Epidemiological dynamics of rabies in Tanzania and its impacts on local communities

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Abstract

Rabies is a fatal viral zoonotic infection caused by a Lyssavirus. Rabies exerts a major public health and economic burden; it is responsible for at least 55,000 deaths worldwide, predominantly in Africa and Asia. More than 90% of rabies deaths are caused by domestic dogs. Global expenditure on rabies prevention and control exceeds US$500 million per annum. Although human rabies is 100% preventable, through vaccination of animal reservoirs and post-exposure prophylaxis (PEP) of people exposed to bites, no effective large-scale control of rabies has been achieved in sub-Saharan Africa.

Effective implementation of sustainable rabies control and prevention programs, involves full participation of individuals, veterinary and medical services. Veterinary services must control rabies transmission through mass dog vaccination campaigns because human deaths are caused by epidemics in domestic dogs, medical services must provide PEP to prevent disease in exposed individuals and exposed individuals must seek PEP and dog owners must take their dogs to be vaccinated. This thesis focuses on factors affecting individuals and medical services.

This thesis examines challenges in the control and prevention of rabies in sub-Saharan Africa. Firstly, to address these challenges, we developed an analytical framework to portray the influence of individual and institutional factors within both the veterinary and medical services, in controlling and preventing rabies. The research carried out in chapters two and three investigate different aspects of this framework. Specifically in Chapter 2, we conducted a knowledge, attitude and practice (KAP) survey in seven districts covering southern, central and northern Tanzania. We used the collected data to investigate factors that influence knowledge of rabies and how knowledge of rabies influences attitudes and practice in control and prevention of rabies. Our findings show that knowledge about rabies in Tanzania is limited. However, we found an indication that those who were more knowledgeable of rabies claimed to practise better rabies control and prevention. In Chapter 3, we collected information using contact tracing and questionnaires to evaluate the burden of rabies and its

impacts on local communities. The study demonstrated that rabies is a substantial economic concern to bite victims. A bite victim in Tanzania would be required to spend over US$70 to complete WHO recommended PEP schedules. The costs of PEP disproportionately affect bite victims from rural areas where PEP doses are often not available. Families reported spending family allowances, borrowing money and or selling crops or livestock to pay for PEP. Fewer than 10% of families paid for PEP from their salary compared to 15% of patients from urban areas. Otherwise, patients depended on external financial sources such as contributions from relatives or friends or decided not to seek PEP because of the high costs involved.

High PEP costs also affected compliance with PEP schedules. The probability of obtaining the first dose of PEP was about 70%, declined slightly for the second and third doses but declined dramatically for the fourth and fifth doses. We also found that 15% of bite victims who did not receive any PEP went on to develop rabies. The costs of PEP were 2 times higher than costs previously reported from Africa. In Chapter 4 we discuss our overall results and conclude that interventions to control and prevent rabies require multi-sector commitment of all key stakeholders.

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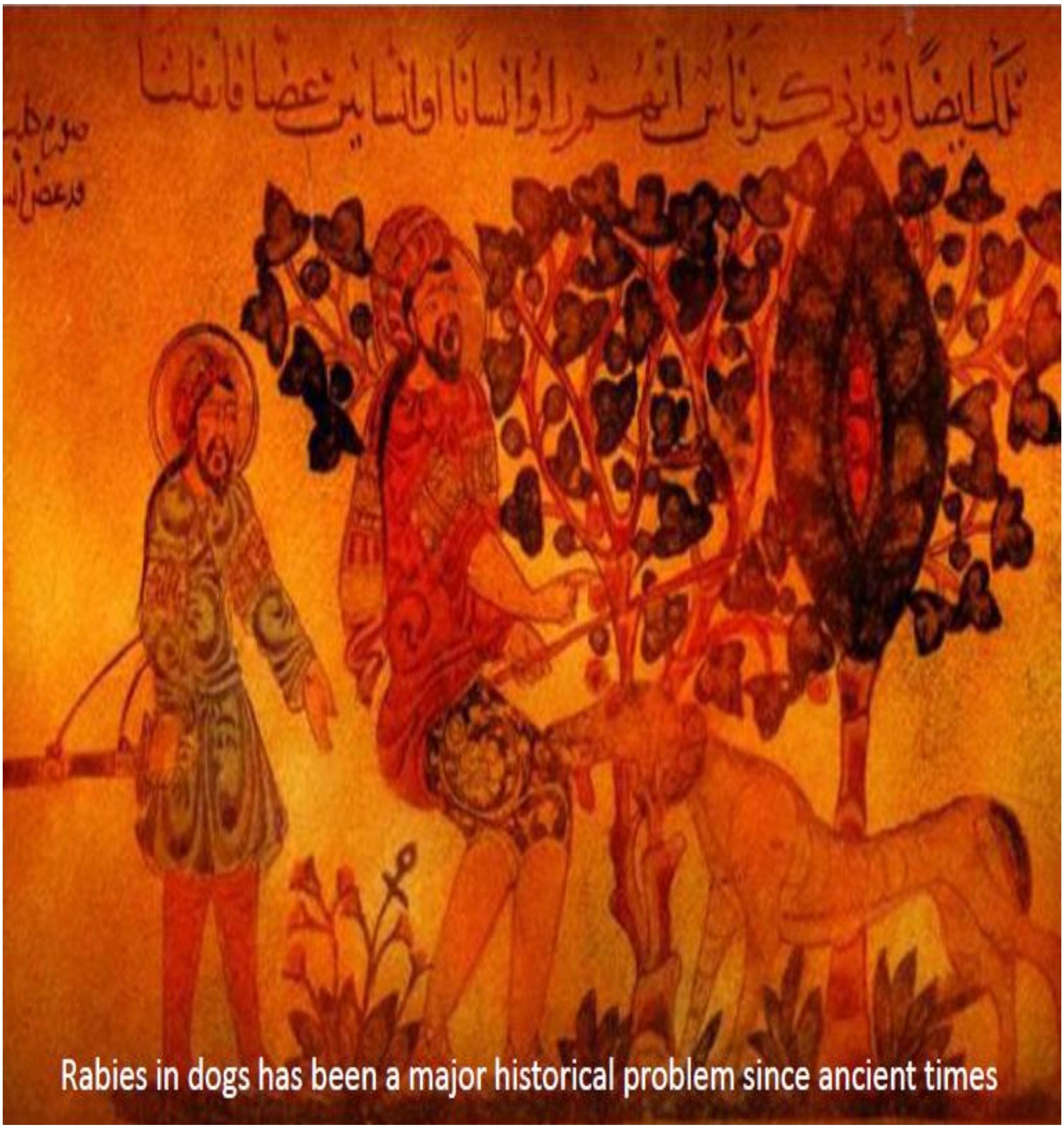
Preface

Dedication

Dedicated to my grandmother Brelia Burton Kahema, a woman with a heart of gold, and to my late father Mwalimu Abdiel Msechu who passed away in 2010 without seeing my graduation and whom I miss every day.

“If science has no country, the scientist should have one, and ascribe to it the influence which his works may have in this world”

Rene Vallery-Radot, (1923) in “The Life of Pasteur”



“..after all efficacious rabies vaccine is available to those that can afford it”.

Ertl HCJ (2009) Novel Vaccines to Human Rabies. PLoS Negl Trop Dis 3(9): e515. doi:10.1371

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I am grateful for the help and encouragement of many people, so I apologise at the beginning for missing anyone from the list. It's not my intentional plan, merely symptom of my failing memory.

I would certainly say that my first trip to the Kilombero valley, in south Tanzania in June, to pursue field attachment in 2006 was a beginning of my inspiration to work on infectious disease. I deliberately decided to opt a course on Health Geography so that I can integrate skills on human, environment and diseases. My priority disease was malaria that is why I joined Ifakara Health Institute (IHI), then known as Ifakara Health Research and Development Centre. Dr. Heather Ferguson to whom I owe many thanks, she changed my career plan from malaria to rabies. I had no idea that one day I would do research on rabies until 2007 when an outbreak of rabies occurred in South Tanzania at that time I was working with Heather as research intern. Heather inspired, assisted, instructed, encouraged and pressed me to become independent research scientist, and of course she is the one who introduced me to Dr. Katie Hampson. I am very much indebted to her for all the research opportunities and academic mentoring she has given me

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Author's Declaration

This thesis is a presentation of my original research work. Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature, and acknowledgement of collaborative research and discussions. I declare that the work recorded in this thesis is entirely my own, except where otherwise stated, and that it is also of my own composition. Much of the material included in this thesis has been produced in co-authorship with others, and my personal contribution to each chapter is as follows:

- Chapter 2. Is being prepared for submission as Sambo, B.M., Lembo T and Hampson K. Knowledge, attitudes and practices (KAP) related to rabies and its prevention and control: A community survey in Tanzania. MBS carried out the fieldwork, conducted the surveys and wrote the manuscript. All authors provided assistance and advice with the analyses and design of the study. My estimated personal contribution was 90%.

- Chapter 3. Is being prepared for submission as Sambo, B.M., Cleaveland S., Ferguson H., Urassa H., Lembo T and Hampson K. The burden of rabies in Tanzania and its impacts on local communities. MBS carried out the fieldwork, conducted the surveys and wrote the manuscript. All authors provided assistance with analyses and advice on the study design. My estimated personal contribution was 80%.

I further declare that no part of this work has been submitted as part of any other degree.

Maganga Sambo, September, 2011

Definitions/Abbreviations

ACIP	Advisory Committee on Immunization Practices
BOT	Bank of Tanzania
CI	Confidence Intervals
GIS	Geographic Information System
BC	Before Christ
GPS	Global Positioning System
HBS	Household Budget Survey
IHI	Ifakara Health Institute
IRB	Institutional Review Board
KAP	Knowledge, Attitude and Practices
LFO	Livestock field officer
MDG	Millennium development goal
NBS	National Bureau of Statistics
NIMR	National Institute for Medical Research, Tanzania
NSGRP	National Strategy for Growth and Reduction of Poverty
OR	Odds ratio
PCA	Principal Component Analysis
PEP	Post-exposure prophylaxis
RIG	Rabies Immunoglobulin
TB	Tuberculosis
TRC-ID	Thai Red Cross intramuscular
TZS	Tanzanian Shillings
US$	United States of America dollar
UTM	Universal Transverse Mercator
VIF	Variance Inflation Factors
WHO	World Health Organization

1 General Introduction

1.1 Historical perspective

Historically, rabies been known since 3500 B.C. The first written record of rabies is in the Codex of Eshnunna (1930 BC), ancient Mesopotamia now known as Iraq. The record states that the owner of a dog that shows signs of rabies should take measures to prevent it from biting. It further stated that if a person was bitten by a rabid dog and later died of rabies, the owner of the rabid dog had to pay two third of mina as fine (Baer et al., 1996). The historical perspective of the disease has been extensively reviewed elsewhere with rabies being documented by many individuals including Aristotle and Hippocrates, who noted a connection between human infection and bites from “mad” dogs (Tierkel and Sikes, 1967, Neville, 2004). The French bacteriologist Louis Pasteur developed a post-exposure vaccine against rabies in 1885 made from desiccated nerve tissue containing the virus, after successfully treating a small boy bitten by a rabid dog (Hoenig., 1986).

1.2 Rabies pathology and transmission

Rabies Virus belongs to the genus Lyssavirus, family Rhabdoviridae and causes the disease rabies. Rabies virus is enzootic throughout Africa with the domestic dog (*Canis familiaris*) being the principal vector (Hayman et al., 2011). The disease affects all mammals and is nearly always fatal once clinical signs appear (Hemachudha et al., 2002). The most common mode of rabies transmission is through the bite and virus-containing saliva of infected animals, usually domestic dogs (Chopra and Lal, 1999, Knobel et al., 2005). Another possible route of transmission is oral, especially for animals feeding on dead infected animals (Hofmeyr et al., 2004).

Following primary infection (stage 1 of Figure 1.1), the uptake of virus into peripheral nerves is important for progressive infection to occur. After uptake into peripheral nerves (stage 2 of Figure 1.1), rabies virus is transported to the central nervous system via retrograde axonal flow (stage 3 of Figure 1.1). The incubation period (stage 1-3, Figure 1.1), is the length of time between infection with the rabies virus and the onset of clinical signs. During this period the virus is multiplying within the body. The incubation period may vary from a few days to several years, but is typically 1-3 months. Bite victims must obtain Post-exposure Prophylaxis (PEP) early in the incubation period to prevent the clinical onset of rabies. The incubation period depends largely on the site on the body which has been bitten and the severity of the wound, with shorter incubation periods for bites to the head, severe wounds and multiple bites. Single bites at or below the waist, or small wounds are associated with longer incubation periods (Warrell and Warrell, 2004). It has been reported that the longest incubation period for rabies exceeded 6 years (Johnson et al., 2008). However the majority of cases (90% in India), develop disease within 6 months of exposure (Lakhanpal and Sharma, 1985).

If rabies is not prevented at an early stage, and the virus reaches the brain (stage 4 of Figure 1.1) and moves to the salivary glands (stage 5 of Figure 1.1), bite victims will begin to show the first signs of rabies. This period is called the infectious period and when signs of rabies begin, death is inevitable. The case fatality rate of rabies is 100% when symptoms present except for one known survivor to date (Willoughby et al., 2005). The infectious period for rabies in animals ranges from 2 days to approximately two weeks (Hampson et al., 2009).

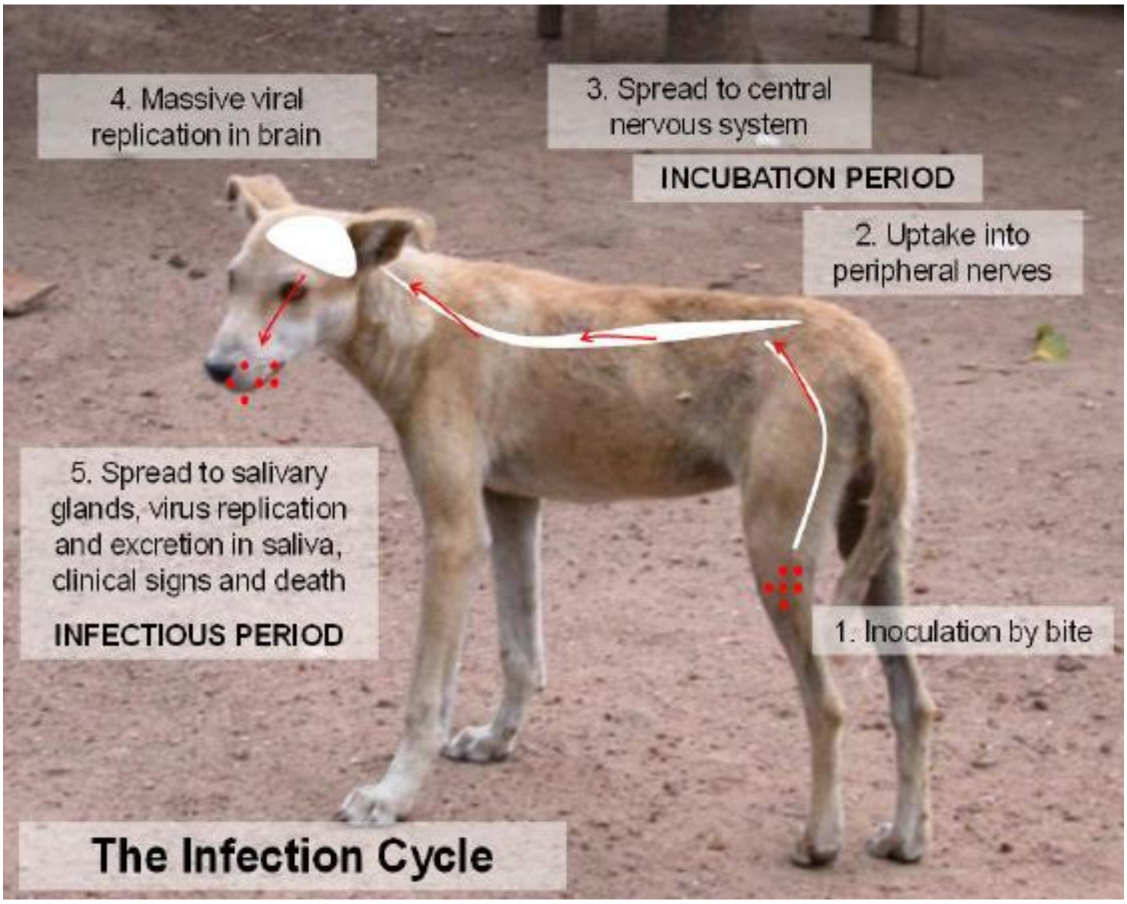

Figure 1.1: Diagram showing rabies pathogenesis, whereby the virus moves from the site of the bite to the central nervous system then replicates in the brain.

