DOG-RELATED PRACTICES AMONG RURAL COMMUNITIES IN THE KILOSA DISTRICT, TANZANIA: IMPLICATIONS FOR RABIES PREVENTION INTERVENTIONS

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A Dissertation Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in Public Health Research at the Nelson Mandela African Institution of Science and Technology

Arusha, Tanzania

July, 2021

ABSTRACT

Rabies is a disease which is most transmitted to humans through infected domestic dog bites. The disease is preventable through mass dog vaccination (MDV) or timely access to Post-exposure Prophylaxis (PEP) injections for humans. Accessing a full course of PEP, however, is a challenge, due to high costs and lack of availability. In Africa, rural populations are most affected by rabies; this is also the case in Tanzania. Since the group who is most at risk of exposure are children, emphasizing correct dog handling practices, for example, can minimize dog bites and hence prevent disease incidences. MDV of the susceptible canine population is the best way of breaking the disease transmission cycle, but achieving the recommended coverage of 70% is still a challenge. To rectify this, it is important to understand dog ownership systems, management and handling practices and the decision-making process within households. The current study identified these to help addressing constraints related to rabies prevention and control in the community. The study focused on characteristics of dog ownership in the household (HH), decision-making process regarding dog ownership, dog vaccination and access to PEP for a child once exposed. A cross-sectional study conducted in Kilosa district between May 2016 and March 2017, looked at 1216 households in rural communities in Tanzania. The findings elucidated significant factors affecting dog ownership and the number of dogs kept per household. Larger households are more likely to own dogs <0.001. While a child is likely to take the dog for vaccination, the decision to vaccinate the dog is usually made by the father. The findings also showed that mothers are responsible for the child's health once exposed and take the child to access PEP. The research findings will help to understand HH decision making with regards to dog ownership and responsibility for child health. These results are relevant for the design and implementation of rabies interventions and other zoonoses.

DECLARATION

I, Lwitiko Sikana, do hereby declare to the Senate of Nelson Mandela African Institution of Science and Technology that this dissertation is my own original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

Lwitiko Sikana

July 2021

Name and Signature of Candidate **Date**

The above declaration is confirmed by

Dr. Katharina Kreppel

July 2021

Name and Signature of Main Supervisor **Date**

Dr. Sally Mtenga

July 2021

Name and Signature of Co-Supervisor **Date**

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CERTIFICATION

We hereby confirm that the dissertation entitled "Dog-related practices among rural communities in the Kilosa district, Tanzania: Implications for rabies prevention interventions" submitted by Lwitiko Sikana to Nelson Mandela African Institution of Science and Technology, Tanzania in partial fulfilment of the requirements for the award of Degree of Master of Science in Public Health Research, is original work and has been done under our supervision.

Dr. Katharina Kreppel

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ACKNOWLEDGEMENTS

Firstly, I would like to thank the almighty God for his protection during the entire period of my studies. He always showed the way when I encountered challenges: *"So, don't fear, for I am with you, don't be dismayed, for I am your God, I will strengthen you and help you, I will uphold with my righteous hands."*- (Isaiah 41:10).

I would like to express many thanks for the tireless support from my academic supervisor Dr. Katharina Kreppel during my research work and Dr. Sally Mtenga for her insights and constructive remarks on my initial work. Also, I would like to give appreciations and thanks to Dr. Tiziana Lembo (overseas supervisor), Jane Coutts (Co-researcher) and Prof. Katie Hampson (mentor and supervisor). I have enjoyed working with you until the successful completion of this work as part of my MSc studies. I would also like to give my sincere gratitude to lecturers from the Ifakara Health Institute (IHI) and the Nelson Mandela African Institution of Science and Technology (NM-AIST) when I was attending taught courses as a requirement for my MSc programme.

This study would not have been possible without the funding support from different funders. Firstly, I acknowledge the funding support for this research on "Dog-related practices among rural communities in the Kilosa district, Tanzania, and their implications for rabies prevention" from the Community Against Rabies Exposure (CARE) project coordinated by the Global Alliance for Rabies Control (GARC). Secondly, I acknowledge the funding support of the framework of the DELTAS Africa Initiative [Afrique One-ASPIRE /DEL-15-008]. Afrique One-ASPIRE is funded by a consortium of donor including the African Academy of Sciences (AAS) Alliance for Accelerating Excellence in Science in Africa (AESA), the New Partnership for Africa's Development Planning and Coordinating (NEPAD) Agency, the Wellcome Trust [107753/A/15/Z] and the United Kingdom (UK) government. The consortium supported me with additional research costs, stipends, and University fees for the entire period of my studies.

The research work was implemented in collaboration of two institutions, the IHI and NM-AIST, therefore I would like to thank administration, finance and the training unit who worked together during my studies.

I also, greatly appreciate the contributions from my colleagues from the rabies crew in Tanzania (Dr. Maganga Sambo, Mr. Kennedy Lushasi, Dr. Zac Mtema, M/s. Ritha Godfrey

and Mr. Joel Changalucha) for their valuable support and encouragement during my studies. I would also like to thank the Kilosa District Executive Office through the District Veterinary Office- Ministry of Livestock Development and Fisheries, the Ministry of Health, Community Development, Gender, Elderly, and Children; Livestock Field Officers and the community members, especially the six selected villages, for their support during the data collection process. Also, I will not forget the National Institute for Medical Research (NIMR) for ethical clearance to conduct this research work.

This study could not have been accomplished without the huge support of drivers (Eliud Kissinger and Danistan Liyumba) and field assistants (Adili Moshi, Natalis Mlundachuma, Rhoda Musoke, Christopher Msokame, Shabani Ndulango, Goodluck John and Gerald Mwambeta).

DEDICATION

This research work is dedicated to my beloved mother (Christina Asajile Isakwisa Mwambulukutu-Sikana) and my late father who left me when I was too young.

Likewise, it is dedicated to my lovely wife (Aloycia Laurent Duma-Sikana) and my kids (Careen Lwitiko Sikana, Brian Lwitiko Sikana and Christina Lwitiko Sikana), for their inspiration and compassion when I was away for my studies.

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LIST OF ABBREVIATIONS AND SYMBOLS

AAS	African Academy of Sciences
AESA	Accelerating Excellence in Science in Africa
AIM	African Index Medics
ASPIRE	African Science Partnership for Intervention and Research Excellence
CARE	Community Against Rabies Exposure
CBO's	Community based organizations
CI	Confidence Interval
DELTA	Developing Excellence in Leadership, Training and Science
FGD	Focus Group Discussion
GARC	Global Alliance for Rabies Control
GLMs	Generalized Linear Models
GPS	Geographical Positioning System
ID	Identification
IDIs	In-depth Interviews
HH	Household
HHSurv.	Household surveys
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Virus
HQ	Headquarter
IHI	Ifakara Health Institute
IHI-IRB	Ifakara Health Institute-Institutional Review Board
KAP	Knowledge Attitude Practices
KII	Key-Informant Interviews
LFOs	Livestock Field Officers
LRT	Likelihood Ratio Test
N	Sample size
NA	Not Applicable
NGO	Non-governmental organization
NM-AIST	Nelson Mandela African Institution of Science and Technology
MDV	Mass Dog Vaccination
NBS	National Bureau of Statistics
NEPAD	New Partnership for Africa's Development Planning and Coordinating
NIMR	National Institute for Medical Research

PI	Principal Investigator
P-Value	Probability Value
PEP	Post Exposure Prophylaxis
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta–Analyses
UK	United Kingdom
UoG	University of Glasgow
USA	United States of America
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

This chapter contains a general introduction, the objectives, research problems, justification, hypotheses, and significance of the study. The general objective was to investigate dog ownership and care patterns in the context of rabies interventions and mass-dog vaccination as well as household (HH) responsibilities for children's health care, to better inform rabies prevention interventions. The study investigated general factors related to dog ownership and the value of dogs to a HH. This includes who keeps dogs and aspects which influence the number of dogs kept, responsibility for dogs in the HH, and responsibility for the associated risks to children's health. It also established how factors relating to dog ownership and responsibilities for dog and child health can present obstacles to rabies prevention.

1.1 Background of the Problem

Rabies is a disease caused by a virus of the genus "Lyssavirus" from the "Rhabdoviridae" family, and it results in death of both humans and animals (Hayman *et al.,* 2011; Liu & Ertl, 2012; World Health Organization [WHO], 2013). Breaking rabies transmission from dogs can be an effective way to prevent infections to humans of up to 99% (Lembo *et al.*, 2010).

Rabies was successfully eliminated in most of the western world, but in Africa and Asia the disease is still common and results in considerable mortality (Hampson *et al.,* 2015). Due to a lack of priority in controlling the disease (Knobel *et al.,* 2005; Lembo *et al.,* 2010), rabies is still widely prevalent, especially in rural settings. According to a study conducted in Tanzania, rabies is greatly underreported with 10 to 100 times more cases occurring than actually reported (Cleaveland *et al.,* 2002; Kitala *et al.,* 2001).

Rabies is a fatal disease once a person get exposed and symptoms appear (Jackson, 2013). It is suggested that Mass Dog Vaccination (MDV) of more than 70% of the susceptible dog population and access to a series of human rabies vaccine injections called Post Exposure Prophylaxis (PEP), is an effective way of breaking the transmission cycle and preventing deaths (Jackson, 2013). However, currently the vaccination levels among the dog populations of pastoralists in rural Tanzania are estimated to be below 20% (Kaare *et al.,* 2009) and the rate of completion of PEP among bite victims is estimated to be only 30.9% (Hatch *et al.,* 2017; Mpolya *et al.,* 2017). Vaccination costs, misinformation on negative side effects of

rabies vaccination in dogs, and limited awareness of the disease are some of the reasons known to affect uptake of vaccination and treatment (Hampson *et al.*, 2008; Kipanyula, 2015; Lembo *et al.*, 2010). Unfortunately, access to PEP is still a major challenge in most African countries due to high costs and limited availability (Dodet *et al.*, 2008).

However, many reasons for the low uptake of MDV, especially at the HH level, are not entirely clear and therefore, this study aims to understand dog-related practises, including responsibilities of dog ownership, vaccination and child health risks.

