Kisumu	**Number of bites**	1976	3267	2906	2468	3441	Recorded as animal and snake bites
	Bites/ 100,000 people	204	337	300	255	355	Computed using 2009 census statistics
Siaya	**Number of bites**	1372	3407	3400	4112	4997	Recorded as animal and snake bites
	Bites/ 100,000 people	163	404	404	488	593	Computed using 2009 census statistics

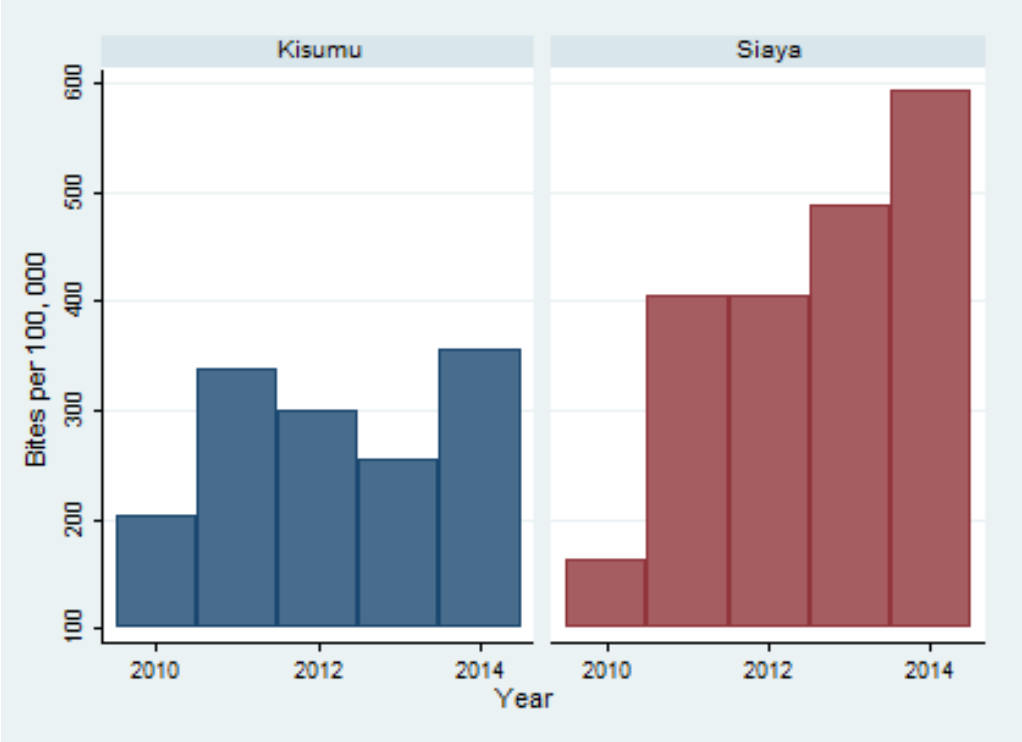

Figure 4.8: Incidence of animal bites per 100,000 people for the period 2010 to 2014

5 CHAPTER FIVE

5.1 Discussion

The knowledge, attitude and practices (KAPs) analysis in this study was aimed at generating information that will help identify knowledge gaps, behavioral patterns and cultural practices that may hinder rabies control and exacerbate disease burden in Kisumu and Siaya counties. This information will act as baseline data for planning, implementation and evaluation of public awareness and rabies control programs. KAPs studies have been used widely to help increase community knowledge and thus change attitude and improve practices that may aid in disease prevention and control (Sambo *et al.*, 2014; Tiembré *et al.*, 2014; Balogh *et al.*, 2001).

Over 67% of respondents in both counties in this study had achieved primary and secondary school education, which compares well with a similar study done in Tanzania (Sambo *et al.*, 2014) where 74% of respondents had achieved primary school education. The fact that majority of people in the study areas have gone to school is a positive attribute towards rabies control as this study has demonstrated that knowledge of the disease is associated with acquisition of formal education.