1.3 Impacts of rabies

Every year at least 55,000 people are thought to die from rabies and more than 10 million are treated for exposure to the virus (Knobel et al., 2005). The risk and burden of rabies falls disproportionately on the most vulnerable sectors of society: children (who are at greatest risk from dog bite injuries) (Cleaveland et al., 2002) and particularly those in rural, poor communities who have limited access to human rabies vaccine (Hampson et al., 2008). Rabies exerts a significant economic burden; the total estimated global annual expenditure due to rabies control and prevention is more than US$500 million and the high costs of post-exposure prophylaxis (PEP) are a burden for governments and individuals especially in developing countries (Knobel et al., 2005). Poor rural dog bite victims are likely to be unable to meet the relatively expensive costs of PEP. Additionally, livestock losses from rabies can be substantial for subsistence communities (Coleman et al., 2004). Frequent vaccine shortages mean that bite-victims must often travel long distances to obtain PEP, which is extremely costly, and can increase delays to treatment and therefore the risks of developing rabies (Hampson et al., 2008). A large proportion of the rural population in Africa and Asia subsist below the poverty line, yet it is in these rural areas that rabies has its most profound impacts, with five times more deaths due to rabies occurring than in urban areas. Sometimes this can be prohibitively expensive with fatal consequences. When human cases do occur, the distressing clinical signs and inevitable death results in considerable psychological trauma for families, communities and health-care professionals involved with the victim (Warrell and Warrell, 2004). This thesis investigates in practice the burden of rabies in Tanzanian communities.

1.4 Canine rabies control

Most human rabies deaths occur as a result of epidemics in animal populations, as the disease is maintained in animals, particularly domestic dogs (Krebs et al., 1995, Knobel et al., 2005). For infection of rabies to be eliminated, control measures must therefore target the reservoir (Lembo et al., 2008). Mass dog vaccination is the most cost-effective way to control rabies (Kaare et al., 2009, Kayali et al., 2006, Cleaveland, 2003). Examples from around the world have repeatedly shown that canine rabies can be effectively controlled and human deaths eliminated through mass vaccination of domestic dogs (Hampson et al., 2007). Culling of dogs is sometimes promoted by local and national authorities as a method to control rabies, however dog population reduction alone has been shown to be ineffective and oftentimes counterproductive (WHO, 2005). Although under control in the developed world (Lembo et al., 2011), control of rabies in Africa and Asia has been severely neglected, partly due to poor surveillance and unreliable statistics on rabies incidence (Knobel et al., 2005, Cleaveland et al., 2002). The absence of accurate data on the burden of rabies has meant that rabies control has not been prioritized (Lembo et al., 2011).

Despite the failure to arrest rabies in most developing countries, well-designed local programs in Tanzania have shown domestic dog vaccination campaigns to be cost-effective and efficacious in reducing rabies incidence and human exposures (Cleaveland et al., 2003, Kaare et al., 2009).

1.5 Rabies prevention

Rabies is a disease for which vaccines are currently available for both animals and humans (Ertl, 2009). Almost all human deaths from rabies could be prevented given appropriate wound management and prompt delivery of PEP following exposure (Rupprecht, 2006, Quiambao et al., 2005). Ensuring a reliable and affordable supply of PEP is therefore an essential step for eliminating human deaths from rabies, but is not on its own a sustainable or economically viable solution (Hampson et al., 2011, Shim et al., 2009). The World Health Organization (WHO) recommends a PEP regimen which requires 5 successive visits to hospital over the course of a month (WHO, 2005). However, in many areas of sub-Saharan Africa, access to PEP is a challenge; shortages are frequent and bite-victims have to travel long distances to obtain expensive PEP (Cleaveland et al., 2007, Hampson et al., 2008, Sudarshan et al., 2007). The challenge of access to PEP, acts as barrier for poor families to comply with WHO recommended PEP schedules.

1.6 Rabies in Tanzania

Rabies was reported for the first time in Tanzania in 1923, and was laboratory confirmed in 1933 (Magembe, 1988). Since then the disease has been endemic in Tanzania. Several attempts to control the disease have been instituted, but not successfully (Magembe, 1988). In Tanzania as in other developing countries, the domestic dog is the most important source of rabies for humans. Tanzania has an estimated 4.9 rabies deaths per 100,000 people, which translates to around 1500 human deaths annually (Cleaveland et al., 2002). Several studies on the dynamics, epidemiology, burden and control of rabies have been conducted in the northwest of Tanzania (Cleaveland, 1996, Lembo et al., 2008, Hampson et al., 2008, Kaare et al., 2009), but little has been done in other areas. This study is the first in southern Tanzania to collect baseline data directly from communities, on individuals who have been bitten by rabid animals.

Despite relevant data from northwest Tanzania on the issue of rabies, there has been no clear national rabies control strategy developed (Mazigo, 2011). According to an official report presented during the Southern and Eastern Africa Rabies Group (SEARG) meeting in Maputo, Mozambique, the Government of Tanzania through the Ministry of Livestock and Fisheries Development imported 99,000 vials of dog rabies vaccine in 2009, which would be sufficient to vaccinate around 990,000 dogs, while Tanzania is estimated to have dog population of more than 5,000,000 dogs (Kaare et al., 2009, Knobel et al., 2008). With the amount of dog vaccine imported into the country, it is apparent that the requirements for rabies control in the country are not appreciated. Lack of accurate data on the burden of rabies, make it difficult to get political and financial support for a national control programme. Generally, in Africa and Asia where rabies is endemic, poor surveillance and unreliable statistics on rabies incidence make it very difficult to attract policy makers to invest in control and prevention of rabies (Knobel et al., 2005).

1.7 Objective

The main aim of this study was to investigate and identify the factors contributing to ongoing preventable human rabies deaths in Tanzania and to evaluate the true disease burden and the inequity of health access in Tanzania. The specific objectives were:

i) To assess knowledge, attitudes and practices with regards to rabies and evaluate factors that influence knowledge of rabies.

ii) To investigate and quantify the socio-economic burden due to rabies in local communities in Tanzania and compare the hypothesized costs from the literature (Knobel et al., 2005).

iii) To evaluate factors those contribute to preventable rabies deaths

In order to investigate these objectives, we developed an analytical framework (as shown in Figure 1.2), to help understand the processes that lead to rabies deaths within Tanzania. The analytical framework captures the different components of rabies prevention and control, which include those from individuals, communities, veterinary services and medical services.

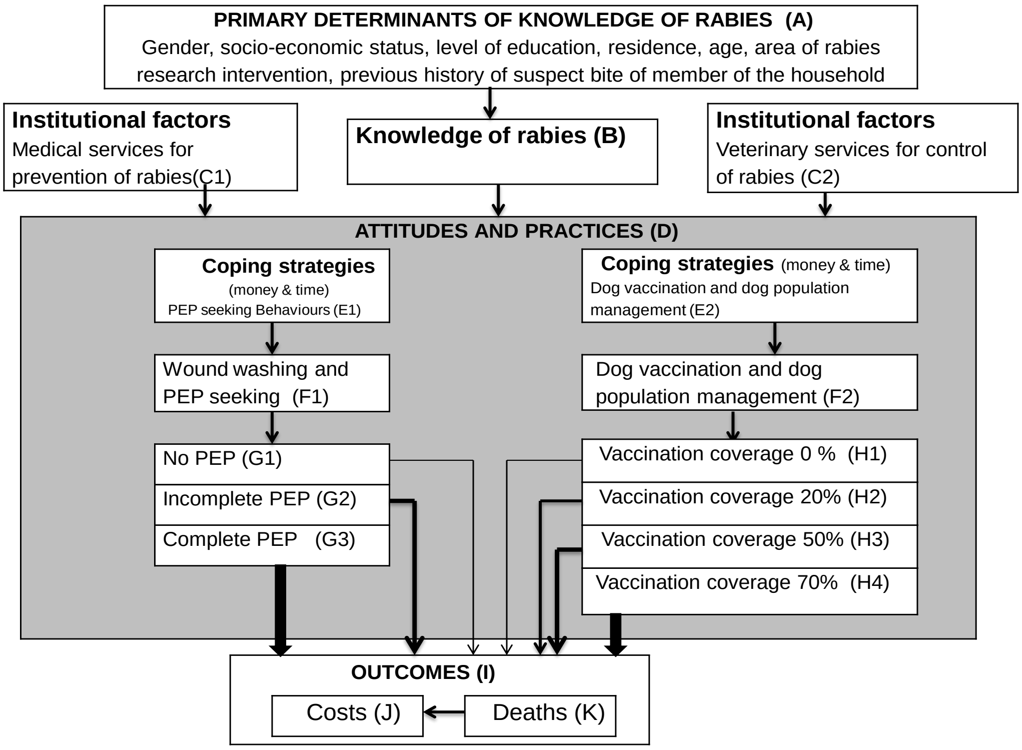

Figure 1.2: Analytical framework showing how individual's knowledge of rabies and institutional factors determine practices for control and prevention of rabies. The bolder the arrow the greater the costs incurred but lower probability of resulting in rabies.

This framework (Figure 1.2) helps to clarify the different treatment seeking behaviours and factors influencing these pathways that are investigated in this thesis. In chapter two, we conducted a KAP survey to investigate our hypothesis that an individual's knowledge of rabies determines treatment-seeking behaviour (Figure 1.2, A and B determines D). In chapter three, we investigated individual compliance with PEP regimens and the outcomes for affected persons, in terms of probability of death and costs incurred (Figure 1.2, G1, G2 and G3 to produce outcomes I). In addition in chapter three we investigated how institutional factors such as cost-sharing health policies and access to health services determines the coping strategies of bite victims (Figure 1.2, C1 and C2 determine E1 and E2; however E2 was not investigated in this thesis).

1.8 Ethics

The study protocol was approved by the Medical Research Coordinating Committee of the National Institute for Medical Research of Tanzania, with approval number NIMR/HQ/R.8a/vol.IX/994 and the institutional Review Board of the Ifakara Health Institute. The study was cleared by the District Executive Director in every study district and the village executive officers were asked for permission prior to starting work in each village. Before administering questionnaires, verbal consent was sought from participants. Participants were informed that their answers would be kept confidential and about the purpose of the study, emphasizing that participation was voluntary. Participants were not given money and were informed of their entitlement to refuse at any stage for whatever reason and to withdraw the data supplied. After administering questionnaire, advice was given on the risks of rabies and how to prevent and control rabies, allowing sufficient time for participants to ask questions. The study was largely quantitative rather than anthropological, and the analyses have been prepared for the public health and medical literature, and are generally limited with regards to more detailed reflective social sciences methodology. Hence, we followed common procedures for such studies carried out in Tanzania when only in-depth data are collected without the collection of biological samples.

2 Knowledge, Attitudes and Practices (KAP) related to rabies and its prevention and control: A community survey in Tanzania

2.1 Abstract:

Rabies is endemic in developing countries, claiming the lives of an estimated 55,000 people each year. Published data are available on economic, biological, epidemiological and technological reasons for the persistence of rabies in resource-limited countries. However there is very little published information about community beliefs and practices with respect to rabies control and prevention. This chapter reports the results of a cross-sectional study of the knowledge, attitudes and practices (KAP) related to rabies and its prevention and control in Tanzania. We carried out KAP surveys among 5140 respondents within randomly selected communities in urban and rural areas across central, south and north Tanzania. The resulting data were analyzed using logistic regression to determine factors affecting levels of knowledge about rabies and its control and prevention and how this knowledge translates into practice. Over 95% of respondents had heard of rabies and more than 80% knew that rabies is transmitted through bites from infected dogs. However, overall knowledge of rabies and its prevention and control is very low in Tanzania. Secondary and higher levels of education (odds ratio [OR] 2.33, 95% confidence interval [CI] 1.82-2.97), areas with rabies research interventions (OR 1.65 CI 1.35-1.92) and households with a previous history of suspect rabid animal bites (1.56 CI 1.26-1.28) were significantly associated with greater knowledge of rabies ($P<0.001$), and greater knowledge of rabies translated into better practices on rabies control and prevention ($P<0.01$). The low knowledge of rabies across Tanzania contributes to unnecessary deaths from the disease. Participants who were knowledgeable about rabies indicated better behavioural practises compared to those who were less knowledgeable. Together, these findings suggest the potential for communicating public health information to address knowledge gaps and improve rabies control and prevention practices.

2.2 Introduction

Rabies is one of the oldest recognized infectious diseases, and affects all mammals (Rupprecht et al., 2002). The disease is caused by a rhabdovirus (Warrell and Warrell, 2004, Hankins and Rosekrans, 2004) and is transmitted to humans by animal bites, most usually domestic dogs (WHO, 1999). It is estimated that over 10 million people are exposed to rabies annually (Knobel et al., 2005) and the disease remains a major socio-economic and public health problem in developing countries, claiming the lives of an estimated 55,000 people each year (Knobel et al., 2005, Coleman et al., 2004).

Although rabies has the highest case fatality rate of any disease known to man, the disease is preventable (Ertl, 2009, Lembo et al., 2011). However the control and prevention of rabies requires the engagement and collaboration of many stakeholders (roles and responsibilities of stakeholders are outlined in Figure 1.2). Firstly, veterinary services must participate in the control of canine rabies through mass dog vaccinations (Hampson et al., 2007, Kaare et al., 2009), in order to achieve 70% vaccination coverage, which is the target required for rabies elimination (Coleman and Dye, 1996). Secondly medical services must provide access to post-exposure prophylaxis (PEP) for rabies-exposed individuals. The World Health Organization (WHO) recommended protocol for PEP administration involves prompt wound washing after an exposure, followed by a series of rabies vaccinations and administration of immunoglobulin (RIG) for severe exposures (WHO, 2005). Finally, individuals must promptly seek PEP when a bite does occur and must bring their dogs to rabies vaccination campaigns to vaccinate them against rabies.

The theory behind knowledge, attitude and practice (KAP) studies is that increasing knowledge will change attitudes and practices (Mascie-Taylor et al., 2003). KAP surveys provide a suitable format to evaluate existing programs and to identify effective strategies for behaviour change (Koenraadt et al., 2006). Many published studies demonstrate the influence of increasing community knowledge on the control and prevention of infectious diseases. For example, a KAP survey together with an extensive entomologic survey was conducted in two sub-districts of Kamphaeng Phet province, Thailand. This study showed that a better knowledge of dengue resulted in better practices for dengue prevention and protection (Koenraadt et al., 2006). We hypothesize that correct knowledge will result in reduced rabies through proper treatment seeking behaviour and increased vaccination of dogs and cats.

Key messages for public health education awareness campaigns could be guided by findings from KAP studies (Acka et al., 2010). KAP studies have been widely used around the world for different applications in public health, including identifying knowledge gaps, cultural beliefs and behaviour patterns that may pose barriers to controlling infectious diseases (Krentel et al., 2006, Quick et al., 1996, Mfinanga et al., 2003, Matibag et al., 2007) and for designing relevant public health awareness campaigns (Espinoza-Gomez et al., 2002, Cantey et al.). In Swaziland, KAP surveys provided baseline data for planning, implementation and evaluation of national malaria control programmes (Hlongwana et al., 2009).

Tanzania is a relevant country to undertake this study because it is a resource-poor country and representative of many other rabies endemic countries. Tanzania has an estimated incidence of 4.9 rabies deaths per 100,000 people annually (Cleaveland et al., 2002). There have been similar reports of human rabies incidence in other countries, for example 2.5 deaths per 100,000 in Machakos district in Kenya (Kitala et al., 2000), 2-3/100,000 in India (Sudarshan et al., 2007), 5.8/100,000 in Cambodia (Ly et al., 2009), 1.8/100,000 in Bangladesh and 18/100,000 in Ethiopia (Haupt., 1999). These figures are not from official records but are the results of active surveillance studies. Most cases of rabies are not officially reported, especially in developing countries (Fevre et al., 2005, Cleaveland et al., 2002, Knobel et al., 2005). Official figures can therefore under-estimate the true burden of rabies by more than 100 times (Cleaveland et al., 2002).

Tanzania is among three countries selected by WHO for implementing large-scale rabies elimination projects (Lembo et al., 2011). The large-scale rabies elimination project covers districts in the southern part of Tanzania where this study was also undertaken. Therefore this study will provide baseline data that can contribute to large-scale efforts to eliminate rabies in Tanzania. We also anticipate that a KAP study in Tanzania will highlight knowledge gaps and provide useful information for improving knowledge of rabies and reducing the risks of rabies infection generally. To address our objectives we developed a systematic framework to investigate the influence of individual's knowledge on attitudes and practice for controlling and preventing rabies (Figure 2.1, A and B influences C).