1.2 Statement of the Problem

Rabies still causes thousands of preventable deaths in African and Asian countries where it is endemic. Around half of these deaths involve children less than 15 years of age (Kilic *et al.*, 2006; WHO, 2018a), particularly in rural areas. Rabies is transmitted through bites by infected animals. Domestics dogs are the source of rabies transmission in approximately 99% of cases (WHO, 2018b). Death can be prevented through the provision of PEP to individuals exposed to suspect dog bites, and transmission can be stopped by vaccinating at least 70% of the domestic dog population (Ertl, 2009; Hampson *et al.*, 2007; Kaare *et al.*, 2009; Lembo *et al.*, 2011). Despite the availability of effective measures to prevent infection and death, the disease is still very prevalent, mainly because the recommended vaccination coverage is not reached. One of the reasons is a lack of awareness of the importance of prevention, particularly in remote rural communities (Hampson *et al.*, 2008; Kipanyula, 2015; Sambo *et al.*, 2017), despite a myriad of awareness campaigns. However, few studies in Africa investigated for example who is responsible for dog vaccination and child health decisions, especially in rural communities (Bardosh *et al.*, 2014b; Knobel *et al.*, 2008a). Therefore, this study aims to understand management of rabies prevention in dogs by dog owning households and health care practices regarding exposed children to be able to inform rabies prevention strategies in rural Tanzania.

1.3 Rationale of the Study

Most deaths caused by rabies occur among the poorest HHs in rural areas (Sambo *et al.*, 2013; Tenzin *et al.*, 2011). The disease affects HHs by causing disability and deaths, affecting their health budget, especially due to high PEP cost, and leading to livestock losses in some cases (Changalucha *et al.*, 2018; Hampson *et al.*, 2015). These losses can be avoided by improving rabies prevention through dog vaccination at community level.

Focusing on Tanzania, information on dog ownership patterns and HH level responsibilities for the health of dogs and children is needed, particularly in relation to rabies and other zoonoses. This information will inform intervention and control strategies and expose any weaknesses and obstacles. The current study is well aligned with the global strategic plan to end rabies by 2030, which highlights the importance of these aspects to achieve optimal rabies prevention(WHO, 2018b). The findings are likely to contribute to the current initiatives to Tanzania National Rabies Strategy for 2017-2030, as well as providing data and methods relevant to rural Africa more broadly.

1.4 Research Objectives

1.4.1 Main Objective

Understanding practices and management of rabies in dogs and establish exposed children health care concerns to inform rabies prevention strategies in rural Tanzania

1.4.2 Specific Objectives

(i) To identify factors associated with dog ownership in the household.

(ii) To determine the responsibilities related to dog ownership and child health risks in the household.

(iii) To identify factors which present obstacles to rabies prevention interventions and are linked to dog ownership and dog and child health care responsibilities.

1.5 Significance of the Research Study

The study highlights important information regarding the responsibility of dog ownership and child health risks in the HH, focussing on a rural setting. Until now, intervention strategies have not considered many of the factors related to dog ownership practices and responsibilities for child and dog health at the HH level. Therefore, the findings from the study can help to prioritise resource use in interventions trying to raise awareness and improve MDV. The research findings are also likely to identify further research needs of other zoonotic diseases apart from rabies and contribute to the Tanzania Rabies Control Strategy for 2017-2030 and other control strategies.

1.6 Research Questions

(i) What factors determine the number of dogs owned in the household?

(ii) How are responsibilities of dog ownership and child health risks once exposed shared in the household?

(iii) How do factors for dog ownership and responsibilities for dog and child health present obstacles to rabies preventions?

1.7 Delineations of the Study

The findings rely on data from two different surveys, and while they both originate from the same study population, the Knowledge Attitudes and Practice Survey **(**KAP) survey looks at fewer HHs than the overall Household Survey (HHSurv). Other limitations include the lack of information on the impacts of the father's decision on vaccination, e.g., if vaccination of dogs is approved, are all dogs vaccinated and if vaccination is free, is the father more inclined to allow vaccination. Details on the gender and age of children bringing dogs for vaccination would also enrich the findings from this study. This could help to provide more insights on planning for the rabies interventions such as awareness or MDV.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

A systematic literature review was carried out to establish the present information on the topics relevant to the study such as: 1) global burden of rabies and prevention, 2) dog ownership in Africa, 3) dog ownership in Tanzania, 4) rabies vaccination in Africa, 5) rabies vaccination in Tanzania and 6) rabies awareness in Tanzania.

2.2 Global Burden of Rabies and Prevention

Rabies, a deadly disease of humans and other mammals, remains to be a major health problem in Africa and Asia and causes approximately 55 000 human deaths annually (Hampson *et al.,* 2015; Knobel *et al.,* 2005; WHO, 2013). Domestic dogs are responsible for causing approximately 99% of these deaths (Cleaveland *et al.,* 2006; WHO, 2013). It is estimated that, in Africa alone, rabies causes around 24,000 human deaths annually (Cleaveland *et al.,* 2002; Knobel *et al.,* 2005). Once rabies symptoms start, the infection always results in death (Jackson, 2013; Sambo *et al.,* 2013; WHO, 2013). Children are the most vulnerable group in terms of bites by suspected rabid animals (Knobel *et al.,* 2005). Evidence suggests, that MDV exceeding 70% coverage can effectively control rabies (Coleman & Dye, 1996). If a person is exposed to rabies by an infected animal bite or scratch, without prompt access to PEP, the infection results in death. Even though methods for disease prevention are available, accessing PEP vaccine once a bite occurred remains a major challenge for many victims.

In Tanzania, even though the country ranked rabies as number one out of the five zoonotic priority diseases, control implementation remains poor compared to other diseases like malaria and HIV/AIDS (Sambo *et al.,* 2013). Thus, around 55 000 deaths still occur every year, due to limited awareness about adequate prevention measures and low dog vaccination rates against rabies (Hampson *et al.,* 2008; WHO, 2018b).

2.3 Dog Ownership in Africa

In rural areas of African countries, dog ownership differs from one country to another according to social, cultural, religious, geographical and socio economic factors (Bardosh *et al.,* 2014b; Knobel *et al.,* 2008b). A household survey conducted in Kenya revealed that between 53% and 81% households own dogs (Kitala *et al.,* 2001). In Tanzania, dog ownership is observed in one study to be 14% (Gsell *et al.,* 2012), but country wide information on dog ownership rates are missing. The average ratio is 1:7 for HHs owning dogs in rural Africa (De Balogh *et al.,* 1993). Based on meta-analysis studies, dog ownership in rural Africa is estimated to be 7:4 (Knobel *et al.,* 2005). In Tanzania and Ethiopia, Christians reported to own more dogs than Muslims (Kabeta *et al.,* 2015; Knobel *et al.,* 2008a). Other findings showed that, in Africa, a dog can be owned by a single person, but all family members are responsible for its care (Taylor *et al.,* 2017). Therefore, understanding responsibilities and practices related to dogs in the household is crucial for informing rabies prevention campaigns, by helping to target the right HHs and people within.

2.4 Dog ownership in Tanzania

A cross-sectional study was conducted in rural and urban Tanzania between October 2004 and July 2005 through surveying 1471 HHs (Knobel *et al.,* 2008a). The findings showed that dog ownership was common in most of the highland rural areas, but few people kept dogs in urban areas. The study also highlighted the relationship between religion and dog ownership where Christians reported to own more dogs compared to Muslims (Knobel et *al.,* 2008b). The majority (61.9%) of dog owners were keeping dogs for their own security at the HH, whereas the majority of livestock keepers reported to own a high number of dogs for protecting livestock against wild animals (Knobel *et al.,* 2008a). Another study conducted in 28 districts between 2011 and 2015 reported that more dogs are owned by livestock keepers in rural settings (Sambo *et al.,* 2018). According to the cited literature, dog ownership is also associated with the wealth of the HH (Knobel *et al.,* 2008a). The reported human-dog ratio for Tanzania was largely like other sub-Saharan countries. Understanding responsibilities and practices of dog ownership distributed within the family, such as who feeds them and takes them to get vaccinated (Czupryna *et al.,* 2016), is important for improving rabies prevention in the community.

2.5 Rabies Vaccination in Africa

Despite the ongoing MDV interventions, rabies in Africa is still a major public health problem, especially in remote areas. The disease can be prevented through MDV, but often the coverage is insufficient. According to a study conducted in 2003, costs for controlling the disease ranges from $ 2 to $ 3 per dog (Kayali *et al.,* 2003). Still, these estimated costs per dog are not affordable to some HHs in African countries and thus many depend on free vaccinations (Durr *et al.,* 2009; Jibat *et al.,* 2015). Jibat *et al.* (2015) revealed that vaccination free of charge raised the vaccination coverage to 68% compared to 18.1% when owners were charged for vaccination. Additionally, challenges such as inadequate infrastructure, cold chains and delivery strategies as well as remoteness of populations contribute to inadequate vaccination coverage (Acosta *et al.,* 2019; McCarney *et al.,* 2013). The findings from this study highlighted important aspects to consider when planning dog vaccination campaigns. A community engagement approach was suggested for raising awareness (Lembo *et al.,* 2010) to improve the situation.

2.6 Rabies Vaccination in Tanzania

In Tanzania, attaining the recommended rabies vaccination coverage in the dog population is still a challenge (Bardosh *et al.,* 2014b; Cleaveland *et al.,* 2002; Kitala *et al.,* 2001) and understanding factors resulting in insufficient coverage is essential. Furthermore, Bardosh *et al*. (2014) reported that the central government uses a "top-down" approach to implement public health programmes, which affects participation to vaccination coverage due to the communication gaps from the central to the local government. Vaccination coverage varies from one district to another (Sambo *et al.,* 2017), due to the fact that some districts had rabies projects that provide support to vaccination. In addition, access to PEP for rabies is greater in urban areas compared to rural settings and prices are lower (Sambo *et al.,* 2013). As a feasible way for disease control and prevention it was therefore suggested to employ rabies education to raise awareness in the communities (Leonard *et al.,* 2015; Minghui *et al.,* 2018) targeting children who are at high risk of exposure and death (Knobel *et al.,* 2005).

2.7 Rabies Awareness in Tanzania

Rabies is still a major public health threat in rural Tanzania. Low awareness about the disease and insufficient investment in public health awareness and surveillance (Kipanyula, 2015).

This was justified by Sambo *et al.* (2014) who reported that only 5% of the study population were aware about the importance of washing a wound once bitten by a suspect rabid animal.