Households in the study areas were large with an average of 5.8 and 6.4people in Kisumu and Siaya respectively. Majority of the households (61.8% in Kisumu and 71.4% in Siaya) had at least one dog with an average of 2.3 and 2.5 dogs per household respectively. This is comparable to a study done in Abidjan, Côte d'Ivoirewhere71.7% of households had at least one dog (Tiembré *et al*., 2014). The human: dog ratios in Kisumu and Siaya counties of 4.1:1 and 3.6:1 respectively were close to that of 3:1 in Makueni county (Zdu, 2014), 4.5:1 in Madagascar

(Ratsitorahina*et al.*, 2009), 4.5:1 in Zimbabwe (Brooks, 1990), 4.3:1 in Mexico (Flores-Ibarra and Estrella-Valenzuela, 2004) and 4.6:1 in Thailand (Kongkaew *et al.*, 2004). However, these ratios were lower compared to those reported elsewhere: 14.3:1 in Tanzania (Sambo *et al.*, 2014), 8: 1 in Machakos (Kitala *et al.*, 2001), 7: 1 in France and 8- 12: 1 in Asia (WHO, 2004a and Knobel *et al.*, 2005). American and European countries have human to dog ratios of between 10:1 and 6:1 (Balogh*et al.*, 1993). This could be because in the developed countries dogs are mainly kept as pets whereas in developing countries they are mainly kept for home guarding.

Human: dog ratio (HDR) and human population data can be used to provide preliminary estimates of the owned dog population (Cleaveland *et al.*, 2014; Perry, 1993). Therefore, using the human: dog ratios of 4.1:1 and 3.6:1, and the 2009 national census statistics, 968,909 and 842,304 people, the owned dog population in Kisumu and Siaya counties could be estimated at 236,319 and 233,973 dogs respectively which is lower than that of Makueni county at 300,000 dogs (Zdu, 2014).

Majority of the dogs kept in households were males with male: female ratios of 1.4:1 and 1.7:1 in owned dog population in Kisumu and Siaya counties and was comparable to that reported in Makueni (1.5: 1) and Machakos (1.5: 1) (Zdu, 2014; Kitala *et al.*, 1993). Preference of male dogs has been reported by other authors elsewhere (Kitaa *et al*., 2014; Ratsitorahina*et al.*, 2009; Kitala *et al.*, 1993; Brooks, 1990; Beran and Frith, 1988; Beck, 1975). Male-biased sex ratios in households may be attributed to selection of males as pets due to a perception that males are better guard dogs than females. Moreover, over 98% of respondents in this study kept dogs mainly to guard the homes, a practice that may reinforce this perception. Also, many dog owners may want to avoid the nuisance of a bitch in estrus, or dealing with unwanted puppies. Estrus

females also cause complaints from neighbours as they attract large groups of intact males (Cleaveland*et al.,* 2010).The fact that most of the respondents kept dogs as home guards is in agreement with studies in other countries such as Tanzania (Sambo *et al.*, 2014), Zimbabwe (Brooks, 1990), Zambia (Balogh*et al.*, 1993), Madagascar (Ratsitorahina*et al.*, 2009), Mexico (Rangel *et al.*, 1981), Philippines (Beran, 1982) and Ecuador (Beran and Frith, 1988).

Household dogs in Kisumu and Siaya counties mainly depend on kitchen leftovers and scavenging for their meals, which is similar to the observation that had previously been reported in Makueni county (Zdu, 2014). However, more dogs in Kisumu scavaged for food than those in Siaya. This could be associated with the fact that a large proportion of households in Kisumu did not have a fence capable of restraining dogs in the compound and also fewer owners in this county restricted movement of their dogs compared to Siaya county. In this study, most of the households were partially fenced or had no fence at all. Only a small proportion had a fence capable of restraining dogs from roaming out of the homestead. This proportion was higher in Siaya than in Kisumu. Thus, a bigger proportion of owned dogs in Kisumu were free to roam than in that in Siaya.

The kind of dog ownership in Kisumu and Siaya is one that would be refered to as "loose ownership" whereby there is irregular feeding and minimal physical restraint of the dog (ICAM-coalation, 2007), which is a big challenge to rabies control efforts. This has also been observed in other rabies-endemic regions such as Makueni (79%) (Zdu, 2014) and Machakos (81%) (Kitala *et al.*, 1993) in Kenya, and 79% in Madagascar (Ratsitorahina *et al.*, 2009) that allowed their dogs to roam freely scavenging for food. Therefore, the roaming dogs in these areas are not "true strays" but owned dogs that are free to roam and scavange. Confinement of dogs is thus not

adhered to and this could have contributed to the high number of animal bites in the study areas. This is a big challenge to rabies control efforts as increase in the number of stray dogs leads to an increase in dog bites and rabies cases in humans (Abbass *et al.*, 2011).