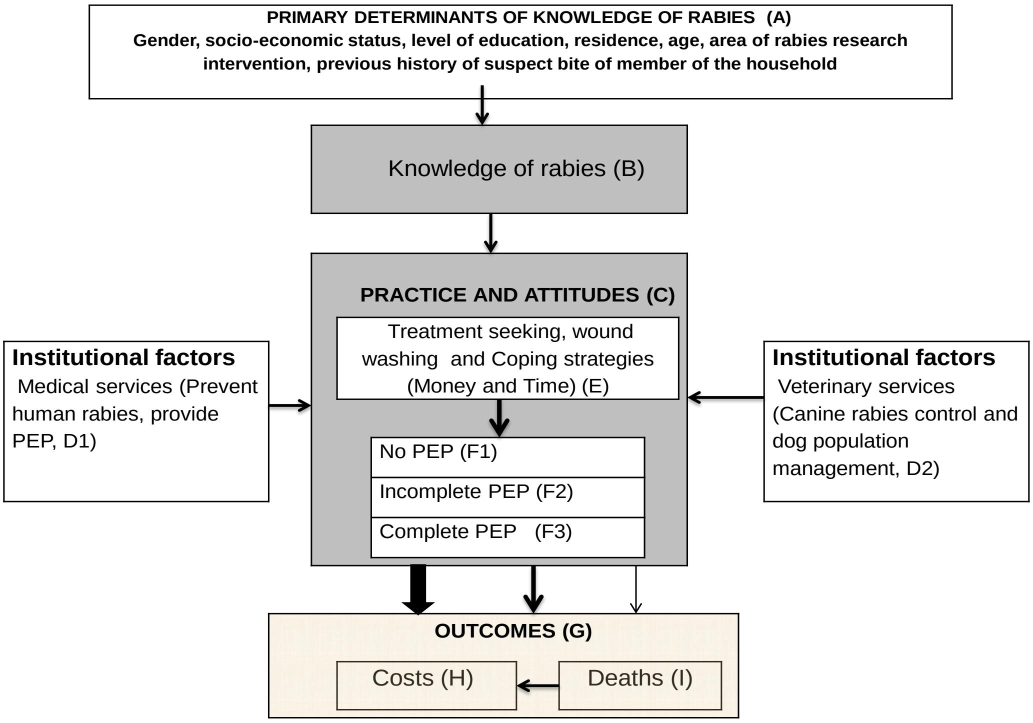

Figure 2.1: Analytical framework showing how individual's knowledge of rabies and institutional factors determine practices for control and prevention of rabies.

2.3 Materials and methods

2.3.1 Study areas

KAP surveys were conducted in seven districts in Tanzania, covering approximately 74,748 square kilometres, an equivalent of 8% of the country. This area is inhabited by about 1.8 million people, or around 5.4% of the Tanzanian population according to the 2002 national census (NBS, 2005). Since rabies is endemic in all areas of Tanzania, seven districts were selected to cover three zones (Figure 2.2), for comparison of the impacts of rabies control interventions. Musoma Urban and Serengeti in northern Tanzania have been subject to long-term rabies research which has involved organising campaigns for mass dog vaccination and contact tracing of suspect bite incidents and human rabies cases (Kaare et al., 2009, Lembo et al., 2008, Cleaveland et al., 2006, Cleaveland et al., 2002). Rabies research in these areas started in the 1990s (Lembo et al., 2008). In Ulanga and Kilombero districts in southern Tanzania rabies research began in 2008, including surveillance through contact tracing, mass dog vaccination and accompanying awareness raising activities. In contrast Kilosa district in south Tanzania, Dodoma Urban and Mpwapwa district in central Tanzania have had no rabies interventions. KAP surveys were conducted during August to September 2009 in Ulanga, Serengeti and Musoma Urban districts and between April and June 2010 in the remaining districts. Ulanga, Kilombero, Serengeti, Kilosa and Mpwapwa are rural districts whereas Musoma Urban and Dodoma Urban are urban districts.

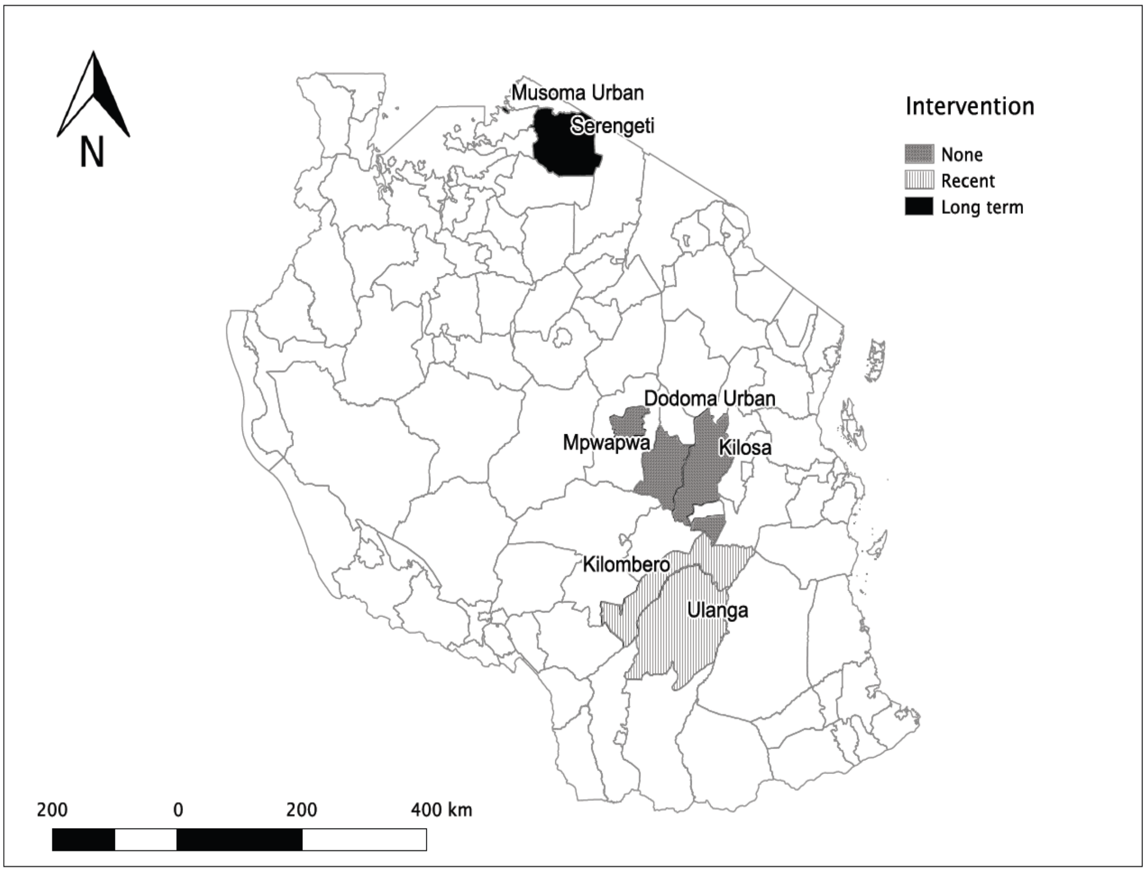

Figure 2.2: Map of Tanzania showing the study districts. Serengeti and Musoma Urban have had long-term rabies research interventions since the 1990s. Ulanga and Kilombero have had recent rabies research interventions. Mpwapwa, Kilosa and Dodoma Urban have not had any rabies interventions.

In each study district, 25% of villages were selected randomly. Assuming an average household size of 4.9 persons based on the Tanzania population and housing census (NBS, 2005), we estimated the number of households necessary to survey to capture 5% of the households in a village. Questionnaires were administered at approximately ~5% of households in each surveyed village after being randomly selected from village households lists.

2.3.2 Survey questions and methodology

Research assistants were accompanied by sub-village leaders to identify household heads. Questions were asked to household heads or other household members of at least 18 years of age in the absence of the household head.

Semi-structured questionnaires with both open and closed-ended questions were used to capture the study's objectives. The questionnaire was conducted in a language understandable to respondents, mainly Swahili. Six questions were used to assess knowledge of rabies covering a description of rabies, its mode of transmission and the outcome of disease, the range of species affected and how it can be either prevented or controlled. Four questions were used to assess attitudes and practices with regards to rabies covering first aid and medical attention and action towards suspect rabid animals (Appendix I). Scores were given according to the completeness and accuracy of respondents' answers, ranging from zero to three depending on the nature of question, with correct answers scoring highest (Di Giuseppe et al., 2008, Abbate et al., 2006, Xiang et al., 2010). If all answers were fully completed and correct a respondent would achieve an overall score of 11 for knowledge of the disease and of 10 for attitudes and practices. The scoring procedures for all questions are detailed in appendix II. For example, for the question on participants ability to describe rabies: a score of 2 was assigned if the participant correctly described rabies as a disease, a score of 1 for those who only described rabies as a change of behaviour of dogs, and a score of zero for those who answered incorrectly or were unable to provide an answer. The same procedure was adapted for the other questions. In order to be assigned as knowledgeable of rabies, a participant had to attain 7 scores or more out of eleven, which is equivalent to 64% according to a Likert-type scale (Xiang et al., 2010). Binary outcomes were assigned to questions about practices for rabies prevention and control described by participants (see appendix II). The questionnaire also captured details of individual and household characteristics that were used to assess socio-economic status and education levels.

2.3.3 Statistical analysis:

Principal component analysis (PCA) was used to estimate the socioeconomic status of respondents (STATA version 10, Stata Corporation; College Station, TX, USA). The possession of household assets was used to derive asset scores, and these asset scores were summed to give a total score that was used to rank socioeconomic status of the household. On the basis of these rankings, households were grouped into wealth quintiles (least poor, less poor, poor, poorer and poorest (Drakeley et al., 2003), but for analysis purposes, quintiles were combined into a variable indicating economic status (0% to 40% corresponding to high economic status, 40% to 60% corresponding to medium economic status and 60% to 100% corresponding to low economic status).

With the exception of socioeconomic status which was analysed in STATA, all other analyses were performed using the R statistical programming language (R Development Core Team, 2009). For categorical explanatory variables (gender, socioeconomic status, education level, residence (i.e. urban/rural dweller) and previous history of bite exposure in the household), frequencies of respondents answers were compared using Pearson's chi-square test. To determine the influence of all the explanatory variables on each dependent variable (i.e. the level of the respondents knowledge regarding specific questions), a series of univariate regression analyses were carried out. Variables that were significant in the univariate analysis ($p \leq 0.05$) were included in a multivariate analysis for each dependent variable. Interaction terms were tested using multiple regression with backward stepwise deletion of non-significant terms ($p > 0.05$). The models were tested for correlations between explanatory variables. Correlations between variables were quantified to obtain the variance inflation factor (VIF). Logistic regression was used to analyse binary outcome data on whether participants were knowledgeable or lacked knowledge about rabies and whether they reported good or bad practices for rabies prevention and control. Odds ratios (OR) and 95% Confidence Intervals (C.I.) of binary outcomes about factors that influence knowledge about rabies and practices for rabies prevention and control were obtained from the final model and goodness of fit was examined using the Hosmer-Lemeshow goodness-of-fit test.

2.4 Results

2.4.1 The study population

A total of 5140 respondents were administered a questionnaire in seven districts of Tanzania: 55% female and 45% male, ranging from 18 to 90 years of age and with a median age of 35 years. Most respondents were from rural areas (68%) and the majority were either pastoralists (dependent on grazing livestock) or subsistence farmers or both (agro-pastoralists) (85%). Most respondents were household heads (61%) and were from areas with no intervention (61%) or areas with recent interventions only (26%). Approximately one quarter of households (22%) owned either domestic dogs or cats or both. Around 8% of households had family members who had previously been bitten by a suspect rabid animal. The majority of respondents (74%) had only attended primary school, with just 10% having secondary school or higher education, whilst 16% had no formal education. Among these respondents without education, the majority (73%) were from rural areas ($p<0.001$) and more were female than male ($p<0.001$). There was also a significant difference in socioeconomic status among urban and rural populations with rural populations on average being poorer than urban populations ($p<0.001$) (Table 2.1).

2.4.2 Knowledge of rabies

Levels of knowledge about rabies transmission, disease pathology and prevention in humans and control in animal populations as well as factors affecting this knowledge are summarised in Table 2.1. In brief, the majority of respondents had heard about rabies (96%). About (27%) of the respondents were able to describe rabies correctly as a disease, with 41% describing rabies only as a change of behaviour in dogs, and 32% unable to provide any description of rabies ($p<0.001$). Pearson's chi-square test showed that a significantly greater proportion of people from areas with a history of rabies research interventions (37%) or with secondary or higher education (35%), were able to correctly describe rabies than those that had no formal education ($p<0.001$). Furthermore, respondents from households that had experienced exposure by a suspected rabid animal, were significantly more likely to describe rabies correctly ($p<0.001$), together with male respondents and respondents of higher socioeconomic status ($p<0.001$), whereas there was no detectible difference in ability to describe rabies among respondents residing in rural versus urban areas ($p=0.60$).

A large proportion of the respondents (81%) knew that rabies was transmitted through bites by suspect rabid animals. While 70% of respondents knew that domestic dogs and humans can suffer from rabies, only (7%) of respondents could name three or more types of animals capable of transmitting rabies. Previous exposure to rabies, presence of rabies interventions and residing in rural areas were all factors that improved respondents' knowledge about how rabies is transmitted. There was no detectable effect of gender on knowledge about the mode of rabies transmission. The majority of respondents (63%) knew that rabies is fatal following the onset of symptoms.

2.4.3 Rabies prevention in humans and control in animal populations

With regards to the knowledge of preventive and control practices, more than half of all respondents (51%) claimed not to know how to prevent rabies, and therefore depend on doctors' advice following a bite by a rabid animal (Table 2.2). Knowledge about the need for rabies PEP was significantly associated with presence of rabies research interventions, education and previous experience of exposure to a suspected rabid animal ($p<0.05$), while there was no effect of gender ($p=0.24$). Very few respondents (4%) knew three or more methods of rabies control in animals, whereas the majority of respondents (67%) knew of the need to vaccinate their dogs. Marginally more respondents of high socioeconomic status and from households that had an experience of exposure to a suspected rabid animal were able to mention at least three or more ways of controlling rabies in animals.

2.4.4 Source of information about rabies

The most common source of information about rabies was from personal contacts (neighbours, parents and friends, 70%), while 15% received information from media (television, radio and newspapers), 12% from health workers, researchers, or at school, and 3% knew of rabies from other sources like leaflets. Multivariate analysis showed that residing in rural versus urban areas and educational background had no statistically significant effect ($p=0.11$ and $p=0.08$, respectively) on reported sources of information about rabies through media, while areas with interventions and high socio-economic status were significantly associated with sources of information of rabies through media ($p<0.001$ and $p<0.007$, respectively).

2.4.5 Health seeking behaviours

Following a suspect bite only 10% reported that they would apply first aid measures before going to the hospital (Table 2.2). About 90% were not aware of wound cleaning as they claimed that they would report to either hospital or to the village leaders/police without cleaning the wound while others reported they would do nothing. Logistic regression showed that the odds of applying first aid were higher in households with a previous history of rabies exposure (OR 3.17, CI 1.91–5.72, Table 2.4). About 83% of respondents claimed that they would seek medical care immediately after a bite, while 12% claimed that they would seek treatment within 2 weeks of being bitten, whereas 3% reported to that they would seek medical care after 2 weeks. When asked what treatment bite patients should expect at a hospital, 35% reported PEP, 14% reported other treatments like antibiotics, Tetanus and pain killers, whereas the rest of the respondents reported that they would depend on physicians' advice.

2.4.6 Practices on suspect rabid animals and control of rabies

When asked about actions to be taken with regards to a suspect rabid animal, most respondents (79%) reported that they would kill the animal whereas only 7% would report the incident to a livestock office for further investigation (Table 2.2). Factors that influenced reporting to livestock offices included gender, households with a history of exposure and levels of education. Most respondents (75%) reported that they would bury or burn the carcass whereas a minority (25%) stated they would throw away the carcass. Only 15 respondents (<0.01%) were aware that the head of a suspected rabid animal should be submitted to a diagnostic laboratory for rabies diagnosis and confirmation (Table 2.2). In the univariate analysis only education, socioeconomic status and gender significantly affected this response (Table 2.4). We found that a slightly higher proportion (50%) of those who qualified as knowledgeable about rabies vaccinated their dogs and cats compared to those who did not qualify as knowledgeable (44%, P=0.05).

2.4.7 Factors that influence individual knowledge of rabies

Results of logistic regressions to determine factors that influence knowledge of rabies prevention and control are summarized in Table 2.3. The logistic model was sufficient as tested in Hosmer-Lemeshow's goodness-of-fit test (P=0.66). Variables that were not significant in univariate analyses were age, occupation of the household head and residence (rural or urban). A final logistic regression model showed that the odds of being knowledgeable of rabies were higher among respondents with more education, living in areas with long-term research interventions, male respondents, higher socio-economic status and households that had previously experienced suspect rabid bites. There were no correlations between variables that were high enough to cause concern, indicating that there were no substantial correlations that had an excessive influence on the models; see appendix III for the results of correlations between variables and the variance inflation factor (VIF) of this model.