The situation can be improved by an inter-disciplinary approach on raising awareness, through involvement of various stakeholders in the community (Kipanyula, 2015; Sambo *et al.,* 2014), such as Community Based Organizations (CBO's), Non-Governmental Organization (NGO's) parents, children, professionals and non-professionals.

2.8 Summary of the Literature Review

Generally, the literature shows that prioritising zoonotic diseases such as rabies will result in increased attention for control strategies (Munyua *et al.,* 2016). The literature suggests that it is important to involve the community in rabies prevention strategies to improve the impact of control measures, because they are familiar with the environment and have a range of different experiences. Rabies can be prevented by raising awareness using public education (Mbilo *et al.,* 2017), but it is important to identify reliable tools and targets for awareness creation (Global Alliance for Rabies Control [GARC], 2015).

In order to implement public health interventions, adequate planning is essential (Wight *et al.,* 2016) relying on understanding factors linked to responsibility for dog and child health. However, there is insufficient knowledge especially in Tanzania (Bardosh *et al.,* 2014b; Kipanyula, 2015; Knobel *et al.,* 2008a; Sambo *et al.,* 2014). For example, owners' characteristics are unknown, so targeting the HHs owning dogs on a large scale is difficult, as they cannot be easily identified. This is combined with a reluctance to vaccinate dogs and a paucity of data showing who in the HH influences decisions and who makes decisions on dog and child health.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Literature Review Methods

3.1.1 Systematic Review Protocol

The literature review used the Preferred Reporting Items for Systematic Reviews and Meta–Analyses (PRISMA) guideline, focussing on rabies in African countries. The review process was conducted using the PubMed and Google Scholar databases, while other information was gathered from the National Bureau of Statistics (NBS), the World Health Organization (WHO) database, Web of Science and Scopus.

3.1.2 Search Strategy

The review process considered all studies conducted in Africa, mainly on six topics focusing on the objective of the study: (a) Global burden of rabies and prevention, (b) Dog ownership in Africa, (c) Dog ownership in Tanzania (d) Dog vaccination in Africa, (e) Dog vaccination in Tanzania and (f) Rabies awareness in Tanzania.

3.1.3 Literature Extraction

All references were screened in a systematic way according to the framework as shown in (Fig. 2) using EndNote X9. The first extraction of articles was done by looking at titles and abstracts and choosing those deemed relevant. Then duplicates were removed. Finally, the inclusion criteria considered factors such as year of publication between 1990 and 2020, type of e study (cross-sectional), objectives (rabies vaccination, dog ownership and awareness), geographic location (Africa and Tanzania) and language of publication (English). This process generated a subset of 33 articles which were then looked at in full.

3.2 Study Area

The study was conducted in Kilosa district, located in the western part of the Morogoro region, Tanzania. The district borders Dodoma region in the west; Tanga and Arusha regions in the north; Mvomero and Morogoro rural districts in the west and northeast; while it is bordered in the south by Iringa region and Kilombero district and is adjacent to the Mikumi National park. The geographical location of the district is 6°S to 8°S, and 36°30'E to 38°E, with a total surface area of about 14, 400 kilometres. The human population is estimated to be 438 175 with 105 635 households (Kimaro, 2014). The district consists of 38 wards and 139 villages and with 3570 to 29 361 inhabitants per ward (Kipanyula, 2015). The district experiences short rains from November to early January and heavy rainfall from March to May. The dry season is from June to October and the average temperature is 24.6^0C (National Bereau of Statistics [NBS], 2013). The communities living in the district engage in farming, livestock keeping, employment and off farm activities, including agro-business especially crops (Pacific, 2011). The famous tribes in the area are the Kaguru and Sagara. In the 20^{th} Century, the Kaguru tribe became very famous during sisal plantation activities. The district is mainly occupied by both Christian and Muslim confession (Ishengoma *et al.,* 2016; Kajembe *et al.,* 2013). The current study was conducted between May 2016 and March 2017.

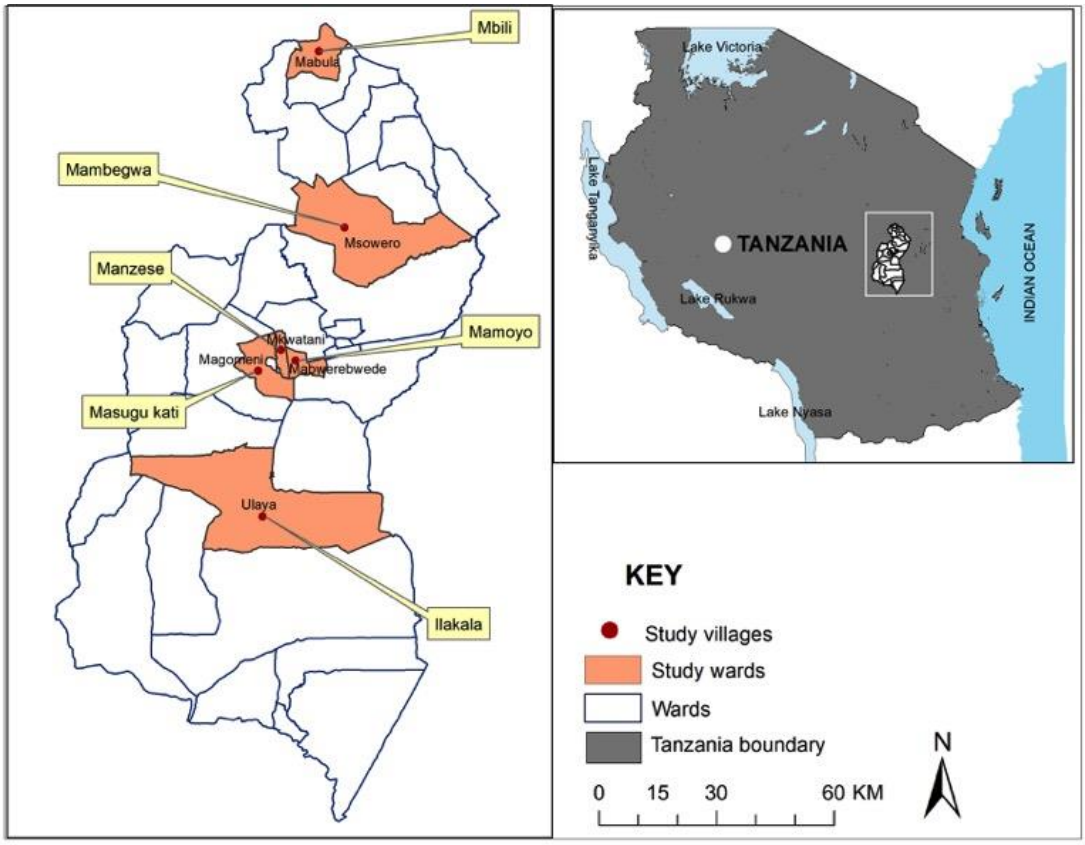

Figure 1: The map of Kilosa district showing study villages

3.3 Sampling and Study Design

The study involved surveying heads of households via questionnaire and collecting data via key informant interviews from LFOs, community representatives and health workers. For questionnaire administration a cross-sectional study design was chosen, while for key informant interviews, participants were specifically targeted.

3.3.1 Villages Selection

The sampling involved a multistage selection "WARD→VILLAGE→HH→INDIVIDUAL". The Kilosa district consists of 38 wards with 3,570 to 29,361 people per ward (Kipanyula, 2015). Six wards were chosen randomly (Fig 1). From each ward, one village was then selected at random: Mamoyo, Ilakala, Masugu Kati, Mbili, Mambegwa and Manzese. The aim was to reach 25% of the total population in the study district. 5% of the village households (n = 1216) were randomly chosen for questionnaire administration for the HHSurv. and the KAP survey, resulting in a total of 1216 respondents. However, in the HHSurv. subsample of 417 were selected for the HHS which owned dogs and were asked if they vaccinated dog previous year. The aim was to look for a person in the HH responsible for dog vaccination.

3.3.2 Participants Selection for interview

A purposive sampling procedure was used, whereby key informants where directly chosen by the researcher. Informants chosen were Livestock Field Officers (LFOs), health workers as well as community representatives. The participants were chosen with a consultation from the veterinary, health, and villages authority, by considering all groups are represented, based on gender, professionals, non-professionals, elders, youth, religion affiliations, to allow equal chance of participation. Qualitative interviews complemented the findings from the quantitative analyses. Research questions mainly focused on responsibility for children's health and MDV. However, qualitative information was also used to address the third objective on how factors associated with dog ownership and dog and child health care responsibilities present obstacles to rabies prevention interventions. Data were collected through key-informant interviews. Key-informants were considered to have broad knowledge relevant to rabies. The targeted group was the health sector (n=4) from Manzese, Masugu Kati and Mamoyo villages and the veterinary sector (n=2) in the Kilosa district council. Other

information was collected from participants from the village authorities (n=4) from Mamoyo, Masugu Kati, Manzese and Mbili villages.

3.3.3 Questionnaire Design and Administration

A cross-sectional study was conducted to determine dog-related practices, focused on responsibilities of the dog ownership and child health care using a pre-tested questionnaire tool (Appendix 2). The design of the questionnaire was semi-structured with both open and closed-ended questions. It included questions on demographics, dog ownership, responsibilities for dogs at the HH level and child health-care patterns in terms of dog-bites. The data collection process was performed by six well-trained enumerators under the supervision of the Principal Investigator (PI) and the master's candidate from Nelson Mandela African Institution of Science and Technology (NM-AIST) and Ifakara Health Institute (IHI) in a single visit. A questionnaire was administered to each head of HH (18+ years) or another adult resident in the same HH according to their position in the community relating to the disease prevention on behalf of the head of HH.

3.4 Data Analysis

3.4.1 Quantitative Data

Data were entered into Epi-Info version 5.2 (Centres for Disease Control and Prevention, Atlanta, Ga, USA) and transcribed into Microsoft Excel version 16.23 (www.microsoft.com). Statistical analyses were performed using R 3.6.1 (Team, 2016). Descriptive analyses were done on the general characteristics of the study population (Table 1). Analysis involved computing percentages, mean, median, ranges and generating graphs. To understand which individuals are largely responsible for HH decisions on dogs and child health, and who takes dogs for vaccination, only data from HH with dogs were included. Double entry of data and checking the dataset for duplicates was used to ensure data quality.