The socio- economic value attached to dogs in these areas is lower than that attached to other domestic animals. Most people do not consider dogs important domestic animals in comparison with livestock and thus do not take care of them. People in these counties were merely living with the dogs rather than keeping them. The low socio- economic value attached to dogs in these areas is a big challenge to both the welfare of the animals as well as the rabies control efforts. This is because people did not take care of the dogs in terms of providing regular feeding and veterinary care when necessary. Young boys were charged with the responsibility of taking care of the dogs and taking them to vaccination points. Some of the reasons given for this is that children are easy to send and that they pity dogs and thus want to take care of them. These therefore explains why the majority of people who bring dogs to vaccination points are children and the turn up is usually high on weekends and during school holidays compared to that on school days. Due to their close association with dogs, children, especially boys, appear to be the group most at risk of contracting rabies. They are also the group that often takes dogs to vaccination points and thus schools are very important targets for public education campaigns on animal welfare and rabies control. Due to lack of care, the dogs ended up straying away from homes and suffering from injury through traffic accidents, fighting, abusive treatment by the local people, cruel methods of catching and inhumane methods of killing such as strychnine poisoning, electrocution and drowning (ICAM-coalation, 2007). The roaming dogs are also highly vulnerable to various diseases such as rabies and other zoonotic diseases. Skin conditions, wounds and malnutrition

were commonly seen in roaming dogs in the study areas. Apart from the welfare problems experienced by roaming dogs, such populations poses a human health risk, most notably rabies (Hiby *et al.*, 2011).

In both counties, a total of 386 roaming dogs were counted in urban centres, markets, dump sites and fishing villages. Most of these roaming dogs were males giving a male sex bias and this finding is in agreement with Cleaveland*et al*. (2010) who reported a significant male-biased sex ratio in strays in India. One of the possible reasons for this is the fact that males tend to roam a lot searching for estrus females hence their high numbers. Estrus females are known to attract large groups of intact males (Cleaveland*et al.*, 2010). Similarly, the number of roaming adults recorded in this study was high compared to that of puppies. In stray populations, adults are usually more than puppies in numbers (Cleaveland.*et al.*, 2010). This may be attributed to harsh environmental conditions which leads to puppy mortalities in the open. Puppies in household dog populations tend to survive longer compared to those in roaming dog populations as evidenced by the adult to puppy ratios in the two populations. It is expected that the environment and care in households supports puppy survival compared to the open environment.

Problems associated with free roaming dogs as cited by participants included transmission of rabies, dog bites in people, dog fights, inflicting fear in people, nuisance in fishing grounds and markets, noise pollution by barking, predation on livestock, poultry and caught fish, and causation of road traffic accidents. Hence the locals consider them a nuisance and thus kill or inflict injuries on them and thus presenting an animal welfare issue. Some of the inhumane actions towards the roaming dogs include poisoning, stoning, pouring hot water and sharp cuts with pangas and spears. Most of the roaming dogs observed in this study were in poor body

condition and had wounds, most of which were inflicted by the local people. The local population indicated a desire to eliminate the stray dogs which they considered a nuisance. The control of such populations is important both for the welfare of the dogs as well as for rabies control.

In both counties, over 90% of the respondents had good knowledge about rabies, main species affected, its zoonotic importance and transmission methods. However, very few people knew that rabies could infect livestock (13% in Kisumu and 19% in Siaya). Similarly in Kakamega, 90% of study participants were aware of rabies as a disease, but only 29% knew that it could affect other animals apart from dogs (Mucheru *et al.*, 2014). This is a big risk for human exposure by the unsuspecting livestock owners.

Schools, friends and neighbours seemed to play an important role in dissemination of information compared to media, veterinary services and health centres. From these findings, it can be concluded that non-media sources play a significant role in disseminating information about rabies and its zoonotic importance to the local community. In a study done in Abidjan, 82.19% of the people interviewed knew about rabies and school was the source of information for 88.6% of them (Tiembré *et al*., 2014). This makes schools an important target of any public education program on rabies. The veterinary and medical services did not serve as an important source of information about rabies as only a small proportion of respondents said they learnt about the disease from these two departments. This calls for these departments to be more aggressive in public education about rabies.