	Level of education				Rabies intervention				Gender		
Knowledge Variables	**None 858 (17%)**	**Primary 3816 (74%)**	**Secondary & above 466 (9%)**	**P-value**	**None 3118 (61%)**	**Recent 1313 (26%)**	**Long-term 709 (14%)**	**P-value**	**Female 2810 (55%)**	**Male 2330 (45%)**	**P-value**
Description of rabies:				<0.001				<0.001			<0.001
Correctly described as a disease	159 (19)	1084 (28)	163 (35)		686 (22)	458 (35)	262 (37)		679 (24)	727 (31)	
Partially described	330 (38)	1543 (41)	198 (42)		1354 (43)	417 (32)	300 (42)		1097 (39)	974 (42)	
Unable to describe	369 (43)	1189 (31)	105 (23)		1078 (35)	438 (33)	147 (21)		1034 (37)	629 (27)	
Mode of transmission:				<0.001				<0.001			<0.001
Through bites	628 (73)	3131 (82)	390 (84)		2432 (78)	1108 (84)	609 (86)		2210 (79)	1939 (83)	
Through scratches	2 (0)	12 (0)	1 (0)		10 (0)	2 (0)	3 (0)		5 (0)	10 (1)	
Unknown	228 (27)	673 (18)	75 (16)		676 (22)	203 (16)	97 (14)		595 (21)	381 (16)	
Animals that can suffer from rabies:				<0.01				<0.001			=0.03
3 or more species identified	44 (5)	267 (7)	34 (7)		197 (6)	117 (9)	31 (5)		171 (6)	174 (8)	
1 or 2 species known	591 (69)	2695 (71)	299 (64)		2109 (68)	1070 (81)	406 (57)		1947 (69)	1638 (70)	
Unknown	223 (26)	854 (22)	133 (29)		812 (26)	126 (10)	272 (38)		518 (25)	518 (22)	
Rabies prevention in humans (PEP):				<0.001				<0.001			=0.24
Expect anti-rabies vaccines	235 (27)	1367 (36)	195 (42)		1138 (36)	328 (25)	331 (47)		956 (34)	841 (36)	
Expect medical attention but unaware of PEP	107 (13)	541 (14)	54 (12)		487 (16)	132 (10)	83 (12)		397 (14)	132 (10)	
Unknown	516 (60)	1908 (50)	217 (46)		1493 (48)	853 (65)	295 (42)		1457 (52)	1184 (51)	
Rabies control in animals:				<0.001				<0.001			<0.001
Know 3 or more methods	15 (2)	140 (4)	26 (6)		107 (3)	62 (5)	12 (2)		88 (3)	93 (4)	
Know between 1 to 2 methods	449 (52)	2605 (68)	406 (87)		2088 (67)	677 (51)	695 (98)		1789 (64)	1671 (72)	
Unknown	394 (46)	1071 (28)	34 (7)		923 (30)	574 (44)	2 (0)		933 (33)	566 (24)	
Knowledge that rabies is fatal:				=0.04				=0.03			=0.09
Known	569 (66)	2355 (62)	297 (64)		1913 (61)	837 (64)	471 (66)		1759 (63)	1462 (63)	

Table 2.1: Knowledge about rabies pathology, transmission, prevention and control in relation to different determinants of knowledge. P-values obtained from chi-square test.

Table 2.1: (continued)

	Socioeconomic status				Residence			Previous exposure to a rabid animal		
Knowledge Variables	**Low 2056(40%)**	**Medium 1030 (20%)**	**High 2054 (40%)**	**P-value**	**Rural 3475 (68%)**	**Urban 1665 (32%)**	**P-value**	**No 4752 (92%)**	**Yes 388 (8%)**	**P-value**
Description of rabies:				<0.001			=0.6			<0.001
Correctly described as a disease	470 (23)	290 (28)	646(31)		944 (27)	462 (28)		1275 (27)	131 (34)	
Partially described	923 (45)	434 (42)	714 (35)		1391 (40)	680 (41)		1884 (40)	187 (48)	
Unable to describe	663 (32)	306 (30)	694 (34)		1140 (33)	523 (31)		1593 (33)	70 (18)	
Mode of transmission:				<0.001			=0.03			<0.001
Through bites	1569(76)	862 (84)	1718(84)		2839 (82)	1310 (79)		3783 (80)	366 (94)	
Through scratches	8 (1)	1 (0)	6 (0)		11 (0)	4 (0)		14 (0)	1 (0)	
Unknown	479 (23)	167 (16)	330 (16)		625 (18)	351 (21)		955 (20)	21 (21)	
Animals that can suffer from rabies:				<0.001			<0.001			<0.001
3 or more species identified	111 (5)	80 (8)	154 (8)		256 (7)	89 (5)		308 (7)	37 (9)	
1 or 2 species known	1183 (58)	672 (65)	1730 (84)		2559 (74)	1026 (62)		3295 (69)	290 (75)	
Unknown	762 (37)	278 (27)	170 (8)		660 (19)	550 (33)		1149 (24)	61 (16)	
Rabies prevention in humans (PEP)				<0.001			<0.001			=0.04
Expect anti-rabies vaccines	778 (38)	410 (40)	609 (30)		1155 (33)	642 (38)		1638 (34)	159 (41)	
Expect medical attention but unaware of PEP	247 (12)	136 (13)	319 (15)		526 (15)	176 (11)		654 (14)	48 (12)	
Unknown	1031 (50)	484 (47)	1126 (55)		1794 (52)	847 (51)		2460 (52)	181 (47)	
Rabies control in animals:				<0.001			<0.001			<0.001
Know 3 or more methods	63 (3)	44 (4)	74 (4)		106 (3)	75 (5)		156 (3)	25 (6)	
Know between 1 to 2 method	1712 (83)	762 (74)	987 (48)		2086 (60)	1374 (82)		3189 (67)	271 (70)	
Unknown	281(14)	225 (22)	993 (48)		1283 (37)	216 (13)		1407 (30)	92 (24)	
Knowledge that rabies is fatal:				=0. 56			<0.001		0.69	=0.69
Known	1270 (62)	652 (63)	1299 (63)		2109 (61)	1112 (67)		2982 (63)	239 (62)	

Table 2.2: Factors affecting reported practices for rabies prevention and control. P-value obtained from chi-square tests.

	First aid and medical attention (%)					Hospital presentation after exposure (%)				
	Do nothing, n=262 (5%)	**Report to police/ village leader, n=207 (4%)**	**Report to hospital, n=4148 (81%)**	**Wash wound then report to hospital, n=523 (10%)**	**P-value**	**>15 days, n=647 (12%)**	**2-14 days, n=142 (3%)**	**1 day n=103 (2%)**	**day of bite, n=4248 (83%)**	**P-value**
Intervention					<0.001					<0.01
None, 3118	338 (11)	162 (5)	2533 (81)	85 (3)		432 (14)	85 (3)	61(2)	2540 (81)	
Recent, 1313	124 (9)	29 (2)	1007 (77)	153 (12)		156 (12)	39 (3)	27 (2)	1091(83)	
Long-term, 709	61 (9)	16 (2)	608 (86)	24 (3)		59 (8)	18 (3)	15 (2)	617 (87)	
Education					<0.001					<0.001
None, 858	118 (14)	34 (4)	684 (79)	22 (3)		145 (17)	26 (3)	12 (1)	675 (77)	
Primary, 3816	372 (10)	151 (4)	3093 (81)	200 (5)		457 (12)	110 (3)	82 (2)	3167 (83)	
Secondary and above, 466	33 (7)	22 (5)	371 (80)	40 (8)		45 (10)	6 (1)	9 (2)	406 (87)	
Socioeconomic status					<0.001					<0.01
Low, 2056	283 (14)	114 (6)	1607 (78)	52 (2)		339 (16)	56 (3)	36 (2)	1625 (79)	
Medium,1030	91 (9)	50 (5)	848 (82)	41(4)		118 (11)	32 (3)	15 (2)	865 (84)	
High, 2054	149 (7)	43 (2)	1693 (83)	169 (8)		190 (9)	54 (3)	52 (2)	1758 (86)	
Residence					<0.001					<0.001
Rural, 3475	331(9)	90 (3)	2860 (82)	194 (6)		386 (11)	111 (3)	80 (2)	2898 (84)	
Urban,1665	192 (12)	117 (7)	1288 (77)	68 (4)		261 (16)	31 (2)	23 (1)	1350 (81)	
Gender					<0.001					<0.01
Female, 2810	325 (11)	102 (4)	2282 (81)	101(4)		386 (14)	74 (3)	43 (1)	2307 (82)	
Male, 2330	198 (8)	105 (5)	1866 (80)	161(7)		261(11)	68 (3)	60 (3)	1941 (83)	
Previous history of exposure					<0.001					<0.001
No, 4752	509 (11)	189 (4)	3834 (81)	220 (4)		624 (13)	117 (2)	89 (2)	3922 (83)	
Yes, 388	14 (3)	18 (5)	314(81)	42 (11)		23 (6)	25 (6)	14 (4)	326 (84)	

Table 2.2: (Continued)

	Action to the suspect biting animal				Action to carcass of biting animal			
	Do nothing 732 (14)	Kill the animal 4059 (79)	Report to livestock office 349 (7)	P-value	Throw away/ do nothing 1281 (25)	Bury or burn 3844 (75)	Cut head and send to livestock office 15 (0)	P-value
Intervention				<0.001				<0.001
None, 3118	410 (13)	2483 (80)	225 (7)		782 (25)	2333(75)	3 (0)	
Recent, 1313	185 (14)	1054 (80)	74(6)		308(23)	994 (76)	11(1)	
Long-term, 709	137 (19)	522 (74)	50 (7)		191(27)	517 (73)	1(0)	
Education				<0.001				=0.002
None, 858	163 (19)	629 (73)	66 (8)		260 (30)	597 (70)	1 (0)	
Primary, 3816	509 (13)	3067 (81)	240 (6)		912 (24)	2891(76)	13 (0)	
Secondary and above, 466	60 (13)	363 (78)	43 (9)		109 (23)	356 (77)	1(0)	
Socio economic status				<0.001				<0.001
Low, 2056	338 (16)	1534 (75)	184 (9)		604 (29)	1450 (71)	2 (0)	
Medium,1030	147 (14)	791 (77)	92 (9)		243 (24)	784 (76)	3 (0)	
High, 2054	247 (12)	1734 (84)	73(4)		434 (21)	1610 (78)	10 (1)	
Residence				<0.001				=0.56
Rural, 3475	460 (13)	2622 (81)	193 (6)		861(25)	2602 (75)	12 (0)	
Urban,1665	272 (16)	1237 (74)	156 (10)		420 (25)	1242 (75)	3 (0)	
Gender				<0.001				<0.001
Female, 2810	473 (17)	2147 (76)	190 (7)		773 (28)	2032 (72)	5 (0)	
Male, 2330	259 (11)	1912 (82)	159 (7)		508 (22)	1812 (78)	10 (0)	
Previous history of exposure				<0.001				<0.001
No, 4752	693 (14)	3739 (79)	320 (7)		1196 (25)	3543 (75)	13 (0)	
Yes, 388	39 (10)	320 (82)	29 (8)		85 (22)	301 (78)	2 (0)	

Factors		OR	95% CI	p-value
Education background				
	No formal education§			
	Primary	1.90	1.60 – 2.25	<0.001
	Secondary and above	2.33	1.82 – 2.97	<0.001
Interventions				
	No intervention §			
	Recent	0.95	1.82 – 1.10	0.49
	Long term	1.65	1.35 – 1.92	<0.001
Previous history of exposure				
	Yes	1.56	1.26 – 1.93	<0.001
	No §			
Socio-economic status				
	Low	0.84	0.72 – 0.97	0.02
	Medium	1.08	0.92 - 1.28	0.34
	High §			
Gender				
	Male	1.15	1.02 – 1.29	0.02
	Female §			

Table 2.3: Multivariate analysis for factors affecting levels of knowledge about rabies in Tanzania: § used as reference

Variable	First aid			Treatment seeking			action to suspect animal			Action to the carcass		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Intervention												
None ‡												
Recent		-	-	0.78	0.62-0.98	=0.03	0.77	0.62-0.92	=0.01	-	-	
Long-term		-	-	2.3	1.72-3.15	<0.001	0.67	0.53-0.83	<0.001	-	-	
Education												
None ‡												
Primary	1.41	1.12-1.76	<0.01	1.49	1.20-1.84	<0.001	1.47	1.21-1.79	<0.001	1.32	1.12-1.55	<0.01
Secondary and above	*2.17*	*1.45-3.31*	*<0.01*	*2.06*	*1.43-3.03*	<0.001	1.64	1.19-2.30	<0.01	1.43	1.10-1.87	<0.01
Socio economic status												
Low	0.47	0.38-0.58	=0.05	0.39	0.31-0.49	<0.001	0.71	0.57-0.89	<0.01	0.64	0.55-0.74	=0.08
Medium	0.77	0.58-1.01	<0.001	0.64	0.49-0.84	<0.001	0.81	0.64-1.03	0.08	0.85	0.71-1.02	<0.001
High ‡												
Urban		-	-	0.76	0.63-0.91	<0.01	0.87	0.73-1.03	=0.10	-	-	
Male	1.33	1.10-1.61	<0.01	1.2	1.01-1.44	=0.04	1.54	1.31-1.82	<0.001	1.32	1.16-1.51	<0.001
Previous history of exposure												
Yes	3.17	1.91-5.72	<0.001	2.94	1.87-4.95	<0.001	1.49	1.07-2.14	=0.02	-	-	

Table 2.4: The influence of knowledge on practice for rabies prevention and control. ‡ used as reference.

2.5 Discussion

Rabies remains a significant public health problem in Tanzania, where canine rabies is not controlled, and the bite of an infected dog is the most common means of transmission. No major steps have been taken by the government to promote awareness and precautionary behaviours in the community with regards to rabies prevention and control, possibly because of a lack of baseline data on knowledge, attitudes and practices regarding rabies. To our knowledge this is the first KAP study conducted in Tanzania on rabies.

Our findings demonstrate that the majority of Tanzanians are aware of rabies and know that it is transmitted through bites from infected dogs, but they lack a comprehensive understanding of rabies. Low levels of knowledge about rabies and poor practice with regards to rabies control and prevention in communities reflects the lack of higher-level commitment to a national program to control and prevent rabies in Tanzania.

There is no national rabies control program in Tanzania (Mazigo, 2011). Therefore people have limited knowledge of rabies especially the risks associated with bites from dogs. As there is no national plan to control rabies, most respondents got information about rabies either at school from teachers, from rabies researchers and livestock officers or from hospitals by clinicians. It is therefore necessary to introduce rabies in the education curricula in schools, where it is currently missing and since children are those most often affected by rabies. Again households with a history of exposure seem to have higher levels of knowledge, obtained as a result of advice from clinicians. Advice on risks of rabies from clinicians is important but is often too late. Education should be provided on preventive measures, for example using mass media, before a rabid animal bites someone.

A lack of detailed and precise knowledge about disease prevention and the risks associated with rabies was observed among many of the respondents. WHO guidelines require immediate wound washing using water and soap and disinfection before hospital presentation (WHO, 2005). Our results showed that most respondents were unaware of the need for immediate washing of the injury with water and soap. Studies in India, Pakistan and Uganda where rabies is endemic, also showed that a low proportion of people practice wound washing with soap and water (Ichhpujani et al., 2008, Fevre et al., 2005, Chhabra et al., 2004, Parviz et al., 1998). In our analysis reported wound washing was significantly associated with households with a history of suspect bite exposure, formal education, males and with families of high socio-economic status. People should be informed of these simple first aid measures that they should apply before consulting a doctor.

Previous studies have found that health professionals' knowledge is a major determinant of appropriate treatment for patients (Dube et al., 2010). For prevention of human rabies deaths, both the public and health practitioners should be aware of how rabies is transmitted, what animals suffer from rabies and how it is prevented. Knowing the risks associated with rabies could raise the proportion of bite victims who obtain PEP. However, the reported low levels of knowledge about zoonotic disease among health practitioners in Tanzania, especially among rural health practitioners (John et al., 2008) may also lead to incorrect advice (misdiagnosis) for bite exposures. The problem of misdiagnosis of rabies occurs elsewhere in Africa. In Malawi 11.5% of human rabies cases were misdiagnosed as cerebral malaria (Mallewa et al., 2007). Training about rabies diagnosis for health practitioners should also be encouraged in areas where rabies is endemic.

Proper administration of PEP is critical for saving the lives of exposed individuals. Our study reported about 10% of victims would not seek medical attention, potentially due to a lack of knowledge about the dangers of rabies. Previous studies in Tanzania reported that about 20% of human bite exposures who do not seek PEP, subsequently develop rabies (Hampson et al., 2008). This behaviour could be corrected by public awareness about the dangers of rabies and could therefore prevent unnecessary human rabies deaths.

Mass dog vaccination is the most effective measure to control rabies. The majority of respondents claimed to be willing to vaccinate their dogs. However the majority also reported that vaccinations are not regularly conducted in their areas except in those districts with rabies interventions. Our findings showed that there is a lack of sharing of information with livestock officers when suspect bites occur in a village. Most respondents reported they would kill the biting animal without informing livestock officers. This makes it difficult for veterinary services to appreciate the scale of the problem and take appropriate steps to prevent further transmission. In areas where rabies is endemic, reporting information on rabies cases should be an ongoing part of surveillance by the veterinary services and should involve community participation. Our results suggest about one quarter of respondents claimed they would throw away the carcass of a rabid animal. This habit poses a threat for scavengers which may feed on dead infected animals. In Madikwe Game Reserve, in South Africa, an outbreak of rabies in endangered wild dogs (*Lycaon pictus*) in 2000 was associated with feeding on the carcass of a rabid jackal (Hofmeyr et al., 2004). Educational information should indicate that all mammals suffer from rabies and that carcasses should be burned or buried to stop the transmission of rabies to scavengers. Similar findings were reported in a survey conducted in Thungsong District in Thailand which found that only 16% of participants knew that all mammals can suffer from rabies (Kongkaew et al., 2004).