Multivariate analyses were used to test associations between variables (P-value ≤ 0.05). For this, generalised linear models (GLMs) were fitted using the lme4 package (Brooks *et al.*, 2017).

Constant formula for the GLM ($F_i = c + a_j$)

Whereby: F_i = Response variables

$c + a_j$ = Explanatory variables

For factors associated with dog ownership, data were combined from the HHSurv. and KAP, resulting in a total of 1216 unique households, to determine predictors of dog ownership and factors affecting the number of dogs owned. For models containing the response variables "dog ownership" and "number of dogs owned" (numeric, integer), the explanatory variables "village" (categorical), "cattle" (numeric), "pig" (numeric), "sheep and goats"" (numeric), "other livestock" (numeric), "chickens" (numeric), and "household size" (numeric), were included. The data for the response variable "dog ownership" were modelled using a binomial distribution, resulting in odds ratios. For the response variable "number of dogs owned", a Poisson distribution was used. A glm with binomial distribution was used to assess the relationship between the family member responsible for children's health if they are bitten, and village and household size.

The final model was selected based on the rule of parsimony, and by using a likelihood ratio test (LRT) with a significant p-value of ≤ 0.05, as well as visual inspection of the residuals for the fitted-model (Bolker *et al.*, 2009; Wagenmakers & Farrell, 2004).

3.4.2 Qualitative Data

Interviews were recorded using a digital tape recorder and notes were taken throughout the conversations. Participants narratives were categorized according to the study topics included in the study tools, these helped to generate relevant themes with responses to the research questions. Themes were analysed using framework analysis (Ritchie & Spencer, 2002), and were made available for use in the current study. All interviews were conducted in Swahili, and conversations were transcribed and later translated into English. Data were entered into Microsoft office 2013, and themes were developed according to the relevance of the study topics. The findings from the qualitative data were used to complement the findings from the quantitative analyses of the HHSurv. data.

3.5 Ethical Approval

Ethical approval was obtained through the Ethical Review Board of the IHI-(IHI/IRB/No.23-2014) and the National Institute for Medical Research (NIMR), Tanzania (NIMR/HQ/R.8a/Vol. IX/2200) (appendix 1). Additionally, permission for data collection at the district, village and sub-village level was obtained from the respective authorities.

Participation in this study was voluntary. The study participants were adults, and before the questionnaire was administered, participants gave written, informed consent after the purpose and procedures of the study, as well as their roles were explained. For qualitative data collection, verbal consent was acquired from each participant. All information from this study remains confidential, and qualitative data responses were coded to prevent identification of respondents.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results obtained from the data collected and their interpretation in the context of the current scientific knowledge. It mainly covers the following aspects: demographic characteristics of the study population and variables; factors associated with dog ownership and the number of dogs owned; responsibilities for dog vaccination; person who takes dogs to the vaccination location; responsibilities for the children's health once bitten by a dog; and obstacles on responsibilities of dog ownership and child health care on interventions against rabies. The key qualitative results were incorporated to add significant information related to the interpretation of the quantitative findings. The findings are important to inform rabies prevention and intervention plans.

4.1 Results

4.1.1 Identification, screening and inclusion of articles into the systematic review

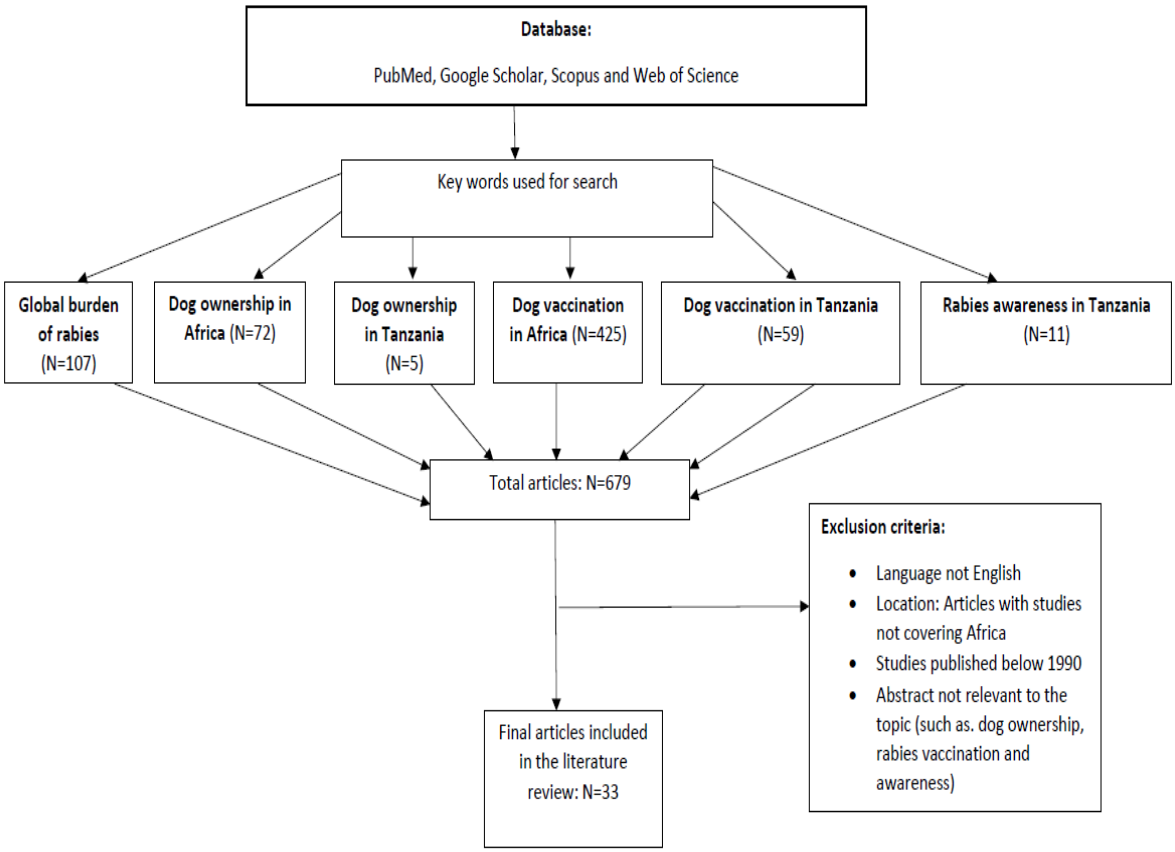

Figure 2: Flow diagram of identification, screening and inclusion of articles into the systematic review

4.1.2 Characteristics of the Study Population

In 1216 samples from HHs and KAP surveys, over half of respondents (64.9%) were female, and 35.1% were male. The age of half of the respondents (52.9%) was between 18 to 35years, 27.9% were aged between 36 to 50 years and 19.2% were above 50 years (Table 1). The HH family size of respondents was categorized between less than 6 people (72.2%) and 6 or more (27.8%, Table 1).

Only 11% of the 1216 HHs surveyed in the six villages owned dogs (Table 1). There were differences between villages in terms of the number of dogs owned and the probability that a HH would own dogs at all P =0.001 (Table 2).

Table 1: Demographic characteristics of respondents to the Household Survey (HHSurv.) and Knowledge Attitudes and Practice Survey (KAP) and their dog ownership information.

Dataset	Variable	Category	No. of respondents (*n*)	Proportion (*%*)
KAP and HHSurv. data	Gender (n=1216)	Male	427	35.1
		Female	789	64.9
	Age groups (n=1216)	Range	18-99	NA
		Median	35	NA
		15-35 years	644	52.9
		36-50 Years	339	27.9
		>50 years	233	19.2
	Household size (n=1216)	<6 members	878	72.2
		>6 members	338	27.8
KAP data	HH Dog ownership by village (n=325)	Ilakala	73	22.5
		Mambegwa	77	23.7
		Mamoyo	6	1.8
		Manzese	57	17.5
		Masugu Kati	18	6.9
		Mbili	94	28.9
HHSurv. data	No. of HHs owning each type of livestock (n=798)	Dog	126	15.7
		Cattle	63	7.9
		Goat	84	10.5
		Sheep	10	1.2
		Pig	26	3.2
		Chicken	692	86.7
		Cat	129	16.2
		Other livestock*	89	11.1
HHSurv. data	Religion (n=798)	Christian	491	61.4
		Muslim	297	37.2
		Traditional beliefs	2	0.25
		NA	9	1.13

* E.g., Pigeons, ducks and rabbits.

4.1.3 Factors Associated with Dog Ownership and Number of Dogs Owned

The probability of owning dogs varied by village (Fig. 3, table 2). Living in Mamoyo village was associated with a lower probability of owning a dog (coefficient= -0.08, p-value=0.01), while living in Masugu village was associated with a higher probability of owning dogs (coefficient=0.18, p-value=0.002). The number of dogs per HH differed by village, with living in Mamoyo (coefficient=0.26, p-value=0.01) and Manzese (coefficient -0.19, p-value=0.02) negatively associated with the total number of dogs owned (Table 2). A lager HH size was positively associated with dog ownership (coefficient=0.03; p-value <0.001) and the number of dogs kept (coefficient=0.08, p-value<0.001). There was also a highly positive association between the probability of owning dogs and cattle and pig ownership. The number of dogs owned was also highly positively associated with cattle and pig ownership (Table 2).

During community interviews with the key-informants, a respondent suggested the reasons why fewer people owned dogs, specifically in Mamoyo village: *"In our village, there are fewer dogs, because most of the people are Muslims, they are not keeping dogs.* (Interview, Village level _Mamoyo village, ID# C 001).