More than half of the respondents in this study were not aware of any presenting feature of a rabid animal. This poses risk of human exposure as owners may try to help their sick animals.

Any successful rabies control program must educate the public on the most common presenting features of rabies in animals. This will help people to avoid contact with such animals and thus reduce human exposure.

For those who suspected rabies, a big proportion would kill the animal and only a few of them would call a veterinarian for further action. These findings have also been reported in Kakamega (Mucheru *et al.,* 2014) and depicts a negative practice that must be campaigned against. It is recommeded that suspect animals that have made contacts with humans but are not showing signs of disease not be euthanised immediately but isolated and observed for development of clinical rabies to aid diagnosis (Radostits *et al.,* 1994). Moreover, killing suspect animals implies that many cases of rabies go unreported and thus the true situation of rabies is greatly under-reported in official records (Cleaveland *et al.*, 2001; Zdu, 2014). Therefore, the local communities should be educated on the need to call veterinarians to collect such animals for isolation, observation, diagnosis, and if killed, to ensure a laboratory diagnosis is undertaken.

Though 66% of the respondents in both counties were aware that vaccination of dogsprevents rabies, and the veterinary departments offers this service for free at least twice a year, only 20% had vaccinated their dogs against rabies. This finding is comparable to the 23% reported in Makueni (Zdu, 2014). Kitala *et al.*(1993) reported that less than 33% of dogs in Machakos were vaccinated against rabies. In Kakamega, out of all dog-owning households involved in a study (Mucheru *et al.*, 2014), only 35% had dogs with up to date vaccination status. All these figures are far below the recommended 70% coverage for rabies control (Cleaveland *et al*., 2014). It is therefore true to say that the knowledge is there but the practice is not adhered to. Again, as discussed above, this may be attributed to the low socio- economic value attached to dogs in

these counties. Very few respondents knew that confining dogs was equally important to prevent rabies. Lack of such vital information coupled with the high numbers of homesteads without fencing or dog-confining facilities may be an important driver associated with the high numbers of roaming dogs and animal bites in the study areas.

Though washing bite wounds with water and soap immediately after a bite minimizes the risk of developing rabies in animals and humans (Radostits *et al.,* 1994; Balogh *et al.,* 2001), 52.6% of the respondents in Kisumu and 32.5% in Siaya were not aware of any home level first line of action. A significant propotion of respondents in Kisumu county considered traditional treatment as their first line of action after an animal bite. Only a small proportion of the respondents (9% in Kisumu and 26% in Siaya) would wash bite wounds with soap and water immediately after a bite. In Kakamega, only 3% of the respondents said the wound should be washed with soap and water (Mucheru *et al.*, 2014) while in Abidjan, 96.18% of people interviewed did not know that the wound should be washed with soap and water immediately after exposure (Tiembré *et al*., 2014). This indicates that this knowledge is not common in most rabies-endemic countries and hence there is an urgent need to educate the people on this basic preventive measure that can assist in saving lives. Since women are the ones usually actively involved in taking care of the bite victims, especially their children, they should be educated on the first line of action after a dog bite at home level, and the need for taking the victim to hospital for PEP (Balogh *et al.*, 2001).

In this study, 75%and 87% of respondents in Kisumu and Siaya respectively would take an animal-bite victim to hospital to get conventional post-exposure prophylaxis (PEP).These proportions are lower than that of 96% reported in Kakamega (Mucheru *et al.*, 2014).The key

opinion leaders in Kisumu and Siayaindicated that knowlegde of rabies is increasing among the communities. More and more victims of dog bites are now seeking conventional medical help with very few seeking help from traditional healers compared to some years past. However, some of the victims ends up not receiving the necessary treatment due to unavailability of the vaccine, its high cost or long distance travelled to acquire it. According to key informants involved in this study, PEP is usually not available in public health facilities and victims of dog bites have to buy anti-rabies vaccines from private pharmacies. This costs the victim a minimum of about $85 for the whole course of PEP, a cost that may not be affordable to majority of the community members. The victims become hopeless and resign to fate. Similar observations have been reported in Kisumu (Kagira and Kanyari, 2012) and Kakamega (Mucheru *et al.*, 2014). This is a negative step towards rabies control and must be addressed with utmost urgency.