2.5.1 Conclusion and recommendations

In conclusion, most respondents showed low levels of knowledge about rabies that could be affected by the lack of a national rabies control programme to impart to the community knowledge about risks associated with rabies. This lack of critical knowledge about rabies undoubtedly results in unnecessary deaths. In order to correct the knowledge gaps highlighted in this study, there is a need for a national rabies control program emphasising preventative behaviours, especially simple messages that address major knowledge gaps like "all mammals suffer from rabies", "bury or burn carcasses of dead rabid animals", "vaccinate your dogs and cats against rabies", "immediately wash your wound with water and soap and seek PEP after a bite from a rabid animal". This information could be channelled through media, community meetings and professionals' including community health workers, teachers, livestock officers and clinicians. Based on our findings we recommend that:

1. There is a need to increase knowledge of rabies, particularly on proper prevention and control because current levels of knowledge in Tanzania are very low.
2. Educational information should be incorporated in school curricula so that children are made aware of the dangers of rabies.
3. National rabies education campaigns should address knowledge gaps and improve rabies control and prevention practices.
4. Health education by researchers, teachers and clinicians currently plays an important role in raising awareness about rabies and it should be promoted and strengthened.
5. Attention should be paid to all bites from suspect animal, as all mammals suffer from rabies, and burying or burning the carcass of suspect rabid animal could stop transmission of rabies.
6. People should report incidences of rabies to their local livestock office.

These recommendations based on experiences in Tanzania could be applied in other developing countries were rabies is endemic.

3 The burden of rabies in Tanzania and its impacts on local communities

3.1 Abstract

Every year more than 10 million people are exposed to bites from rabid animals and an estimated 55,000 people die of rabies. The estimated annual cost of rabies globally has been calculated at around US$ 580 million, with nearly half of these costs due to expenditure by patients on post-exposure prophylaxis (PEP). However, this may be a substantial underestimate of the true burden of rabies as the indirect costs associated with rabies prevention in low income settings have not been validated. Information about the true burden of rabies and its impacts on local communities is needed for setting health policy priorities. We used hospital and veterinary records to initiate contact tracing to estimate rabies incidence (human deaths and bite exposures) in local communities in rural Tanzania and we used questionnaires with bite-victims and their families to investigate health-seeking behaviour and associated costs. We found that the probability of an individual bitten by a suspected rabid dog obtaining their first post-exposure vaccine dose was 0.72 (with no bite victims obtaining immunoglobulin), with lower probabilities for subsequent doses indicating poor compliance (0.67, 0.61, 0.03 and 0.01 for the second, third, fourth and fifth doses respectively). The average cost incurred by bite victims was ~US$35 but varied from US$0 (for ~17% of bite victims who were provided PEP free-of-charge and the 28% of bite victims who did not obtain PEP) to over US$300 (for patients with complicated dog bites). We calculated that an average patient in rural Tanzania, where the majority live on less than US$1 per day would need to spend over US$70 to complete WHO recommended PEP schedules. This estimate is more than 2 times higher than has been previously estimated for the indirect costs associated with rabies in Africa, and suggests that the true cost of rabies in this setting has been substantially underestimated and should be considered in re-evaluations of the burden of rabies.

3.2 Introduction

Rabies is a fatal viral zoonotic infection of the central nervous system caused by a lyssavirus (Rupprecht et al., 2002, Hemachudha et al., 2002, Willoughby et al., 2005). This disease, which can affect all mammals, is transmitted in the saliva of infectious animals (Baer, 1975). Rabies is endemic in low income countries (Hampson et al., 2008, Chulasugandha et al., 2006, Knobel et al., 2005, Dodet et al., 2008a, Dodet et al., 2008b), causing an estimated 55,000 human deaths each year, with 98% of all these deaths following bites from rabid dogs (Knobel et al., 2005). Tanzania provides an excellent example of the public health impact of rabies in these low-income settings. Tanzania has an estimated annual incidence of ~5 rabies deaths per 100,000 population which is equivalent to 380 – 1,900 human rabies deaths per year (Cleaveland et al., 2002).

Human rabies deaths can be prevented through timely and appropriate post-exposure prophylaxis (PEP), which following a bite by a rabid animal provides effective protection against rabies (Haupt, 1999, Rupprecht, 2006, David, 1997, Quiambao et al., 2005). Unfortunately many people still die from rabies, especially in Asia and Africa where canine rabies is endemic, because they either cannot afford PEP or because PEP are not available where they live (Briggs, 2010, Hampson et al., 2008). Globally, the total annual expenditure for rabies control and prevention was estimated to be US$583 million. In Africa alone, it was estimated to be US$20.5 million (Knobel et al., 2005).

A major challenge in preventing human rabies is access to PEP. Generally, access to health services has been well defined as a multidimensional process that in addition to the quality of care, involves geographical accessibility, availability of the right type of care for those who need it, financial accessibility, and acceptability of services (Peters et al., 2008). Geographical factors are known to be an important but often overlooked factor in quantifying the economic burden of diseases, but can have large impacts (Hosseinpoor et al., Habibov, Kruk et al., Barat et al., 2004, Onwujekwe et al., 2006). The distance that must be traveled in order to use health services therefore plays an important role in the use of primary healthcare as it can present an important barrier (Al-Taiar et al., 2010). More generally, problems of access to adequate and appropriate health care are common in developing countries (Attanayake et al., 2000, Chuma et al., 2010, Chuma et al., 2006, Meslin, 1994, Schellenberg et al., 2005).

To prevent human rabies deaths, bite patients should comply with the World Health Organization (WHO) recommended rabies vaccination schedules plus inoculation with rabies immunoglobulin for severely exposed bite-victims (Rupprecht et al., 2002, WHO, 2007). The WHO standard post-exposure vaccination schedules are the 'Essen' 5-dose regimen on days 0, 3, 7, 14, 28 and Thai Red Cross intradermal (TRC-ID) regimen on days 0, 3, 7, 30, whereas the Advisory Committee on Immunization Practices (ACIP) recommended a reduced 'Essen' 4 dose schedule on days 0, 3, 7 and 14. National health authorities choose their preferred PEP regimen. In Tanzania, generally patients receive 3 doses of PEP administered on days 0, 7 and 28; though this Tanzanian regimen is not recommended by WHO.

Elimination of human rabies deaths has been achieved in Western Europe, North America and in much of Latin America through effective, large scale mass canine vaccination (Hampson et al., 2007, WHO, 2005, Belotto et al., 2005, King et al., 2004, WHO, 1992), demonstrating that the rabies can be controlled and eliminated by effective vaccination of reservoir animal populations. Again, local programs in Tanzania have shown that mass domestic dog vaccination campaigns can lead to a dramatic reduction in demand for PEP and be cost-effective and efficacious in reducing rabies incidence and human exposures (Kaare et al., 2009, Cleaveland, 2003).

In Tanzania, obtaining PEP is a serious challenge for bite-victims. The PEP cold chain storage requirements of 2–8°C (Dodet, 2007) limit access to PEP in areas where electricity is not available, especially in rural areas where most rabies cases occur (Hampson et al., 2008). This results in inequalities whereby bite victims from rural areas bear a disproportionately higher burden than bite victims from urban areas. Frequent shortages of PEP at health centres and expenses of PEP also limit access. Rabies immunoglobulin are almost never administered in Tanzania (Hampson et al., 2008). The treatment seeking behaviour of bite victims and the associated costs of accessing rabies PEP has never been investigated in Tanzania or in Africa as a whole. Therefore, evaluating health service delivery in developing countries may be useful in understanding the true burden of rabies in terms of the costs of acquiring PEP.

In this chapter, we present comprehensive field data to portray a more holistic picture of the true burden of rabies in an endemic setting and compare these with previously reported estimates of the burden of rabies. In addition we investigate the health seeking behaviour and coping strategies of bite victims in terms of money and time. Psychological issues and long-term impacts due to the death of household members due to rabies were not quantified in this study. Our findings are guided by the analytical framework presented in Figure 1.2, particularly with regard to individual compliance with PEP regimens and outcomes for affected persons (Figure 1.2, G1, G2 and G3 to produce outcomes). We also investigate how institutional factors such as cost-sharing health policies and access to health services, determine coping strategies of bite victims (Figure 1.2, C1 and C2 determine E1 and E2).

3.3 Materials and Methods

3.3.1 Study areas

The study was conducted in 4 districts in Tanzania covering both urban and rural populations, and including the main livelihoods in Tanzania, which are agro-pastoralism and subsistence agriculture (Figure 3.1). In northern Tanzania, this study was conducted in Serengeti district and Musoma Urban district. In southern Tanzania, it was conducted in Ulanga and Kilombero districts. Serengeti district is inhabited mainly by agropastoralists and subsistence farmers. The district hospital of Serengeti district is located in Mugumu town, the headquarters of the district. There is no tarmac road in Serengeti district and thus most roads are in poor condition especially during the rainy seasons. Musoma Urban district is located on the shores of Lake Victoria. In this district most people are employed in small business, small-scale agriculture, the Tanzanian civil service and fishing (NBS, 2005). Musoma Urban is an urban district with better physical and social infrastructure and where all major town roads are tarmac. Musoma Urban district serves as the headquarters of the Mara region and is where Mara regional hospital is located. In southern Tanzania, Ulanga and Kilombero districts are situated in the floodplain of the Kilombero valley. The majority of people living in these two districts are subsistence farmers, fishermen and pastoralists. District hospitals in Ulanga and Kilombero are located in Mahenge town and Ifakara town, which are the respective district headquarters. Both districts have very poor roads although there are a few short stretches of tarmac in the district capitals and on the steepest roads. Flooding in the Kilombero valley makes roads inaccessible during the rainy season, reducing access to health facilities.

We used the criteria used by Tanzanian National Bureaus of Statistics (NBS) in differentiating rural and urban areas (NBS, 2005). The definition of urban areas according to NBS and that is applied in this study is that urban areas are regional and district headquarters with boundaries as identified by the Tanzanian Village Act of 1975 and Urban Ward Act of 1976. In this study, Musoma Urban district was identified as a typical urban area, whereas all district headquarters were assigned as urban areas, and other areas outside of district headquarters were classified as rural areas. Hence, these four districts provide a representative comparison of the economic burden of rabies between rural and urban areas.

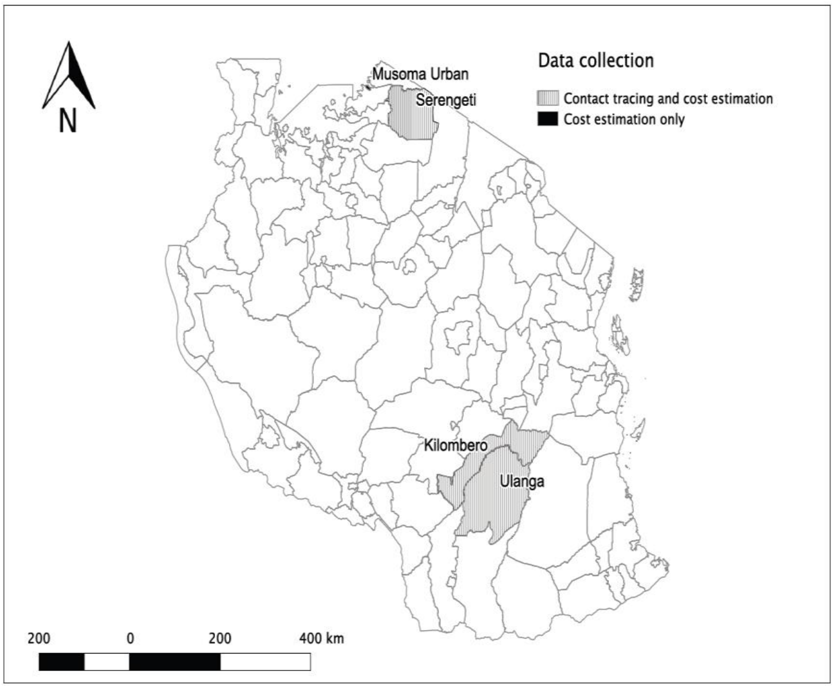

Figure 3.1: Map of Tanzania showing the study areas. The legend indicates where contact tracing was administered and where cost data only was collected.

3.3.2 Research methodologies

Two methodologies were used in this study: 1) contact tracing was used to determine rabies incidence in the study areas and was conducted only in the three districts of Serengeti, Ulanga and Kilombero; 2) questionnaires were administered in all 4 study districts to determine health seeking behaviour, associated costs and coping strategies.

3.3.2.1 Contact tracing

Contact tracing is a method adopted from public health surveillance (Hampson et al., 2007, Hampson et al., 2008, Lembo et al., 2008), whereby extensive investigative interviews are used to determine networks of transmission, identify case histories, source of exposures and other bite contacts if known. We collected and compiled animal bite records and case reports from veterinary and livestock offices and details of patients reporting with animal-bite injuries from hospitals, clinics and dispensaries within the focal districts of Kilombero, Ulanga and Serengeti. These records were used to initiate contact tracing which involved making visits to the households of bite victims. During contact tracing we collected information about the age, gender, and livelihood of bite victims, the severity of the bite, and the circumstances of the bite. Information on the attacking species was collected including observed characteristics such as aggressiveness, drooling/salivation, abnormal behavior and vocalization, roaming, listlessness, or paralysis. In addition we recorded information on the subsequent fate of the attacking animal e.g. killed, disappeared, alive or dead. For the known biting species, which were mostly domestic dogs, information was collected from their owner (if identified) on how the animal may have become infected and whether it had any previous history of vaccination.

The aforementioned clinical signs were used to evaluate whether the attacking animal could be clinically categorized as rabid, based on the criteria of the 'six-step' method (Tepsumethanon et al., 2005). The 'six step' method is a diagnostic method based on epidemiological (history of exposure) and clinical criteria. It is applicable when brain tissues are not available for laboratory confirmation. Information on clinical signs of the suspect rabid animal obtained from the witnessing villagers or LFOs was used for clinical diagnosis. Such criteria were previously reported to be accurate for about 75% of specimens submitted for laboratory confirmation (Hampson et al., 2008, Lembo et al., 2008). Whenever possible, brain stem samples from carcasses of animals that caused bite injuries were collected using the ‘straw’ technique as recommended by the World Health Organisation (Lembo et al., 2006, Barrat, 1996). These samples were sent to Sokoine University of Agriculture in Tanzania for rabies case confirmation using the fluorescent antibody test. Universal Transverse Mercator (UTM) coordinates were collected using a Global Positioning System (GPS) for each health facility and household visited and used to estimate an overall straight-line distance travelled by bite patients whilst seeking PEP.

3.3.2.2 Questionnaires

A structured open-ended questionnaire was administered to bite victims and to the families of rabies victims (n=706, including 18 rabies death cases) that were affected between January 2006 to December 2008. We collected information on demographic characteristics of the household of the victims, costs related to seeking PEP and coping strategies for bitten individuals. We also recorded the number of health facilities visited by the victim whilst seeking PEP, the number of days spent at each health facility and the amount of money paid for medical services, travel and other costs. When patients were escorted during the PEP seeking process, related costs were also captured. Information was also collected about how households raised funds to pay for PEP. In order to validate PEP costs incurred, heads of households were asked to produce receipts and in the absence of receipts, market prices or local fares were used to estimate the costs. Respondents were also asked to mention how much time both the patient and carer spent in seeking PEP. However the questionnaire did not capture losses due to the premature death of a household member due to rabies and of being absent from school for school children.

3.3.3 Epidemiological and economic parameters

3.3.3.1 Demographic data

Human demographic data for the study were drawn from the Tanzanian national population and housing census of 2002 (NBS, 2005). The estimated population growth rates for each district according to the 2002 census were used to project the population size of the study areas for 2006-8. The total numbers of traced suspect bite and death cases that occurred in the study areas for the period of January 2006 - December 2008, together with the projected demographic data were used to estimate of annual rabies bite incidence and annual death incidence per 100,000 persons.

3.3.3.2 Economic costs

For this analysis, the direct medical costs included the costs of biological (only rabies vaccines, since immunoglobulin were not administered in the study areas) and the costs associated with wound care such as antibiotics and tetanus immunizations and toilet wound costs. The price year was 2010. The indirect costs included out-of-pocket expenses for patients, such as transport costs to and from health centres and hospitals, accommodation costs in seeking PEP, other costs for communication (phone calls), food and drinks. Non-medical costs included all productivity loss due to time spent seeking PEP. The time lost for both patients and escorts was valued in monetary terms according to projections of per capita daily income from the Tanzanian Household Budget Survey (HBS) of 2007 (NBS, 2009). All medical and non-medical costs were expressed in terms of Tanzanian shillings (TZS), and converted to US dollars (US$) using the average annual exchange rate in 2010, which was estimated to be 1 TZS to US$ 0.000687 (BOT, 2011). Average costs of PEP according to different regimens and methods of subsidization were calculated as mean cost (urban or rural) per dose multiplied by the number of clinic visits in the PEP regimen plus annual income lost (rural or urban respectively). These losses were converted into the percentage of annual income lost and equivalent of day's wage lost.

3.3.3.3 Doses administered

The total number of PEP doses (i.e. injections) administered and patient visits made to health centres to obtain PEP were derived from the questionnaires and validated from hospital records. We used the number of doses received to estimate the proportion of patients that received PEP and patient compliance during PEP courses. For the period of this study, doses of PEP were only delivered at district, regional and national hospitals.