Table 2: Predicted mean estimates and the significance (p-value) of variables associated with dog ownership and the number of dogs owned per household in five villages in rural Tanzania

Response Variable		Explanatory variables									
		Predicted mean estimate									
		Ilakala village	**Mamoyo village**	**Masugu village**	**Manzese village**	**Mambegwa village**	**Cattle**	**Pig**	**Sheep/or goat**	**Household size**	**Other livestock**
Dog ownership	**Coefficient**	-0.012	-0.08	0.18	-0.02	-0.04	0.21	0.16	0.03	0.03	0.09
	p-value	0.61	0.01	0.002	0.48	0.08	<0.001	0.005	0.38	<0.001	0.005
Number of dogs owned	**Coefficient**	-0.02	-0.26	0.34	-0.19	-0.17	0.73	0.65	0.02	0.08	0.19
	p-value	0.75	0.01	0.08	0.02	0.41	<0.001	<0.001	0.86	<0.001	0.07

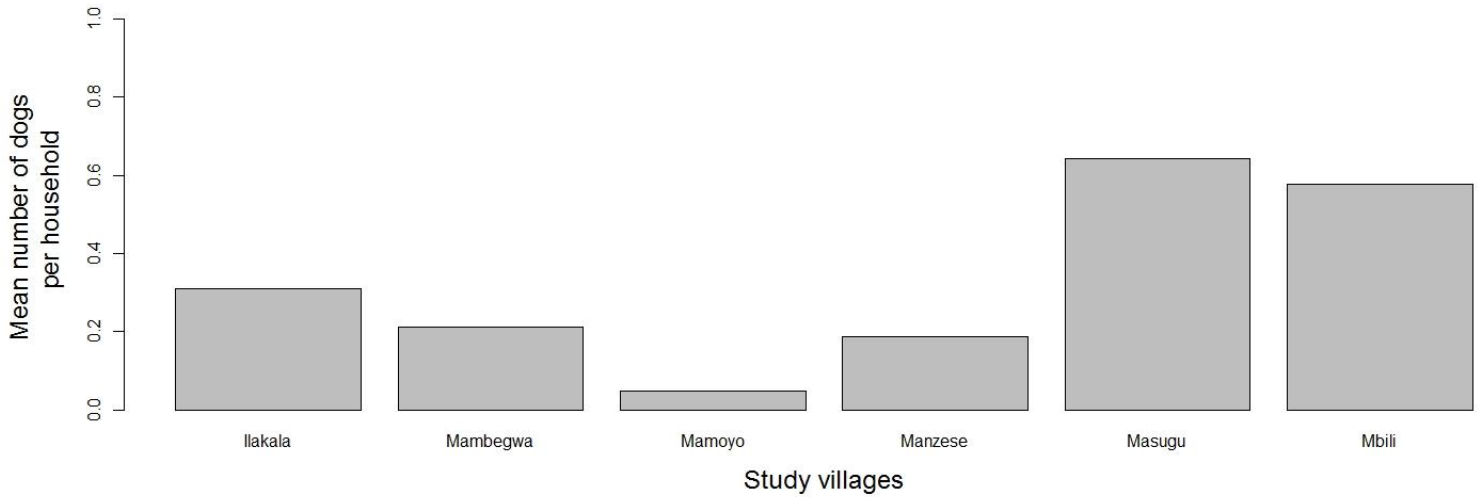

Figure 3: Mean number of dogs per household in each of the six villages within Kilosa district, Tanzania (n=1216)

4.1.4 Responsibilities for Dog Vaccination

The respondents of HHSurv. included in a subsample of 417 during the HHSurv. were asked about the number of dogs owned and whether the dogs were vaccinated in the previous year. Of 417 HHs, 66 were reported owning a total of 162 dogs. Of those animals, 134 were reported to be vaccinated against rabies, which is equivalent to 83%.

Of the dog owning respondents, 53 gave information on responsibilities for vaccinating dogs and decisions regarding children's health care at the HH level. In most HHs with dogs, the father decides whether to vaccinate the animal (66%), followed by children (16%) and 11% of the HHs mother decide (Fig. 4).

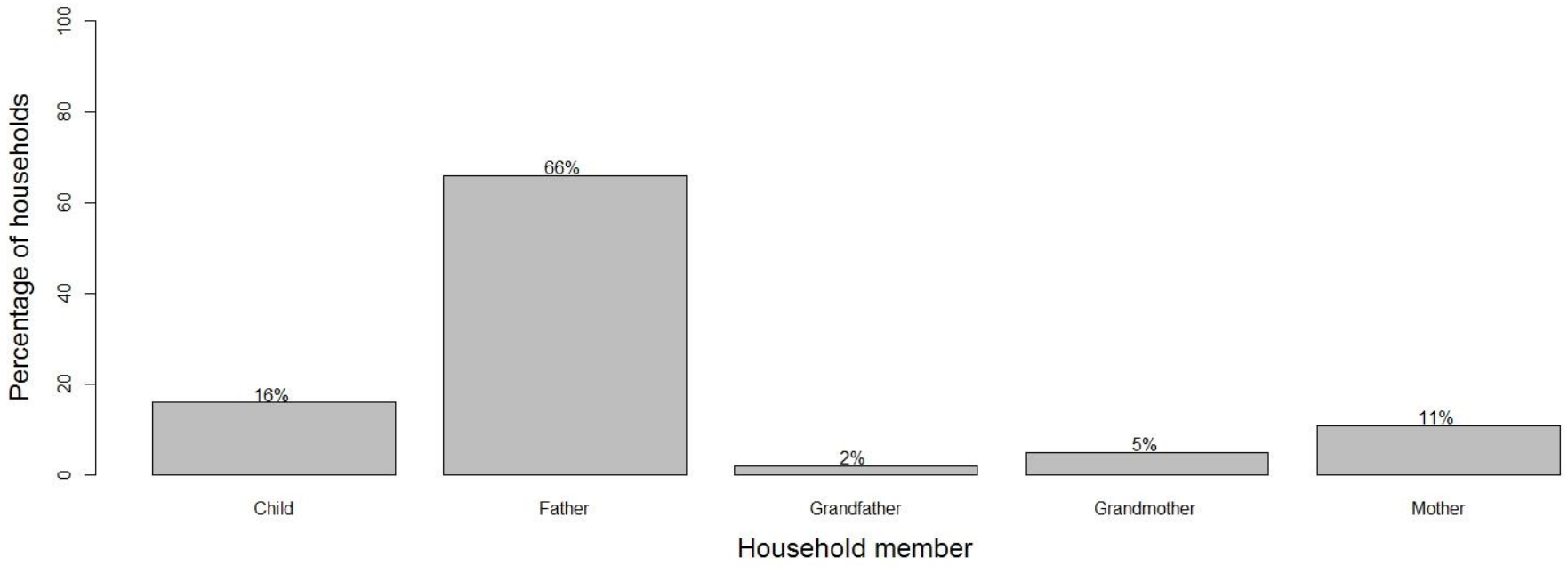

Figure 4: Responsibility of household members for dog vaccination decision at household level in percent (n=798)

4.1.5 Person who Takes Dogs to the Vaccination

Children are likely to be the ones who take dogs for vaccination, as shown in comments made by the LFO in the Kilosa district during qualitative data collection. "*Pupils of standard one to five are very active in bringing dogs for vaccination."* (Interview, Veterinary authorities _Kilosa District, ID# A 001). "*It is normally a parent's obligation to say when he wants to vaccinate".* (Interview, Veterinary authorities _Kilosa District, ID# A 001).

This was corroborated by quantitative analysis of the HHs data. In the 64-dog owning HH which answered the question: "Who takes dogs for vaccination?" 58% said that this was undertaken by children, 33% said the father and only 9% mentioned the mother (Fig. 5).

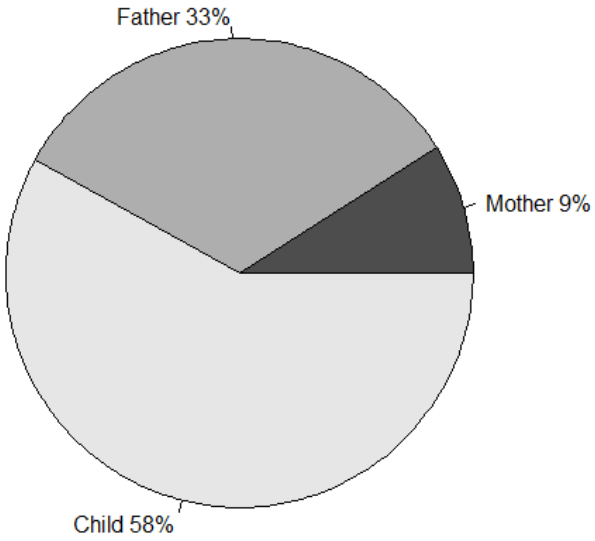

Figure 5: Household member who take dogs to the vaccination point (n=417)

The veterinary authorities were asked about their procedures in terms of organising MDV. They reported that they informed people through public announcements by visiting the veterinary office on Saturdays to inquire about the dog vaccination dates. There was no indication that this involved any exchange of information on difficulties HH might experience in attending and seems to have been a simple notification of dates and times.

> *So, we advertise it to all who come here every Saturday, using poster and local FM radio. Children are also informed using verbal announcement, that we will be vaccinating livestock on a certain day. If there is a cost of vaccinating, people are informed directly about the cost and if it is a free service people will be notified. This depends on who provides the vaccine, if it is a District council or privately owned. We have never supplied free vaccines. That is why we normally conduct the campaign on cost* (Interview, Veterinary authorities _Kilosa District, ID# A 001).

Scheduled village meetings were also a conduit for disseminating information about vaccination campaigns, but the extent of the information is unclear, as is the issue of how it is passed on to people beyond those attending the meeting.

> *Normal meetings are held every three months, by village leaders. Health messages can be incorporated after the normal business, but you would normally need to advertise well and provide some sort of entertainment, like music, to get people to attend. Or incorporate it into sports events* (Interview, Village level _Masugu village, ID# A 002).

4.1.6 Responsibilities for the Children's Health Care if they are Bitten by Dogs

The study found that, when a child is bitten by a dog, the mother decides on the course of action in terms of the child's health care in 69% of HHs interviewed (Fig. 6). According to the data, incidences of dog bites, especially where the victims are children, mostly take place during the morning when they are on the way to school, or in the afternoon when they are going home. These findings were supported by information from the qualitative study in an interview with staff from the health facilities.

"Often a person who escorts a child to health facility is a mother. In most cases treatment instructions, are given to a parent". (Interview, Health facility _Ulaya village, ID# C 002). *"Children are generally brought by their mother, but if they are 3-6 years, they might come*

with the father. Instructions are normally given to the parent". (Health facility _Mbili village, ID# C 003.