Out of the households involved in this study, 11.5% and 15.2% in Kisumu and Siaya respectively had at least one household member bitten by a suspect rabid dog in the previous 12 months. This proportion is high compared to that of 8% and 5% recorded in Tanzania and Zambia respectively (Balogh *et al.,* 1993; Sambo *et al.*, 2014). The estimated incidence of animal bites in Kisumu and Siaya in 2014 is higher than that of 232 bites/100,000 people reported in Machakos, Kenya (Kitala *et al.*, 2000) and that of 220 bites /100,000 people reported in Asia (Knobel *et al.*, 2005). Nationally, there are 330 animal bites/ 100,000 people in Kenya (Zdu, 2014). In 2007, there were about 1270 animal bites in Kisumu municipality alone (Kagira and Kanyari, 2012). The results of this study indicates that the number and incidence of animal bites in humans are on the rise in both Kisumu and Siaya counties over the last 5 years, from about 1976 to 3441 in Kisumu and 1372 to 4997 in Siaya. These high numbers of animal bites could be due to high dog

population without proper confinement and routine vaccination in these counties. Although there was a higher proportion of homesteads without fencing in Kisumu than in Siaya, the incidence and number of bites were higher in the latter county. One of the possible reasons for this could be that a higher proportion of respondents in Kisumu than in Siaya would not seek medical attention after an animal bite but would instead seek help from traditional healers and thus the number of bites reported in the former county is lower. Since dog bite records have been accepted asgood indicators for human rabies incidence in Africa (Kagira and Kanyari, 2012), it may therefore be correct to say that incidences of rabies in animals and humans are on the rise in both counties.

5.2 Conclusions

i. There was a significant proportion of free roaming dogs in both Kisumu and Siaya.

ii. The retrospective survey depicts a high number of animal bites. These numbers depict the economic burden, public health impact and social value of the disease.

iii. Despite that the incidences of rabies in animals and humans are on the rise in both counties, the level of dog vaccination in the study areas remains very low for the control of the disease.

iv. Schools, friends and neighbors are the major sources of information about rabies and its zoonotic importance.

v. There is minimal physical restraint of dogs in both counties as most homesteads do not have fences and owners do not provide housing for the dogs.

vi. Although majority of respondents were not aware of any first line of action after an animal bite at home level, most of them would seek conventional medical treatment.

5.3 Recommendations

- There is need to organize active surveillance programs in these counties so as to get the real situation of the disease as most of the figures available are masked by under-reporting.
- The government and other stakeholders should facilitate dog population control programs and regular vaccinations to ensure a bigger proportion of the dog population is vaccinated.
- A detailed and further research on the spatial and temporal distribution of free roaming dogs is of paramount importance in order to establish a sustainable and effective control program.
- Awareness creation programs should be initiated by concerned stakeholders to the public about the proper management of their dogs (in order to reduce free roaming dogs). Initiating dog registration (responsible dog ownership) and punitive measures against those who leave their dogs unattended.
- Government and other concerned stake holders must pool efforts to ensure availability of anti-rabies vaccine in all local health centres. Providing facilities like refrigeration and power are the vital initial steps in these efforts.

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7 APPENDICES

7.1 Appendix I: Questionnaire

UNIVERSITY OF NAIROBI

DEPARTMENT OF CLINICAL STUDIES

Questionnaire Survey on the Assessment of the Community's Knowledge, Attitude and Practiceof Kisumu and Siaya counties, Kenyaon Rabies Disease

Code: _____ Date of interview…../…/2015

Please fully fill the following information with a great responsibility for good results.