3.3.4 Data analysis

We calculated (i) average costs per suspect bite victim and (ii) average costs per dose. An average cost per suspect bite was defined as the average amount of cash spent by victims and caretakers following a bite, including costs of obtaining PEP. Therefore suspect rabies bite victims including those who did not seek medical attention were included in this calculation. Average cost per dose was defined as the average amount of cash spent by patients and their caretaker in obtaining a single PEP dose. Therefore only patients who did seek and successfully obtain at least one dose of PEP are included in this calculation. This was estimated by summing all cash costs spent on PEP and associated costs and dividing by the total number of doses delivered.

Chi-square tests were used to examine differences in sources of funds to pay for PEP, numbers of escorts and places/hospitals where PEP doses were received for rural and urban patients. A Poisson regression was used to analyse factors that determine the number of PEP doses that a bite-victim completes. Explanatory variables investigated were direct medical costs, travel costs, accommodation costs, other costs, and loss of productivity costs, gender, residence (rural or urban), district and distance to PEP delivering hospitals. Every explanatory variable was tested to assess significance (at $P<0.05$) then a final multivariate regression model was developed using backward stepwise variable selection. All statistical analyses were implemented within the statistical programming environment (R Development Core Team, 2009).

3.4 Results

3.4.1 Rabies bite incidence and incidence of human rabies deaths

A total of 2,439 people who reported animal bite injuries were traced and investigated across three districts, from January 2006 to September 2009 in Ulanga and Kilombero districts and from January 2002 to December 2009 in Serengeti district: 391 in Ulanga, 233 in Kilombero and 1815 in Serengeti. Of these, 1326 (54%) met the case definition of being suspect rabid bite cases as per criteria of the 'six-step' method: 168 (72%) in Kilombero district, 299 (76%) in Ulanga district and 785 (43%) in Serengeti district. Estimates of the annual incidence of bites from suspected rabid dogs per 100,000 persons, and annual incidence of human rabies deaths are summarised in Table 3.1. The majority of suspected bites (54%) were to children less than 15 years of age (overall range 1-90 years old). The proportion of males bitten by suspect rabid animals was 0.53. The sources of exposure were as follows: domestic dogs (1244 or 84%), wild animals (115 or 8%) including jackals, honey badger, genet, hyenas, mongoose, wild pig and monkeys, domestic cats (68 or 5%) and other domestic animals including cows and donkeys (42 or 3%). The peak of bites in Ulanga district was observed between July and September 2007 (Figure 3.2), where there was an outbreak of rabies in which 64 people were bitten by suspect rabid animals.

District	Human population*	Human population growth rate (%)	Human population density (/sq.km)	Average annual bite incidence/ 100,000	Average annual death incidence /100,000
Ulanga	193280	2.4	7.9	37.9	2.5
Kilombero	321611	3.8	21.6	11.2	0.8
Serengeti	176057	3.3	8.2	33.4	1.6

Table 3.1: Average annual incidences of suspect bite injuries and human rabies deaths/100,000 humans in the study area. * Human population in year 2002.

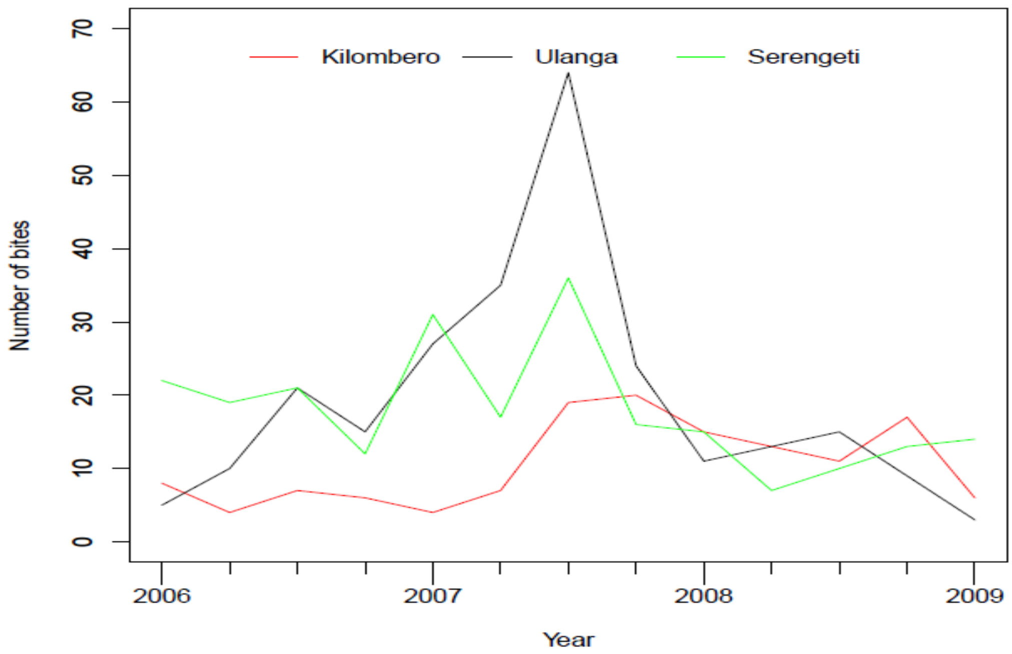

Figure 3.2: Number of traced suspect rabies cases per quarter in the study areas from January 2006 to December 2008.

3.4.2 Estimating costs of PEP and coping strategies of bite victims

Questionnaires were administered to a total of 706 animal bite victims that were bitten between the periods of January 2006 to December 2008 to capture PEP related costs and coping strategies. Of these, 415 (59%) bite victims met the case definition of being bitten by suspect rabid animal as per criteria of the 'six-step' method, 97 in Kilombero (92% of animal bites), 25 in Musoma Urban (23%), 152 in Serengeti (46%) and 141 in Ulanga (87%). Most individuals with bites by suspected rabid animals (68%) were from rural areas. The majority of bite victims were escorted to hospital whilst seeking health services (204 out of 284 in rural areas and 100 out of 131 in urban areas).

3.4.2.1 Health facilities where PEP were received

Significantly more bite victims from villages close to the district hospital reported earlier for PEP compared to those from villages far from district hospitals (Table 3.4, x^2 = 11.13, P= 0.05). Bite patients attended multiple hospitals to receive PEP, in particular patients from rural areas. Although the majority of patients received their PEP doses at the same hospital, some patients completed their PEP doses in other hospitals due to shortages of PEP. About 66% of patients from rural areas received PEP in their district hospital whereas 12% received PEP from another district hospital, 14% from their regional hospital, 3% from another regional hospital, 4% from the National hospital and 0.05% from outside of the country. On the other hand, about 67% of patients from urban areas received PEP at their district hospital (their home town), 3% from another district hospital, 25% from their regional hospital, 1% from another regional hospital and 4% from the national hospital. Patients from Musoma Urban where the regional hospital also serves as the district hospital located in their home town, did not incur many indirect costs. Those who obtained PEP outside of their district hospital or regional hospital experienced shortages of PEP in either their district or regional hospital and sought PEP from another major hospital with PEP in stock.

3.4.2.2 Average costs per suspect bite

On average, rural bite victims spent a total of US$44.79 per suspect bite whereas urban bite victims spent US$43.25 (P=0.01, Table 3.2). Medical costs ranged from US$0 for those who either received free medical services or didn’t seek medical attention, to more than US$ 250 for complicated bites, which involved surgical operations. The monetary value for time lost was equivalent to US$7.22 per suspect bite in rural areas whereas in urban areas it was estimated to be US$17.03.

Components		Average costs (in USD) per suspect bite (range in brackets)		Average (in USD) costs per dose	
		Rural	Urban	Rural	Urban
Direct medical costs		23.85 (0.00 – 82.60)	17.32 (0.00 – 251.05)	12.01	8.19
Indirect medical costs	*Travel costs*	9.51 (0.00 – 73.59)	4.21 (0.00 – 49.52)	4.79	1.99
	Accommodation costs	2.21 (0.00 – 44.71)	4.18 (0.00 – 58.46)	1.11	1.98
	Other costs	2.00 (0.00 – 82.54)	0.51 (0.00 – 34.38)	1.00	0.24
Non medical costs	*Lost income [days lost from work]*	7.22 [11 days] (0.69-38.42)	17.03 [11 days] (1.55-89.94)	3.63	8.00
Total costs		44.79	43.25	22.54	20.40

Table 3.2: Estimated average costs per suspect bite and per PEP vaccination dose.

Cost Scenario		Cost of PEP(US$)		Equivalent percentage of annual income (%)		Equivalent day's wage (productive days)	
		Rural	Urban	Rural	Urban	Rural	Urban
WHO 5 doses regimen[¥]	*No subsidies*	112.70	102.00	51	25	163	66
	100% subsidized	52.65	61.05	28	18	76	39
	100% subsidized and PEP decentralized.	28.70	51.10	18	16	42	33
ACIP 4 doses regimen[§]	*No subsidies*	90.16	81.60	40	19	130	58
	100% subsidized	42.12	48.84	21	13	61	32
	100% subsidized and PEP decentralized.	22.96	40.88	13	12	33	26
Tanzanian[λ] regimen	*No subsidies*	67.62	61.20	29	13	98	39
	100% subsidized	31.59	36.63	15	9	46	24
	100% subsidized and PEP decentralized.	17.22	30.66	9	8	25	20

Table 3.3: The average costs of PEP according to different schedules and methods of subsidization in relation to income. The projected average per capita daily income for 2010 was USD 0.68 in rural areas and USD 1.55 in urban areas. Calculation was ((Cost per dose + (days lost per dose * daily income))*clinic visits)/annual income. [¥]regimen was approved by WHO; [§]regimen was approved by Advisory Committee on Immunization Practices, (ACIP) in USA since 2009; [λ]a Tanzanian regimen which is not WHO approved regimen.

3.4.2.3 Average cost per dose

A total of 841 doses were delivered to suspect rabid bite patients for the period between January 2006 and December 2008 (See Table 3.4). On average the total costs required to obtain one dose of PEP was estimated to be US$ 22.54 in rural areas and US$ 20.40 in urban areas (Table 3.4). Regression analysis for factors determining completion of PEP showed that the number of completed PEP doses is influenced by direct medical costs ($P<0.001$), travel costs ($P<0.001$), distance to hospital ($P=0.02$), and by the district (Musoma Urban, $P=0.02$, Serengeti, $P<0.01$, Ulanga $P=0.76$).

District	Average distance to district hospital in kms (Std. Dev.)	Average distance to regional hospital in kms (Std. Dev.)	Suspect bite victims requiring PEP	Suspect bite victims who got at least one PEP vaccination (%)	Suspect bite victims who got at least one PEP dose for free	Number of PEP doses delivered
Ulanga	20.68 (17.54)	241.23 (13.75)	141	96 (68%)	40	259
Kilombero	23.91 (32.82.97	193.01 (36.63)	97	81(84%)	8	235
Serengeti	27.59 (15.91)	82.43 (18.19)	152	102(67%)	2	288
Musoma Urban	4.12 (1.36)	4.12 (1.36)	25	19(76%)	0	59
Overall	22.96(21.85)	157.51(81.67)	415	298(72%)	50	841
Overall rural	32.19(20.64)	156.02(80.72)	284	201(71%)	22	564
Overall urban	2.97(2.28)	160.74(83.90)	131	97(74%)	28	277

Table 3.4: Average distance to hospitals and the proportion of suspect bite victims to receive doses of PEP.

3.4.3 Coping strategies for obtaining PEP

Families adopted various coping strategies to meet the costs of obtaining PEP. Families had to transform their assets into cash. Poor rural families with little or no assets often were unable to afford PEP and experienced financial hardship while raising funds for PEP. We found that residence (rural or urban) had a significant impact on the source from which households obtained funds to pay for PEP (x^2 = 38.80, $P<0.001$). Patients from urban areas were more likely to use money from their salaries or sell their assets whereas patients from rural areas either obtained funds from selling crops or selling livestock (Figure 3.3). Poor rural farmers were worst affected because they depend solely on one source of income (agricultural produce). Despite the importance of PEP for saving the lives of bite victims, we found that PEP was not affordable to many poor individuals living in rural areas, who have to pay for PEP and transport costs to reach urban areas. The implications of these costs included delays in obtaining PEP, poor compliance with PEP regimens or human rabies deaths.

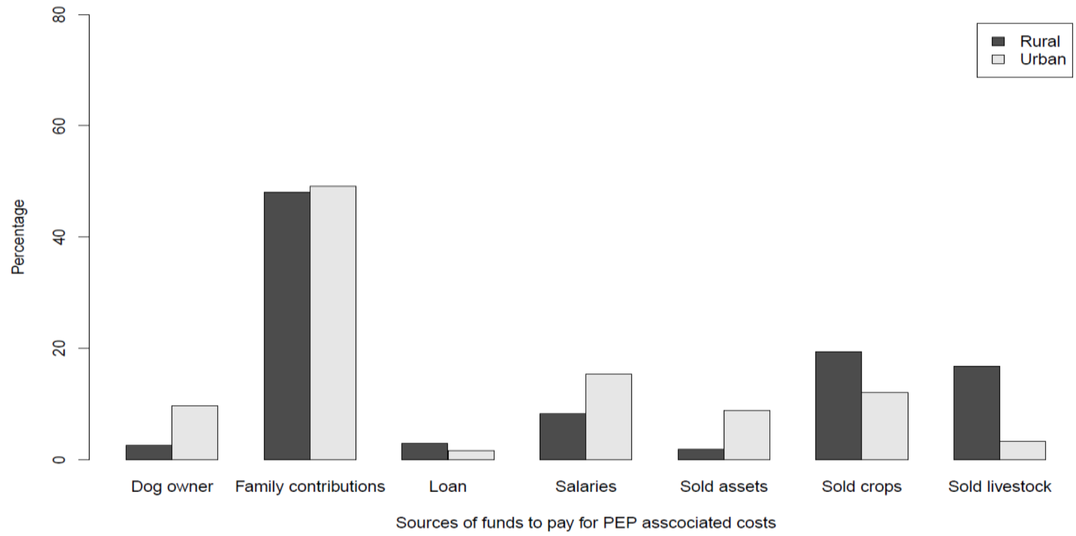

Figure 3.3: Means of obtaining funds to pay for overall costs of PEP.

3.4.3.1 Delays to obtaining PEP

Most people who attended a medical facility did so shortly after exposure, but there was considerable variance in delays before receiving the first PEP dose (Figure 3.4). Patients had to wait for hospitals to procure PEP or had to travel to other districts to obtain PEP. Patients from urban areas reported to clinics earlier than patients from rural areas (x^2 = 37.99, P= 0.04). Distance to the district and regional hospitals were both significant predictors of delays in receiving PEP (P= 0.001).

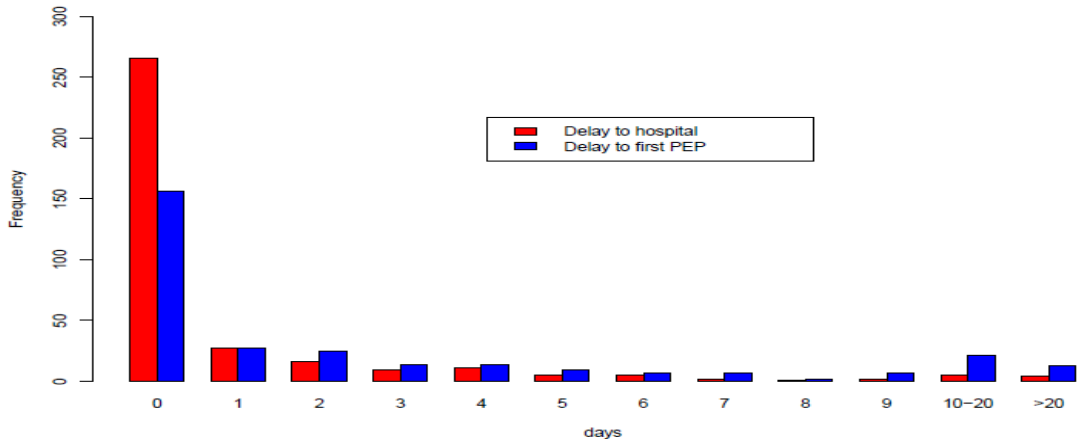

Figure 3.4: Distribution of delays to hospital presentation (red) and till obtaining the first dose of PEP (blue).

3.4.3.2 Probability of receiving and completing PEP schedules

We found that about 72% of bite victims obtained at least one dose of PEP. Among those who received PEP, 67% returned for a second dose, i.e. about 10% of patients dropped out after a single dose (Figure 3.5). Our analysis showed that residence, medical and transport costs were associated with incomplete PEP ($P<0.01$). There were no association between gender of the patient with incomplete PEP ($P=0.09$). Patients from rural areas were more likely to have an incomplete vaccine course.