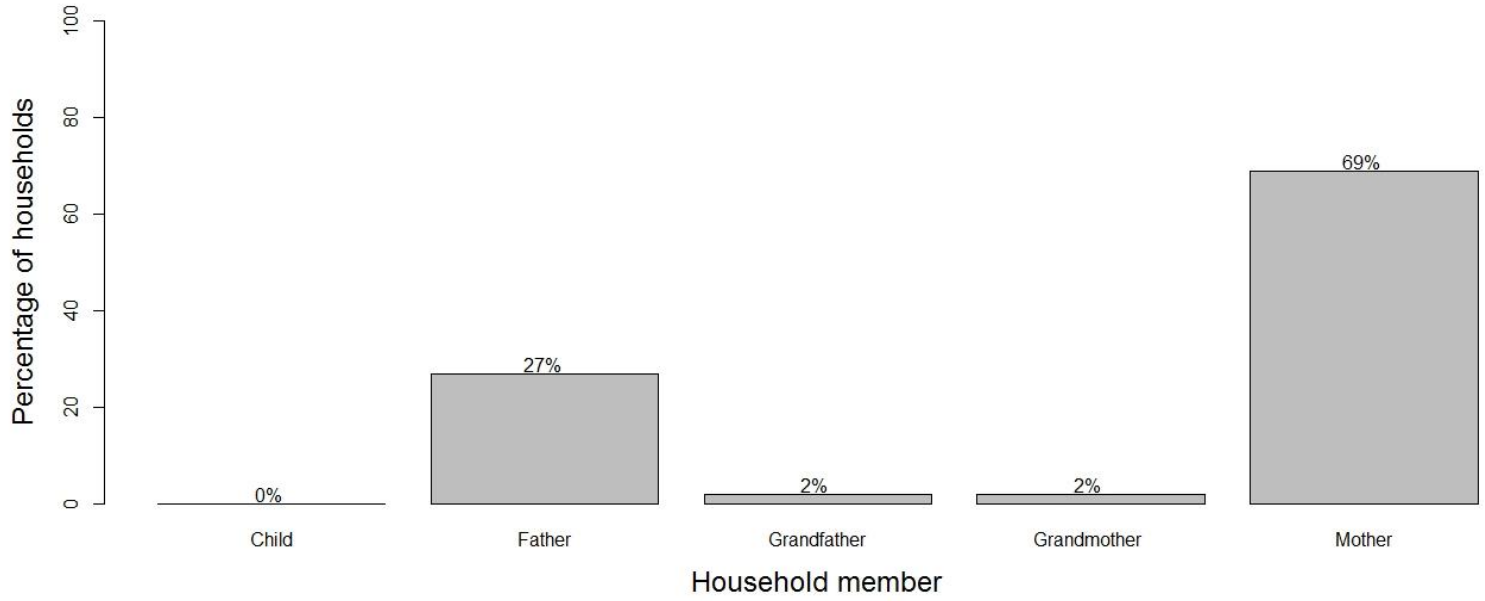

Figure 6: Responsibility of household members for childcare decisions if child is bitten by dog (n=1216)

4.1.7 Challenges for Rabies Control Interventions Related to the Responsibilities of Dog Ownership and Child Health Care once Exposed to Bite

To address objective three, data from the first and the second objectives were used to identify obstacles to successful rabies control. In the majority of interviewed HHs, children do not have a say in decisions on dog vaccinations. Therefore, targeting children alone with information for interventions is not enough to reach all those involved in the prevention chain. The same is true for information on PEP, as children do not influence decisions in the HH on their own health. The key-informant interviews revealed that one-way awareness information campaigns do not provide mechanisms for investigating possible barriers to HHs complying with these prevention measures, and even for developing solutions to the problems. As owning a dog is costly and involves feeding, housing and treating the animal, many owners allow their dogs to stray or get into unhealthy conditions and remain unvaccinated. Also, some places reported to have low vaccination coverage due to misconceptions that dogs died after being vaccinated against rabies or changed their behaviour. Distance to the vaccination central location during MDV has also been an obstacle, dog owners tend to avoid travelling long distances for dog vaccination. However, vaccines are not provided everywhere and if they are available they may not be affordable to all people keeping dogs. Other places have access to vaccines, but sometimes lack equipment to maintain the cold chain. Another obstacle mentioned is the limited number of LFOs to serve all communities.

4.2 Discussion

This study identified factors associated with dog ownership, MDV against rabies and HH responsibilities for child health care patterns. Most households with large livestock, such as cattle, sheep/goats and pigs, are more likely to own more dogs compared to households owning chickens, cats or goats. This is attributed to the fact that dogs are used for security purposes and guarding livestock. The findings were also comparable to Leonard *et al.* (2015) where dogs were used for security at home and for companionship. A similar study, conducted in rural and urban Tanzania, reported that over half of the households kept dogs in their families for security purposes against thieves (Knobel *et al.*, 2008a). In line with the current findings, other studies reported that engaging in farming activities and keeping large number of livestock is positively correlated with large number of dogs in rural areas (Kaare *et al.*, 2009; Knobel *et al.*, 2008b).

In Southern Tanzania, studies indicated that dog ownership was higher in rural areas, with 69.7% of households owning dogs compared to 18.2% in urban areas (Knobel *et al.*, 2008a). A comparable study from Ethiopia showed that the larger the size of the HH, the higher the number of dogs kept (Kabeta *et al.*, 2015). The probability of a HH owning dogs in Tanzania was also found to be dependent on whether or not the family is involved in subsistence food production and farming activities (Knobel *et al.*, 2008b). In Kenya, a study in Machakos district showed that dog ownership differs between locations (Kitala *et al.*, 2001), and in Tanzania it was also not surprising to find a larger number of dogs in livestock keeping communities. Furthermore, the presence of a national park , which hosts wildlife including predators, may be a contributing factor to the community using dogs as guard dogs, hunting and for herding livestock. Previous studies revealed that pastoralist communities own dogs for protecting livestock in areas close to a national park (Knobel *et al.*, 2008b), which indicated that dogs were used for hunting pests amongst the crops or for protecting livestock (Kitala *et al.*, 2001). Occasionally, the number of dogs owned also depends on economic activities or the culture of the community (Knobel *et al.*, 2008b).

This study showed that the responsibility for MDV and child health is shared between family members. Decisions are mainly made by the father as the head of the household, but the mother has the role of ensuring a child has access to health care services. Children are mainly responsible for taking dogs to the vaccination points, particularly those aged between 5 and 15. In rare circumstances, in the absence of children, women may take over this role. However, rabies control interventions through awareness tend to target mainly children while at schools and when present during dog vaccination campaigns. Therefore, the findings presented here are useful for organising MDV and will help organisers to focus more on target groups such as male heads of households.

Responsibilities surrounding dog ownership in the community differs from one place to another. A study conducted in Zambia reported that 76% of the study population, which included children, were involved in dog vaccination (Hergert *et al.*, 2018). It also investigated how the vaccination centre was organised, and considered how parental approaches influenced children in terms of who brought dogs in for vaccination (De Balogh *et al.*, 1993). A study conducted in Southern and Northern Tanzania suggested that understanding responsibilities, roles, practices, willingness for dog ownership in the community is an alternative way to plan accessible and affordable interventions to prevent disease (Bardosh *et*

al., 2014b; Knobel *et al.*, 2008a; Sambo *et al.*, 2014). This will help identify how resources could be organized to ensure activities are successfully implemented. In this study, the veterinary office was mentioned as an essential place for sharing information that could influence the community to bring their animals for the vaccination against rabies and other diseases.

Qualitative data showed that community meetings or gatherings are used to communicate messages about rabies vaccination, and veterinary officers noted that these are essential approaches for sharing information. However, the extent to which these general avenues of communication are directly reaching and influencing HH decision-making remains unclear, particularly anyone who has doubts about vaccination. Furthermore, the information appears to be one-way, and there is no indication whether mechanisms exist for investigating or recording obstacles faced by HH in terms of travelling or agreeing to vaccination, even if they are aware of the importance of it. In other words, the focus seems to be on awareness, rather than assessing feasibility and attitude. A study conducted in Southern-eastern Tanzania suggested that, in planning MDV interventions, it is important to understand the dynamics involved in people's willingness to vaccinate household dogs (Bardosh *et al.*, 2014b). Understanding these factors and working towards formal mechanisms for this type of consultation will help target rabies control and prevention more effectively in communities.

Dog bites occur most frequently in children aged 6-12, and particularly in the lower limbs (Sabhaney & Goldman, 2012). A study conducted in Northern Tanzania demonstrated that children (5-15 years) were at high risk of exposure to suspected rabid dogs (Cleaveland *et al.*, 2002). The findings from different settings also show that male children seem to be bitten more often than female (Abubakar & Bakari, 2012; Ahmed *et al.*, 2000). The current findings of our study confirmed that, principally targeting children directly in rabies-prevention interventions may not change the way HH decisions are made about dog vaccination, even though children are the main victims. Children are more vulnerable to being exposed because they have closer interactions with dogs.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The key findings from the study indicate that, (a) larger HH with livestock, namely cattle, sheep/or goats and pigs, are more likely to own dogs and a greater number of dogs compared to HH owning chickens, cats or goats; (b) a child is likely to take a dog to the vaccination point, but (c) the decision on whether a dog will be vaccinated against rabies lies with the father; (d) a mother typically decides on the course of action if the child is bitten by a suspected rabid animal.

Understanding practices around dog ownership and care, as well as family decisions about the health of most at-risk groups such as children, can help to direct rabies-prevention resources better to the people who making these decisions. Specifically, the present study suggests a possible strategy for reaching recommended (>70%) dog vaccination coverage in communities is by identifying and consulting HH members who make decisions on the issue. It also suggests consulting HH decision makers about the dynamics involved in seeking PEP for children bitten by dogs. This more inclusive, yet targeted, approach is more likely to facilitate and maintain changes in practice in HH than focusing more generally on awareness in at-risk groups alone.

5.2 Recommendations

First, there should be further research on the dynamics which specifically influence a HH decision to vaccinate or not vaccinate a dog. Second, the level of children's influence on this decision should be assessed before relying on children alone to filter important prevention information into HH. Third, Veterinary officers and village elders should be approached to find the HH owning dogs . Finally, given the results of the present study, it will be important to involve HH members in both the above investigations, as they have been shown to be the actual decision makers in terms of whether a dog will be vaccinated, or child with a dog bite will be taken for a course of preventative vaccine. Methodology which identifies and consults local decision-makers directly in this way can help make interventions more effective and more sustainable. The findings from this study will be disseminated to the community levels through the use community engagement approach. Finally, results from the study will be

shared with Ministries of Livestock Development and Fisheries and that of Health through meetings, workshop and policy briefing documents.