I. Socio-demographic characteristics of respondents in the sample population

1. Gender**:** **a)** Male † **b)** Female
2. Age: **a)** 15-19 **b)** 20-29 **c)** 30-39 **d)** 40-59 **e)**>60
3. Marital status**: a)** Single **b)** Married
4. Educational status **a)** Primary **b)** Secondary **c)** Tertiary **d)** Illiterate
5. Occupation: a) Formal employment b) Informal employment c) Farmer d) Fisherman e) Business person f) Student
6. Religion: **a.** Christian **b.** Muslim **c.** Other
7. Number of people in the household: _____
8. Type of toilet used in the household: a) Outdoor pit latrine b) Indoor toilet c) a & b d) Bush

9. Homestead fencing: a) Fully fenced b) Incomplete fencing c) No fence

II. Specific questions related to knowledge, attitude and practice of the community on rabies incidence and human exposure

1. Do you take care of or have any animals at home? **1=** Yes **0=** No
2. How many dogs do you have? _____
3. List in order of importance the animals you keep in your household. _____
4. If you have a dog at your home,
   - What food do you feed your dog(s)?

     a) Commercial feed b) Kitchen leftovers c) Scavenging
   - For what purpose do you keep your dog(s)?

     a) Guard the home b) Hunting c) Home pet
   - How does keeping of dogs improve your life and that of the family?

     …….
5. Have you heard about the disease rabies? **1=** Yes **0=** No
6. If your answer is yes, what is your source of information? **A)** Media **B)** School, friends, neighbors **C)** Vaccination campaigns **D)** Vet services **E)** Health centers
7. What animals does it commonly affect? (Please List)

   ……
8. Where do you think these animals get the disease and how?

   a) Bites from rabid animals b) Organ transplant c) Scavenging d) Contaminated drinking water e) Urine/ feces f) Not aware

9. How do you prevent the disease from infecting your animals?

   a) Vaccination b) Restrict movement c) Not aware

10. What signs do you use to tell that an animal could be having rabies?

    ……...……

11. What do you do with an animal that you suspect could be having rabies?

    a) Kill b) Call a veterinarian c) Chase aware from home d) Confine and observe e) Not aware

12. Do you think the disease can be passed from animals to people?

    1= Yes **0=** No

    If yes, how?

    a) Bites of rabid animals b) Meat from rabid animals c) Contaminated formites d) Saliva e) Not aware

13. If a person or an animal is bitten by an animal suspected to be rabid, what would be your first line action at the home level?

A) Wound wash with water **B)** Wound wash with water and soap **C)** Apply alcohol **D)** Apply irritant like lemon **E)** Rubbing the site of bite by soil **F)** Traditional treatment

14. Would you take an animal bite victim to hospital?

1= Yes **0=** No

15. How do you manage your dog? **A.** Tied/housed **B.** Not tied but not allowed to leave out of the home compound **C)** Freely moving to surrounding nearby areas **D)** Other

16. Have you vaccinated your dog(s)? **1=** Yes **0=** No

    If yes, do you have proof of vaccination, e.g. vaccination certificate?

1= Yes **0=** No

When was the last time you vaccinated? **A.** Last 6 months **B.** Last 12 months **C.** Can't remember **D.** Never vaccinated

- At what age and interval should your dog be vaccinated……..

17. Who carries out vaccination for your dogs?

A) Vet **B)** Animal health assistant **C)** Self **D)** Other

18. Do you think that rabid animals can be effectively treated by traditional medication?

A) Yes **B)** No

19. If yes how, by whom and with what?.....

20. Have there been reports of animals or humans being bitten by suspected rabid dogs recently?

A) Yes **B)** No

21. If yes, where is the locality? Or how many people/animals were bitten?

……

Was the dog a stray or owned dog?

……

22. Is there a member of your household who has been bitten by a dog in the previous 12 months?

1= Yes **0=** No

If yes, what kind of treatment he/she/they got/followed?

A) Modern health care for post-exposure vaccine **B)** Modern health care for just simple wound treatment **C)** Traditional treatment **D**) Other

23. What is your opinion about free roaming dogs/stray dogs?

A) Should be eradicated **B)** Should be minimized by ABC method **C)** I don't bother about them

24. Do you think free roaming/stray dogs are important in rabies transmission?

1= Yes **0=** No

25. Would you participate in a rabies controlling program?

1= Yes **0=** No

7.2 Appendix II: Photograph showing dog marking

Figure 7.1: A dog with a paint mark on the forehead

7.3 Appendix III: Digital photographs used to aid identification of dogs

Figure 7.2: Photograph of a roaming dog

Figure 7.3: Photograph of a roaming dog in a village in Kisumu