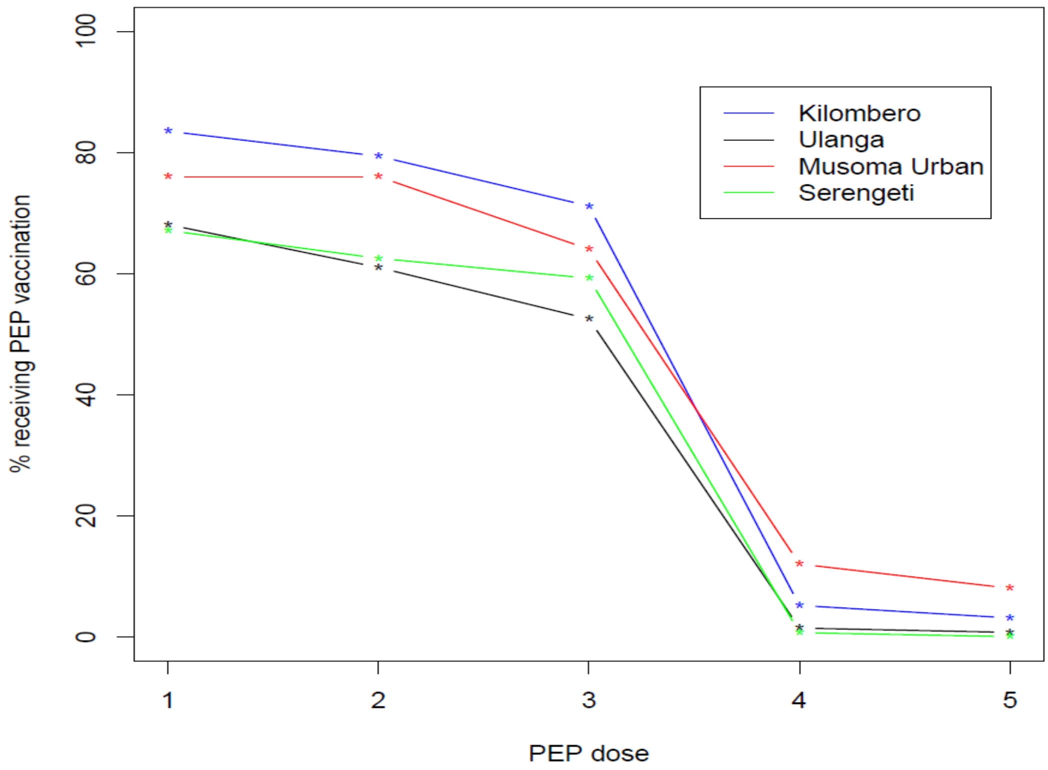

Figure 3.5: The probability of obtaining and completing regimes of PEP in the study areas.

3.4.3.3 Human rabies deaths

We observed that among 117 bite victims who did not seek PEP, 18 (15%) developed rabies. Most of rabies deaths (88%) were subsistence farmers and 78% involved children less than 16 years of age. Distance to the district hospital and regional hospital together with direct medical costs were significant predictors of human rabies deaths ($P<0.01$). Only two deaths occurred among bite victims living within 10 kilometers of a regional hospital who didn't get PEP, with the remainder occurring in patients based more than 60 kilometers from regional hospitals.

3.5 Discussion

We investigated the burden of rabies in Tanzania and its impacts on local communities and demonstrated that human bites from suspect rabid animals impose a substantial burden to households. Poor rural patients suffer disproportionately higher costs to obtain PEP compared to urban patients. Rural patients often live far from health facilities where PEP is available, which are generally located in urban areas. Our study showed that patients from urban areas reported earlier than patients from rural areas. This delayed presentation of bite victims was associated with an increased risk of death.

PEP is vital for rabies prevention. PEP requires repeat visits to hospital to complete a full course. This requires bite patient's compliance for a full course of PEP. We show that compliance with the WHO recommended 5 dose regimen requires over US$ 100 for rural and urban patients, if PEP is not subsidized. Rural patients are more vulnerable due to wage disparities compared with urban patients. For example compliance of 5 doses of PEP requires US$ 112.7 for rural patients, which constitutes 51% of the average annual incomes of people living in rural areas. This amount is unaffordable for most poor rural Tanzanians, of whom the majority survive on less than 1 dollar a day, resulting in poor compliance. To prevent rabies deaths in poor rural communities, it important for governments to subsidize PEP and choose reduced PEP regimens. Very few countries in West Africa are reported to subsidize PEP (Dodet et al., 2008a). But without subsidy, it is apparent that rabies will continue to claim the lives of thousands.

The findings of this study show that there is a need for medical services in Tanzania to improve availability of PEP especially in rural areas. Frequent shortages of PEP in most health facilities cause delays in receiving PEP and increased risk of developing this fatal disease. If the public health sector were to subsidise and decentralize PEP availability this could enable poor families with few assets or little means to pay, especially poor peasants who depend on farm outputs, to obtain PEP. This research also highlighted the importance of adopting the reduced dose PEP regimens, which would help reduce medical costs incurred to treat bite victims exposed to rabies and would help to increase patient compliance.

One of the most effective methods by which Tanzania can reduce expenditure on PEP is for veterinary services to invest in mass dog vaccination. Studies in northwest Tanzania demonstrated the impact of mass dog vaccination on reducing animal-bite injuries and demand for PEP (Cleaveland, 2003, Kaare et al., 2009). Control efforts should therefore be targeted towards domestic dog populations that maintain the disease. High levels of mass dog vaccination coverage in Africa can be achieved at a relatively low cost, less than US$ 2 per dog (Kaare et al., 2009, Kayali et al., 2006), making this a highly effective way to control rabies (Hampson et al., 2009).

We have seen an increased effort by the international community to improve the health of the world’s poor community. Attention has been focused on the relationship between health and poverty particularly in relation to the Millennium Development Goals (MDGs). One of the major goals of the MDGs is a 50% reduction in the number of people living in absolute poverty by 2015. Diseases such as malaria, HIV/AIDS and TB have featured prominently in terms of attracting funding for achieving these goals, being given high priority by the international health community and donor agencies. Rabies is severely neglected and does not appear among the top priority diseases, but it is a disease of poverty. A One-Health approach should be encouraged and strengthened by collaboration and sharing of local epidemiological information between public health and veterinary services for rabies control and prevention.

3.5.1 Recommendations

Our results provide useful data to inform policy makers to justify the integration of rabies control as a strategy for Growth and Reduction of Poverty (NSGRP) for meeting the United Nation’s MDGs 1 and 6, particularly of eradicating extreme poverty and combating HIV/AIDS, malaria, and other diseases. The rabies disease burden is substantial and calls for national and global attention. Even if medical costs are fully (100%) subsidized by the government, out-of-pocket patient expenses are still high (Table 3.3). Therefore, subsidization and decentralization of PEP would potentially have the most benefit for the rural poor and improve compliance, since it would both be available locally and be more affordable.

In comparison to estimated costs in the literature, our current estimates suggest that costs of seeking PEP are substantially underestimated. For instance a previous study assumed PEP was provided by the government free-of-charge to patients (Knobel et al., 2005). Our study showed that only 15% of patients received free PEP. This previous study also estimated a full course of PEP (direct and indirect costs) including RIG costs US$ 92.78 in Africa. Our results showed that for a full course of PEP excluding RIG, a rural Tanzanian patient would have to pay overall costs of US$112.70 for a 5-dose regimen; whereas a patient from urban Tanzania would have to pay US$102.00. This suggests that their findings did not fully capture indirect medical costs or inequalities between rural and urban areas. For example travel costs per visit were estimated to be US$2, whereas our estimates were more than double at US$4.21 for patients from rural areas. Therefore decision makers should take into account the burden of rabies particularly among the rural poor.

3.5.2 Conclusion

In summary, this study demonstrates the importance of evaluating health seeking behavior in local settings. The resulting epidemiological and economic data can be very useful in the planning, prioritization and proper allocation of limited resources. We demonstrated the high economic burden of rabies in Tanzania (twice that previously calculated for rural Africa, (Knobel et al., 2005)), which may be representative of other developing countries. Hence we highly recommend re-evaluation of the burden of rabies in Africa and support plans to establish a comprehensive national rabies control program in Tanzania.

4 General Discussion

Rabies remains an important public health problem in Tanzania where about 1500 people are reported to die from rabies annually (Cleaveland et al., 2002). This study explored the reasons for the existence of unnecessary human rabies deaths in Tanzania. In this study, it has been shown that majority of Tanzanians had insufficient knowledge about rabies dangers and means of prevention. This study also has shown that the risk and burden of rabies falls disproportionately on the most marginalized community, the rural poor. Both ignorance about the risks of rabies and the high costs of obtaining PEP are associated with human rabies deaths in Tanzania. Information generated from our KAP survey and estimation of the burden of rabies can provide useful information that may help guide decisions and actions with regards to controlling and preventing rabies.

In chapter 2, the study was based on a KAP survey. Major findings of the study were that there is insufficient knowledge about rabies dangers and prevention, particularly, wound management and prompt PEP following exposure. This low level of understanding reduces demand for PEP. The majority of respondents do not understand well the species of animals that suffer from rabies. In Tanzania, the Swahili word for rabies is *kichaa cha mbwa,* which means madness of dogs. This wording may be misleading people that dogs are the only animals that suffer from rabies. It is important to correct this through public awareness campaigns to the community, particularly those who live close to national parks and game reserves and also to medical practitioners so that they are aware that all mammals can transmit rabies and bites should be treated promptly following exposure.

Although the majority of respondents reported to know that rabies is a fatal disease, most did not know how to control and prevent rabies. If this situation continues, without intensive education on the risks of rabies and how to control and prevent rabies, it is apparent that rabies will continue to circulate in dogs and claim the lives of Tanzanians. Mass dog vaccination is the most effective method to control rabies. Veterinary services have an important role to play in the control of rabies which includes organising regular and effective mass dog vaccination programs that reach and protect 70% of the dog population to stop circulation of disease in the host reservoir (Coleman and Dye, 1996). Veterinary services should therefore also provide education on preventive behaviours. Particular attention should be paid to educating people through public awareness campaigns and promoting sample submission of the carcasses of rabid animals to the livestock offices and reporting suspect animals. This situation is also common in other countries. In Sri Lanka, for instance, only 43% of survey respondents were aware of the need to cut the head off a suspect rabid animal and send it to a veterinary laboratory for confirmation (Matibag et al., 2007).

The majority of respondents reported that they depend on medical practitioners' advice on how to prevent rabies when they present themselves to a hospital. This means that poor advice from medical personnel may cost lives. Therefore medical personnel require greater training in recognizing cases of rabies exposure and in judicious administration of appropriate PEP (Hampson et al., 2008). Preventive behaviours such as wound management followed by prompt PEP could be integrated into the elementary school curriculum to educate children on public health risks from dog bites. In a randomised control trial of an educational intervention for prevention of dog bites in children in Australia, it was reported that children who had been educated and were provided with information on ways to approach dogs, displayed appreciably greater precautionary behaviours than children that did not receive any awareness on dog behaviours (Chapman et al., 2000).

In chapter three, the study showed that access to PEP is very serious problem particularly in marginalized areas. Frequent shortages of PEP in district and regional hospitals are common in Tanzania. This imposes unnecessary additional costs such as transport, and accommodation costs. Bite victims had to either use their savings or sell their assets to pay for transport costs. The situation is worse for children who require escorts to reach PEP clinics, doubling the indirect costs. These costs clearly give an indication of the substantial financial hardships suffered by households when a bite by a rabid animal occurs. It takes time (many days) for poor families to raise money to pay for PEP, and the raised money may not be enough to buy a full course of PEP, or sometimes patients may not afford any PEP. This can cause delays, poor compliance of PEP and human rabies deaths for those who do not seek or obtain PEP. Therefore medical and veterinary workers together with the community should work together to prevent future deaths.

Reduced dose PEP regimens, subsidization and decentralization of PEP can all potentially offer a breakthrough for poor families who cannot afford to pay for PEP. Although we didn't directly evaluate the efficacy of the reduced 3 dose PEP regimen that is widely used in Tanzania (on days 0, 7 and 28), this regimen seems to still save human lives. It would be in the best interests of public health in the country to re-consider the schedule so that it is in accordance with the WHO recommendations.

A multidisciplinary approach is required to tackle the challenges of zoonotic diseases. In the case of rabies the major disease burden falls within the health sector, yet the veterinary sector is usually responsible for disease control. The two sectors typically operate independently with little coordination (Zinsstag et al., 2007, Zinsstag et al., 2005). In Tanzania where rabies remains a public health threat, little effort has been devoted by the government to tackle the disease (Mazigo, 2011). Data generated from this study provides comprehensive information that will provide valuable guidance to policy makers and practitioners with regard to rabies control in rural Tanzania and elsewhere in Africa. The major finding of this study is that the true costs of rabies prevention are unaffordable by the majority of the rural community in Tanzania who survive on under US$1 a day. Lack of comprehensive knowledge of rabies and the appropriate steps to be taken following suspect bite exposures contributes to these preventable human rabies deaths. Deliberate efforts are immediately required by stakeholders to tackle this disease. It is shocking that a country like Tanzania where rabies is endemic has no national rabies control programme.

Finally, our study demonstrated that rabies represents a substantial burden in local communities in Tanzania. Current estimates on the burden of rabies in Africa underestimate the true burden and should be considered for re-evaluation. The overall burden of rabies in Tanzania would be even higher if we included immunoglobulin costs in our analysis. For countries like Tanzania, where the majority of the population lives below the national poverty line, the true costs of PEP pose a major public health risk.

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6 Appendices

Appendix I Questionnaire for KAP survey

(a) ENGLISH VERSION)

SURVEY ON KNOWLEDGE, ATTITUDES AND PERCEPTION OF RABIES

BACKGROUND INFORMATION OF THE RESPONDENT

Name of respondent…………………………………………………

Age………………… Sex: Female Male (circle correct one)

Village (rural)………………………………… Street (urban)……………………

Geographical location: Rural / Urban (circle correct one) District: ………………

Highest level of education attained:

1= No formal education

2=Primary education

3=Secondary secondary and above [___]

Are you the head of the household YES NO (circle correct one)

[___]

If No, what is the relationship with household head?

1= Son/ Daughter

2=Wife

3=Husband

4=Brother/Sister in law [___]

If respondent is not the head of the household, for the household head, what is the highest level of education received?

1= No formal education

2=Primary education

3=Secondary secondary and above [___]

SOCIO-ECONOMIC STATUS OF THE RESPONDENT

1. Occupation of the head of household:

1=PEASANT
2= BULDER/MANSON
3=SMALL AND MEDIUM BUSINESS
4=MACRO BUSINESS [___]___[___]
5= FISHING
6=GOVERNMENT EMPLOYEE
7=OTHER, Specify…………………

2. The household your living is it rented household: 1=YES 2=NO (circle correct)

3. How many people live in this household? (Write number)

4. How many? (Write number):

Children under 5 years	[___]
Young people (5- 18) years	[___]
Adult (18 years and above)	[___]

HOUSEHOLD CHARACTERISTICS AND ASSET OWNERSHIP

5. Type of the roof of the household (Observe)

1=Iron sheet [___]
2=Thatched
3=Other
Specify………………………………

6. How many rooms are in this household? (Write number)

Kitchen	[___]
Toilet	[___]
Living room	[___]
Bedroom	[___]
Others…………	[___]

7. Where do you cook? 1= inside the house

2= outside the house we sleep [___]

8. What source of energy do you use for cooking?

1= Charcoal

2= Kerosene [___]___[___]

3= fire wood

4= other…………………………..

9. What is the source of light in this house?

1= Electrical

2= Candle [___]___[___[___]

3= Fire wood

4= Traditional lamp

5= Other

10. Does any member of household own: (circle 1=yes 2=no If YES, write total number in box)

Bicycle	YES	NO	[___]
Radio	YES	NO	[___]
Cellular phone	YES	NO	[___]
Television	YES	NO	[___]
Motor vehicle	YES	NO	[___]
Car/truck	YES	NO	[___]
Milling machine	YES	NO	[___]

11. This household has domestic animals? 1=YES 2=NO

If YES how many:

Type of animal	If Yes, Amount
Cattle	|___|___|___|____|
Goats	|___|___|___|____|
Sheep	|___|___|___|____|
Pigs	|___|___|___|____|
Donkeys	|___|___|___|____|
Chicken	|___|___|___|____|
Cats	|___|___|___|____|
Dogs	|___|___|___|____|

Any other animals? State type and number:…………………………………………………..

Knowledge on Rabies

1. Have you ever heard of rabies? 1=YES 2=NO
2. (a) If YES, where did you get knowledge of rabies for the first time?

1= from TV
2= from radio
3= from newspaper [___]___]___[___]
4= from school
5= from government /community meeting
6= from poster/leaflets/ brochur
7= from local community (parent/neighbor/friend etc)
8= other, specify……………………………..

(b) If YES, how would you describe rabies?

....

………………………………………………………………………………………..........…...

3. How can rabies be caught? ....

1= through a bite,
2= through a scratch, [___]
3= don't know,
4= other

4. Which species of animal can transmit rabies? (Circles or use boxes to indicate the number mentioned)

1= humans

2= snakes

3= chickens

4= dogs

5= cats [___]___]___[___]

6= cattle

7= hyenas

8= goats

9= mongoo

10=another way? Specify……………………

5. Has any member of your family been exposed to a suspect rabid animals?
1=YES 2=NO

6. (a) What is the first thing that you should do if you or any family member is exposed to any suspect animal bites (do not prompt for answers, but code if answer given – if respondent says go to hospital, ask if there is anything else that they should also do)?