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APPENDICES

Appendix 1: Research approval certificate

THE UNITED REPUBLIC OF TANZANIA

National Institute for Medical Research
3 Barack Obama Drive
P.O. Box 965
11101 Dar es Salaam
Tel: 255 22 2121400
Fax: 255 22 2121360
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Ministry of Health, Community Development Gender, Elderly & Children
6 Samora Machel Avenue
P.O. Box 9083
11478 Dar es Salaam
Tel: 255 22 2120262-7
Fax: 255 22 2110986

NIMR/HQ/R.8a/Vol. IX/2200

16th May 2016

Lwitiko E Sikana
Ifakara Health Institute
P O Box 53, IFAKARA
Morogoro

CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH IN TANZANIA

This is to certify that the research entitled: Developing Interventions to Raise Rabies Awareness in Rural Tanzanian Communities, (Sikana L E *et al*), has been granted ethical clearance to be conducted in Tanzania.

The Principal Investigator of the study must ensure that the following conditions are fulfilled:

1. Progress report is submitted to the Ministry of Health, Community Development, Gender, Elderly & Children and the National Institute for Medical Research, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from National Institute for Medical Research.
3. Copies of final publications are made available to the Ministry of Health, Community Development, Gender, Elderly & Children and the National Institute for Medical Research.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine. NIMR Act No. 23 of 1979, PART III Section 10(2).
5. Site: Kilosa Distict, Morogoro Region

Approval is for one year: 16th May 2016 to 15th May 2017.

Name: Dr Mwelecele N Malecela

Signature
CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE

Name: Prof. Muhammad Bakari Kambi

Signature
CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH, COMMUNITY DEVELOPMENT, GENDER, ELDERLY &CHILDREN

CC: **RMO**
DED
DMO

Appendix 2: Questionnaire 1_Household questionnaire

Name of interviewer…… Date……..

HOUSEHOLD IDENTIFICATION

District…… Village……..……..…

Village leader name:.....Head of household……

GPS location : Code…… Eastings……..…… Northings ……

BACKGROUND INFORMATION ABOUT INTERVIEWEE

Name ……

Age……

Sex: Female / Male

1. Phone number**……**

2. Are you the head of the household YES / NO

HOUSEHOLD DEMOGRAPHICS / DYNAMICS AND DOG CARE PATTERNS

3. How many people live in this household? [_____]

4. Dogs the household is responsible for:

Name	Sex M/F	Age mths	Age yrs

5. Total n. of dogs <= 3 months [_____]

6. Total n. of dogs > 3 months [_____]

7. Complete the table below for each member of the household:

Name	Sex M/F	Age yrs	Marital status[1]	Role in family[2]	Education[3]	Primary occupation	Secondary occupation	Religion	Do you look after household dogs?	Do you take household dogs for vaccination?

[1] M Married, S single, W widowed, D divorced

[2] Household head, Relative to household head: spouse, son, daughter, brother, sister, father, mother, nephew, niece etc

[3] Highest level of education reached

[4] F employed on farm, S self-employed off farm, E employed off farm – agriculture, salaried, other

8. For each member of the household aged < 18 years, also complete the table below:

Name	School Y/N	N. of hours spent in out-of-school activities	Type of out-of-school activities	Where do you spend most of the morning?	Where do you spend most of the afternoon?	Where do you spend most of the evening?	Where do you spend most of the night?

9. More detail on who mostly influences children and young people during the week:

Name	In the place where this person spends most of the morning, who is their main point of reference/influence?	In the place where this person spends most of the afternoon, who is their main point of reference/influence?	In the place where this person spends most of the evening, who is their main point of reference/influence?	In the place where this person spends most of the night, who is their main point of reference/influence?

10. More detail on who mostly influences children and young people during the weekend:

Name	In the place where this person spends most of the morning, who is their main point of reference/influence?	In the place where this person spends most of the afternoon, who is their main point of reference/influence?	In the place where this person spends most of the evening, who is their main point of reference/influence?	In the place where this person spends most of the night, who is their main point of reference/influence?

11. Who in the household decides whether?
    - Dogs are vaccinated…….
    - A child is taken for PEP if they are bitten…….

12. If dogs are vaccinated, where are they taken for vaccination?

    …….

ASSETS AND INCOME

ASSETS

13. Does any member of household own any of the following assets?

Asset	Number of Units	Purchase Price TSh (If purchased)	Age	Working Y/N
Ox plough				
Ox cart				
Bicycle				
Motorbike				
Motor Vehicle				
Tractor				
Mobile phone				
Radio				
TV				

HOUSE DETAILS

14. Is your house rented? YES / NO
15. How many houses are there? [_____]
16. How many other buildings are there? [_____]
17. Do any living quarters have a metal roof? YES / NO
18. Are any living quarters built of concrete block or brick? YES / NO
19. What is the number of rooms in all living quarters combined?.....
20. Latrine? (circle)
    1. indoor 2. outdoor 3. none
21. Electricity? 1. none 2. grid 3. off grid 4. if off grid, specify……..
22. What is your primary water source now? (circle respective number):

1. private well 2. community well 3. river 4. pond 5. other (mention):
…….....…….....

23. How long (hours) does it take you to travel to obtain drinking water (one way)?
…….

24. How many times per week do you go to obtain drinking water?.....

25. What are the energy sources you use for cooking (circle)?
1. electricity 2. gas 3. Kerosene 4. cow dung 5. firewood 6. charcoal
7. Other (mention)……

26. How long (hours) does it take you to travel to collect firewood (one way)?
…….

27. How many times per week do you go to collect firewood?.....

LAND USE

28. Is the land you use for grazing:
1. owned by you 2. rented from others 3. common land 4. Other (mention):.....

29. Is the land you plant for crops:
1. owned by you 2. rented from others 3. mcommon land 4. Other (mention):.....

30. Is the land where the house is built:
1. owned by you 2. rented from others 3. common land 4. other (mention):.....

31. INCOME SOURCES (Use ticks)

i) Livestock sales ( )

ii) Milk sales ( )

iii) Other livestock income ( )

iv) Crops related ( )

v) Honey related ( )

vi) Wildlife related ( )

vii) Food relief ( )

viii) Off-farm employment ( )

CROPS

32. Have you harvested any crops in the past four months? YES / NO

If **YES**, fill in the table below for crops harvested:

	Crops harvested		Crops sold			Crops given away to others	
	No. (units)	Month	No. (units)	Price per unit	Month sold	No. (units)	Month
Rice							
Millet							
Maize							
Sesame							
Cassava							
Sweet potato							
Bean							
Cabbage							
Lettuce							
Vegetable							
Tomato							

Banana							
Cotton							
Other ……. .							

33. LIVESTOCK IN THE HOUSEHOLD

Type of animal	If Yes, how many
Cattle	|___|___|___|____|
Goats	|___|___|___|____|
Sheep	|___|___|___|____|
Pigs	|___|___|___|____|
Donkeys	|___|___|___|____|
Chicken	|___|___|___|____|
Others…….	|___|___|___|____|
Others…….	|___|___|___|____|

RABIES / BITE INCIDENCE

34. Have you heard of any rabies incidents in animals in the past 2 yrs in the village? YES / NO

If YES, take the following details:

Species	Date of case	Some description of incident if possible

Have you heard of any rabies incidents in humans in the past 5 yrs in the village? YES / NO

If YES, take the following details:

Name	Age	Sex	Date of case	Clinical signs	Date of bite	Species biting	Hospital Y / N	PEP Y / N	PEP completed Y / N	Died/ recovered	If died, date

35. Has any member of your family been exposed to a suspect rabid animal? YES / NO

If YES, take the following details:

Name	Age	Date bite	Species biting	Clinical signs of bite victim	Bite victim alive / dead	PEP Y / N	PEP completed Y / N

36. Do you know anyone else in the village who has been exposed to a suspect rabid animal?

YES / NO

If **YES**, take the following details:

Name	Age	Date bite	Species biting	Clinical signs of bite victim	Bite victim alive / dead

Appendix 3: Questionnaire 2_Pre- and post-intervention knowledge, attitude and practice questionnaire

Do not prompt for answers. If multiple choices are available, use codes (numbers) to record the answer. More than one answer is possible.

INTERVIEWER / INTERVIEWEE IDENTIFICATION

Name of interviewer…… Date……..

Name of interviewee…… Age……

Sex: F / M

Phone n**……**

District…… Village……

Village leader name : ..... Head of household……

GPS location : Code…….. Eastings…….…..……

Northings.……

RESPONSIBILITY FOR DOGS IN THE HOUSEHOLD

1. How many people live in your household? [_____]
2. N. of dogs <= 3 months the household is responsible for [_____]
3. N. of dogs > 3 months the household is responsible for [_____]

4. How important are dogs to you / your household? Rank the following species in order or importance (1=very important, 7=not very important)

Type of animal	Do you own any? Y/N	Rank how important they are to you
Cattle		
Goats		
Sheep		
Pigs		
Donkeys		
Chicken		
Dogs		
Cats		
Others…….		
Others…….		

5. Why have you ranked them in this order?.....

6. Who in the household is responsible for dogs vaccination?……
7. Do you think that vaccinating dogs against rabies is important? YES / NO
8. If YES, why?.....
9. If NO, why not?
   .....
10. Who would take them for rabies vaccination if this were provided?.....

11. Where would you take them for rabies vaccination if this were provided?.....
12. How many dogs < 3 months vaccinated against rabies in previous year? [___]

13. And how many > 3 months? [___]

If dog/s vaccinated, can you show me the vaccination certificate/s?

YES (tick if seen certificate)

YES but uncertain where it is stored

NO

14. If dog/s not vaccinated, what was the reason?

1= no vaccination carried out in the area

2= costs

3= it will stop dogs fulfilling their function in the household

4= other,

specify……

KNOWLEDGE ABOUT RABIES AND RABIES PREVENTION

15. Have you ever heard of rabies? YES / NO

16. If YES, where did you get knowledge of rabies for the first time?

1=because I have seen it personally

2= from TV

3= from radio

4= from newspaper [___] [___] [___]

5= from school

6= from government /community meeting

7= from poster/leaflets/ brochure

8= from local community (parent/neighbour/friend etc)

9= other, specify……..