1= wash wound with soap and water

2= report to police

3= wash with kerosene [___]___]___[___]

4= go to see healer

5= go to hospital

6= other specify……………………………………

(b) If respondent says go to hospital, How quickly should you do this?
………………………...

7. If you were to go to hospital, what treatment would you expect at the hospital (do not prompt respondent for answers, but code if answer given)?

1= Antibiotics

2= Pain killer

3= Vaccine (anti-rabies) [___]___]___[___]

4= Tetanus

5= Dress wound

6= other specify.......................................

8. (a) What would you do to the suspect rabid animal? That attempt to bite you/your family member/neighbor)?

1= immediately kill that animal

2= report to livestock office [___]___[___]

3= I would not take any action

4= other specify.......................................

(b) If the answer is 1 (to kill the animal) what action would you take with the killed animal?

1= throw away

2= burn

3= bury [___]____[___]

4= cut head and send to livestock office

9. (a) Which would you fear most, (1) having malaria or (2) being bitten by a rabid animal?

(b) Why: ....

10. (a) Is there any cure/treatment for a person who started developing rabies symptoms?

1=YES 2=NO

(b) If YES mention it..

11. (a) Do you know ways to control rabies in animals?

1=YES 2=NO

(b) If YES mention them,

i……………………………………………………………….

ii……………………………………………………………….

iii………………………………………………...………….

iv.……………………………………………………………..

For respondents with t dog/cat(s)

12. (a) Has your pet dog/cat been vaccinated against rabies in the previous year?

YES NO UNCERTAIN (circle the correct answer)

(b) If YES can you show me vaccination certificate?

YES (tick if seen certificate)

YES but uncertain where it is stored

NO

Thank you for taking part of this survey

(b) SWAHILI VERSION

SAVEYI YA UELEWA, MWITIKIO NA MTAZAMO JUU YA UGONJWA WA KICHAA CHA MBWA

HALI YA UJUMLA YA MHOJIWA

Jina la mhojiwa:...

Umri...................... Jinsi: KE ME (weka duara kwenye jibu husika)

Kijiji (vijijini).............................Mtaa (mjini)....................................

Eneo la kijiografia: Vijijini Mjini (weka duara kwenye jibu husika) Wilaya.......

Elimu aliyopata mhojiwa :

1= Hajasoma

2=Shule ya msingi

3=Shule ya sekondari au zaidi [___]

Je mhojiwa ni mkuu wa kaya? NDIYO HAPANA (weka duara kwenye jibu husika)

Kama HAPANA, una uhusiano upi na mkuu wa kaya?

1= Mtoto

2=Mke

3=Mume

4=Shemeji [___]

Kama nhojiwa si mkuu wa kaya : Elimu ya mhojiwa ni: -

1= Hajasoma

2=Shule ya msingi

3=Shule ya sekondari au zaidi [___]

HALI YA UCHUMI YA MHOJIWA:

1. Kazi ya mkuu wa kaya: 1=Mkulima

2= Mjenzi (fundi uashi)

3=Mfanya biashara ndogondogo na za kati

4=Mfanya biashara mkubwa

5=Mvuvi [___]___[___[___]

6=Mfanyakazi wa serikari

7=Nyingine, TAJA…………………………………….

2. Nyumba mnamoishi ni ya kupanga? NDIYO HAPANA (weka duara kwenye jibu husika)

3. Kuna watu wangapi wanaishi kwenye hii kaya? (andika idadi kwenye kichumba)

4. Wangapi? (Andika idadi): Chini ya umri wa miaka 5 [___]

Watoto kati ya miaka (5- 18) [___]

Watu wazima (miaka 18 na zaidi) [___]

UMILKI WA VITU KATIKA KAYA

5. Nyumba imeezekwa kwa kutumia nini? (Angalia)

1=Bati [___]

2=Nyasi

3=Nyingine Taja……………………………

6. Nyumba mnamoishi wanakaya ina vyumba vingapi? (Andika idadi) [___]

Jiko [___]

Choo [___]

Sebule [___]

Vyumba vya kulala [___]

Nyingine [___]

7. Mnapikia wapi? 1= ndani ya nyumba tunayolala

2= nje ya nyumba tunayolala [___]

8. Mnapika kwa kutumia nini?

1= Mkaa

2= Mafuta ya taa [___]___]___]

3= Kuni

4= Nyingine, TAJA…………………

9. Chanzo cha mwanga katika kaya hii ni?

1= Umeme

2= Mshumaa

3=Kizinga cha moto [___]___]___]

4= Koroboi

5=Nyingine, TAJA……………………….

10. Kuna mwana kaya yoyote anamiliki;-: (weka duara kwenye NDIYO au HAPANA Kama NDIYO, andika idadi ya vitu kwenye boksi),

		Idadi
Baiskeli	NDIYO HAPANA	[___|___]
Redio	NDIYO HAPANA	[___|___]
Simu ya mkononi	NDIYO HAPANA	[___|___]
Televisheni	NDIYO HAPANA	[___|___]
Pikipiki	NDIYO HAPANA	[___|___]
Gari	NDIYO HAPANA	[___|___]
Mashine ya kusaga	NDIYO HAPANA	[___|___]

12. Je,kaya ina wanyama wakufugwa? 1=NDIYO 2=HAPANA [___]

Kama NDIYO wangapi,

Aina ya mnyama	Kama NDIYO, idadi
Ng'ombe	|___|___|___|____|
Mbuzi	|___|___|___|____|
Kondoo	|___|___|___|____|
Nguruwe	|___|___|___|____|
Punda	|___|___|___|____|
Kuku	|___|___|___|____|
Paka	|___|___|___|____|
Mbwa	|___|___|___|____|

Mnyama mwingine tofauti kama yupo? taja aina na idadi ....

Uelewa wa ugonjwa wa kichaa cha mbwa.

1. Ulishawahi kusikia kuhusu kichaa cha mbwa? 1=NDIYO 2=HAPANA [___]

2. (a) Kama NDIYO,wapi ulipata uelewa kwa mara ya kwanza juu ya kichaa cha mbwa?

1= kwenye televisheni
2= kwenye redio
3= kwenye gazeti [___]___]___[___]
4= shuleni
5= kwenye mkutano wa serikali/jamii
6= kwenye kipeperushi/bango
7= toka kwa jamii/mzazi/rafiki/jirani n.k
8= nyingine, taja……………….……………………………………..

(b) Kama NDIYO,unaweza kuelezeaje kichaa cha mbwa?...

3.Unawezaje kupata kichaa cha mbwa? (Usimtajie majibu andika namba ya jibu analotaja)...................………………………………………

1= kwa njia ya kung'atwa/umwa,
2= kwa njia ya kukwaruzwa,
3= sijui,
4= taja ……………………………………………… [___]

4. Ni wanyama gani huweza kuambukiza ugonjwa wa kichaa chambwa?(Zungushia kinachotajwa)

1= Binadamu
2= Nyoka
3= Kuku
4= Mbwa
5= Paka [___]___]___[___]
6= Ng'ombe
7= Fisi
8= Mbuzi
9= Nguchiro
10=Njia nyingine? Taja……………………

5. Kuna mwanafamilia yeyote amewahi kuumwa na mnyama mwenye kichaa cha mbwa?

1=NDIYO 2=HAPANA [___]

6. (a) Ni kitu gani cha kwanza kabisa kufanya ikiwa wewe/Mwanafamilia ameng'atwa na myama akisiwaye kuwa na kichaa cha mbwa? (Usiionyeshe majibu, ila weka kodi(code) jibu likitolewa

1= Kuosha kidonda kwa maji na sabuni
2= Kuripoti kituo cha polisi [___]___]___[___]
3= Kuosha kwa mafuta ya taa
4= Kwenda kwa mganga wa kienyeji
5= Kwenda hospitali
6= Zingine Taja…………………………………………………………..

(b) Kama jibu ni kwenda hospitali, ni mapema kiasi gani unatakiwa kufanya hivyo? …………

7. Ikiwa utaenda hospitali, Je ni matibabu gani utayategemea kutoka hospitali? (Usionyeshe majibu ila weka code kama jibu limetolewa)?

1= Antibiotiki
2= Dawa za kutuliza maumivu [___]___]___[___]
3= Chanjo ya kichaa cha mbwa(anti-rabies)
4= Tetanusi/Pepopunda
5= Koushwa kidonda kwa dawa
6= Zingine, Toa maelezo…………………………………………..

8. (a) Utamfanyaje mnyama mwenye anayehisiwa kuwa ana kichaa cha mbwa ?anayetaka kuuma wewe/mwanafamilia au jirani yako?

1= Kumuua mnyama hiyo mara moja
2= Kutoa taarifa kwenye ofisi ya mifigo [___[___]
3= Sitafanya jambo lolote
4=Nyingine, Eleza…………………………

(b) Ikiwa jibu ni kumuua mnyama ni kitu gani utafanya kwa mnyama aliyeuwawa?

1=Kutupa

2= Kuchoma moto

3= Kufukia [___]___[___]

4= kukata kichwa na kukipeleka kwenye idara ya mifugo

9. Ni kipi huwa kinatisha zaidi (1) kuwa na malaria au(2)Kuumwa na mnyama mwenye kichaa cha mbwa ?

Kwa nini……………………………………………………………………………………

10. (a) Kuna tiba kwa mtu ambaye ameanza kuonesha dalili za kichaa cha mbwa?
NDIYO HAPANA

(b) Ikiwa NDIYO taja………………………………

11. (a) Unazifahamu njia za kuthibiti ugonjwa wa kichaa cha mbwa kwa wanyama? NDIYO HAPANA

(b) Ikiwa NDIYO zitaje,

i……………………………………………………………….

ii……………………………………………………………….

iii…………………………………………….…………….

iv.…………………………………………………………..

Kwa wenye mbwa/paka

12. (b) Je, Mbwa/paka wako amewahi kuchanjwa miaka iliyopita?

Ndiyo Hapana Sijui (Weka duara kwenye jibu sahihi)

(b)Ikiwa NDIYO unaweza kunionyesha cheti cha chanjo?

NDIYO (Weka √ ikiwa utaonyeshwa cheti cha chanjo)

NDIYO ila hakumbuki cheti kiko wapi

HAPANA

Asante kwa kushiriki kwenye survey hii.

Appendix II

Scoring procedures

Reference question in appendix (i) §	Question that was asked	Answer	Overall score	Binary outcome
#2 (b)	Correct description of rabies describe rabies	correctly describe rabies as a disease	2	NA
		describe rabies as change of behaviour of a dog/animal 1		NA
		0 score who said I do not know/ wrong answer		
#3	Mode of transmission/how rabies can be caught	through bites	2	NA
		through scratches	1	NA
		wrong answer/ I do not know	0	NA
#4	Animals that can be infected by rabies	who mentioned 3 or more animals	2	NA
		who mentioned1 or 2 animals	1	NA
		I do not know/ wrong answer	0	NA
#11	Knowledge of control of rabies in animal	who mentioned 3 or 4 methods	2	NA
		mentioned 1 or 2 methods	1	NA
		I do not know/ wrong answer	0	NA
#7	Know right treatment when exposed	who mentioned human anti rabies vaccines(PEP)	2	NA

		antibiotic and Tetanus without mentioning ant-rabies vaccines	1	NA
		I do not know/advice from medical practitioner	0	NA
#10	Knowledge that rabies ends with fatal	know fatal nature of the disease	1	NA
		I do not know fatal nature of the disease	0	NA
	Knowledgeable of rabies	Who got ≥ 7 of overall scores (≥ 7/11)	≥ 7	1
	Unknowledgeable of rabies	Who got ≤ 6 of overall scores (≤ 6/11)	(≤ 6	0
	Overall score		11	
#6 (a)	First aid and medical attention	who claimed to clean wound with water, soap, kerosene then report to hospital	3	1
		who claimed to report to hospital	2	1
		who claimed to report to police or village leader	1	0
		who claimed to do nothing	0	0
#6 (b)	Hospital presentation after bite	who claimed to report immediately after bite	3	1
		who claimed to report to the hospital next day after a bite	2	1
		Who claimed to reported to the hospital 2 to 14 days after a bite	1	1
		Who claimed to reported to the hospital after 14 days from	0	0

		day of bite or to do nothing		
#8 (a)	Practice to suspect rabid animal	who claimed to report livestock office	2	1
		1 score who claimed to kill the animal	1	1
		0 score who claimed to do nothing	0	0
#8 (b)	Practice to carcass of suspected animal	who claimed to cut the head and sent to livestock office	2	1
		who claimed to bury or burn the carcass	1	1
		who claimed to do nothing	0	0

Note: § Serial number was from part of "Knowledge of rabies" of the questionnaire.

Appendix III

Variance inflation factors to determine correlation of explanatory variable

	Knowledge	Intervention	Sex	Education	Socio economic	History of exposure	Residence	Age
Knowledge	1							
Intervention	0.0165539	1						
Sex	0.054206 3	0.02510829	1					
Education	0.1182894	0.01639459	0.136066	1				
Socio economic	-0.007214	-0.2651818	-0.01336	0.075020	1			
History of exposure	0.0564983	0.00964193	0.014966	0.0170118	-0.005443	1		
Residence	0.022885	-0.1152668	-0.11003	0.133378	0.312174	-0.034125	1	
Age	0.009764 2	0.0351835	0.145652	-0.190354	-0.022297	0.040512	0.014865	1

Variance inflation factors

	GVIF
Knowledge	1.020362
Intervention	1.080804
Sex	1.074494
Education	1.114221
Socio economic	1.180895
History of exposure	1.007113
Residence	1.15197
Age	1.080672

Appendix IV

Questionnaire for evaluating the costs associated with obtaining PEP:

English version

Village.................................Subvillage...
District…......................Urban/Rural(circle) Occupation of the family:........
GPS code .... E.............................. N.................................
Name of victim….. Age.............
Sex............... Bitten by (species): …………………………………………..… Suspect rabid……....................................Date bitten...............................
Escorted for medical care? .... By whom?..........

Date	Place reported	Treatment ie TT	Medical costs (TZS)	PEP dose	PEP cost (TZS)	Accommodation type e.g. hostel, family, etc.	Accommodation costs (inc. escorts, TZS)	Travel type	Travel costs (TZS)	Other costs, food,vouchers, etc

Rabies Immunoglobulins (RIG) administered? .... RIG costs (TZS) ....
Comments (Receipt provided)
....

If patient didn't go to hospital why not? ....If patient didn't have PEP why not? ....
If patient got PEP but didn't complete PEP why not.................................

Days lost from schools........... Days lost from work (including escorts/parents)...

in seeking PEP and medical care and for recovery. How did the patient pay the overall costs?...

Patient outcomes (died/alieve). If died continue……………….Date symptoms started…………………when died …………………………………………

(date or days since development of symptoms)……………..…..

Was medical attention thought after developing symptoms?.......................If not, why not……………………………………………..………………………

did the victim bite anyone…………………If yes mention them……………………………..How long did it take to raise cash to cover costs (days, weeks)………..

Swahili version

Kijiji.................................

Kitongoji………..

Wilaya…........................Mjini/Kijini (Zungushia) Kazi ya kaya………………

.... Kodi za GPS................ E...........

.... N.................................Jina la aliyeumwa…... Umri.............

Jinsi............... Aliumwa na nini ……………………………………………..… Alihisiwa alikuwa na ugonjwa wa kichaa cha mbwa………………………………………………………………………………………………………...……

Tarehe aliyoumwa.............................. Alisindikizwa kupata matibabu................alisindikizwa na nani...

Tarehe aliyofika	Jina la hospitali	Matibabu mfano TT	Gharama za matibabu (TZS)	Dozi ipi	Gharama za chanjo (TZS)	Malazi	Gharama za malazi Pamoja na msindikizajiTZS)	Aina ya usafiri uliotumika	Gharama za usafiri (TZS)	Ghamama zingine mfano chakula

RIG ilitolewa? .... Gharama za RIG (TZS)

....

....

Toa kauli (Risiti ilioneshwa)

....

....

....

....

....

....(Geuza)

Kama mgonjwa hakuenda hospitalini kwa nini hakuenda? Kama hakupata chanjo kwa nini hakupata chanjo?

....

Kama alipata ila hakumaliza kwa nini hakumaliza...

....

Siku alizopoteza bila kwenda shule.......... Siku alizopoteza bila kufanya kazi (pamoja na msindikizaji)...

...

Gharama zote zililipwaje?...

....

....

Matokeo ya mgonjwa (hai/alikufa)……………….Kama alikufa endelea……….Tarehe dalili zilipojionesha…………………kipindi gani alitumia baada

ya kuanza dalili za kichaa cha mbwa………………………………………………………………………………………….……….…..

Baada ya kuanza dalili alienda hospitali?.......................Kama hapana kwa nini……………………………………………..………………………

Je mgonjwa alimuuma mtu mwingine…………………Kama ndio wataje……………………………..Siku/wiki ngapi ziliwachukua kulipa gharama za

Matibabu…………………………………….