17. If YES, can you describe what rabies looks like?

.....……

…….....……...…….....

.....

18. How can rabies be caught? .....

1= through a bite,

2= through a scratch [___]

3= do not know

4= other

19. Which species of animal can transmit rabies?

1= humans

2= snakes

3= chickens

4= dogs

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

6= cattle

7= hyenas

8= goats

9= mongoose

10=another way? Specify……

20. What would you do if you saw a dog behaving strangely or aggressively?

1= throw something at it

2= make a noise to scare it away

3= try to separate it from other dogs

4= report it to someone in authority and make sure no one went near it

21. What is the first thing you should do if you or any family member is exposed to any suspect animal bites?

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……

22. What is the second thing you should do if you or any family member is exposed to any suspect animal bites?

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……

23. If respondent says wash wound with soap and water, how quickly should you do this?

…….....

.....

24. If respondent says wash wound with soap and water, where have you learnt this?

1= from TV

2= from radio

3= from newspaper [___] [___] [___]

4= from school

5= from government /community meeting

6= from poster/leaflets/ brochure

7= from local community (parent/neighbour/friend etc)

8= other, specify……..

25. If respondent says **go to hospital**, how quickly should you do this?

……...

26. If respondent says **go to hospital,** where have you learnt this?...……...

1= from TV

2= from radio

3= from newspaper [___] [___] [___]

4= from school

5= from government /community meeting

6= from poster/leaflets/ brochure

7= from local community (parent/neighbour/friend etc)

8= other, specify……..

27. If you were to go to hospital, what treatment would you expect at the hospital?

1= antibiotics

2= painkiller

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

4= tetanus

5= dress wound

6= would take advice of the staff

7= other, specify……

28. If you were NOT to go to hospital, why?

1= it is too far away

2= it is too expensive

3= it is only a bite and it will heal [___] [___] [___]

4= I was told that it is not necessary

5= other, specify……

29. If the answer is 4 (I was told that it is not necessary), who told you this?.....

30. How would you get to the hospital?

1= on foot

2= by bike

3= by car [___] [___] [___]

4= by public transport

5= other, specify……

31. If it were a child that was bitten and needed to be taken to the hospital, who would take him / her?.....
.....

32. Would the person taking a child to the hospital lose income in the time they are away?.....
.....

33. What use do you make of the health system more generally?.....

34. Do you regularly seek health care for anything else? YES / NO.

If **YES**, provide examples……
……..

35. What would you do to a suspect rabid animal that attempts to bite you/your family member/neighbour)?

1= immediately kill that animal

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

3= I would not take any action

4= other, specify……

36. 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

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

38. Why:

……

39. Is there any cure/treatment for a person who started developing rabies symptoms? YES / NO

40. If YES mention

    it…….…….……

41. Do you know ways to control rabies in animals? YES / NO

42. If YES mention them:

    i…….

    ii…….

    iii……..…….

    iv……..

Appendix 4: Consent form in English language

Informed consent agreement for study participants

Title of project: Developing interventions to raise rabies awareness in rural Tanzanian communities

Project rationale: Rabies is a deadly disease that in Africa is transmitted mainly by domestic dogs, although other species can also act as a source of infection for humans. Rabies can be eliminated through mass dog vaccination, but there has been little investment in dog vaccination in Africa. Once an exposure has occurred, rabies can also be prevented through prompt wound care and administration of human vaccination. However, many people in rural communities are not aware of the importance of these measures to prevent the development of disease and therefore many deaths still occur, particularly amongst children and young people.

Project aims: This study will develop interventions to increase rabies awareness amongst rural community members, with a special focus on children, who are the main victims of rabies. We will work closely with community members, including key community representatives, parents, and teachers, to understand who in the community is likely to have the greatest influence on children and to develop appropriate awareness messages and means of delivering them to children. The study will involve both interventions in schools and in communities in a broader sense to ensure that our interventions reach schooled youth as well as out-of-school children, who are likely to represent a large proportion of children in rural areas.

Potential risks: No risks are anticipated in this study except minimal interruption in your time to participate in surveys and workshops.

Potential benefits: This project will capacitate the whole community, and particularly children and young people, to protect themselves against dog / animal bites and rabies. Increased awareness about rabies and how to prevent it will result in a reduction in deaths, which will be an invaluable benefit for your family and community.

Compensation: The participation in this study will be voluntary. However, rabies awareness materials will be developed as part of the project and will be donated to your schools and communities. Your participation in this study is not compulsory, and you have the right to decline to participate in this study. There will not be any repercussions on the quality of health care you are receiving from withdrawal from this study.

Contact person in case of emergency: For any emergency cases, please contact Lwitiko Elton Sikana, the Principal Investigator (PI) at +255 787 410 210 and +255 682 000 022 or through lwsikana@ihi.or.tz or lwitikosikana@gmail.com or Dr. Mwifadhi Mrisho, the representative of IHI institutional review board at 0788 766 676.

Participant's information

Village name : _____

Village leader : Name **_____ Phone** n.

_____

Study participant: Name **_____ Phone** n.

_____

I hereby give full approval to the researchers of the Ifakara Health Institute to conduct this study in my community/household.

I understand the background and objectives of this research project and I am fully aware of the nature of the research and my role in it.

Signature or thumbprint of participant: _____Date: _____

Signature of witness: _____ Date: _____

Research team statement

Name of the research officer: _____ Signature: _____

Contact details: _____

I hereby confirm that I have explained the objectives, potential risks, benefits, and any compensation of this study to the participants in a language they understand.

Appendix 5: Consent form in Swahili language

Fomu ya ridhaa ya mshiriki/washiriki katika utafiti.

Jina la mradi: Kukuza ufahamu kuhusu kichaa cha mbwa katika jamii ya watanzania vijijini.

Malengo ya mradi: Kichaa cha mbwa ni ugonjwa unao ua, kwa Afrika huenezwa na mbwa wa kufugwa, japokuwa aina nyingine pia inaweza kuwa chanzo cha maambukizi kwa binadamu. Kichaa cha mbwa kinaweza kuzuilika kwa njia ya chanjo, ijapokuwa kumekuwa na uwekezaji mdogo katika chanjo Afrika. Mara tu baada ya kung'atwa ama kujeruhiwa, kichaa cha mbwa kinaweza kuzuilika kwa kutibu jeraha haraka na kupatiwa chanjo dhidi ya kichaa cha mbwa. Hata hivyo jamii nyingi vijijini hawafahamu hatua za kuzuia ugonjwa huu, hivyo vifo vingi hutokea miongoni mwa watoto na vijana.

Malengo ya mradi: Mradi huu unalengo la kuongeza uelewa kuhusu kichaa cha mbwa miongoni mwa wanajamii, kwa kuwalengwa watoto, ambao ni waathirika wakubwa wa kichaa cha mbwa. Mradi huu utahusisha shule za msingi na jamii kwa kuhakikisha kuwa mpango wa uelewa na uthibiti unawafikia vijana, pia na watoto wasiokuwa shuleni ambao watawakilisha sehemu kubwa ya watoto waliopo vijijini/jamii.

Hatari zinazoweza kupatikana: Hakuna hatari zozote zinazoweza kupatikana kutokana na utafiti huu, ila tu tunatumia muda kidogo kushiriki katika utafiti na warsha.

Faida za mradi: Mradi huu utawapatia jamii uelewa na hasa kwa vijana na watoo juu ya kijilinda kuumwa na mbwa/wanyama na kichaa cha mbwa

Fidia: Kushiriki katika utafiti huu ni kwa ihari. Hata hivyo vifaa kuhusu uelewa wa kichaa cha mbwa ikiwa ni sehemu ya mradi vitatolewa katika shule na kwa jamii. Ushiriki wako katika utafiti huu si wa lazima, unaweza kukataa kushiriki. Hakutakuwa na madhara yoyote katika ubora/uboreshaji wa huduma ya afya kwa kujitoa/kukataa kushiriki katika utafiti huu.

Watu wa kuwasiliana nao kwa dharura: Kwa dharura yoyote wasiliana na **Lwitiko Elton Sikana**, Mkuu wa utafiti/mradi huu kwa namba za simu **0787 410 210** na **0682 000 022** au kwa kupitia barua pepe lwsikana@ihi.or.tz au lwitikosikana@gmail.com au mwakilishi wa taasisi ya Afya ya Ifakara katika tume ukaguzi wa tafiti kupitia namba 0788 766 676 au barua pepe mmrisho@ihi.or.tz

Taarifa za mshiriki

Jina la kiongozi wa kijiji: _____ na. ya simu:

_____

Jina la mshiriki: _____ na. ya simu:

_____

RESEARCH OUTPUTS

Output 1: Published Paper in PLoS Neglected Tropical Diseases

Sikana, L., Lembo, T., Hampson, K., Lushasi, K., Mtenga, S., Sambo, M., Wight, D., Coutts, J., & Kreppel, K. (2021). Dog ownership practices and responsibilities for children's health in terms of rabies control and prevention in rural communities in Tanzania. *PLoS Neglected Tropical Diseases, 15*(3), e0009220-e0009220.

Output 2: Poster Presentation

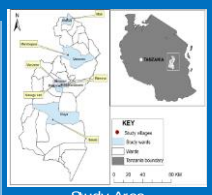
Output 2: Poster Presentation

Introduction

Rabies is a fatal disease caused by a virus and in Tanzania, the disease is responsible for causing approximately 2,000 deaths annually, of which 40% are children below the age of 15. The main source of human rabies is a bite from an infected dog. Mass dog vaccination coverage (>70% of population) is an effective strategy in preventing the disease in both dogs and humans, as it breaks the transmission cycle in dogs. However, dog vaccination is not currently compulsory and is not always free of charge and vaccination campaigns are not reaching the recommended coverage. Little research has been done at village level to establish why this is the case. The present study establishes patterns of dog ownership and considers who is responsible for dogs in households in rural Tanzania, to help understand where and why dogs are kept, as well as how decisions are made to vaccinate dogs, which can inform policy for future vaccination campaigns.

Key Message

Low vaccination coverage is the main contributing factor hindering rabies prevention efforts. To address this, understanding practices around dog ownership and child health care decisions can help to direct resources to communities and households which keep dogs or which have an interest in keeping dogs.



Study Area
Southern Tanzania

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Acknowledgement

The authors acknowledge support from the research consortium Afrique One-African Science Partnership for Intervention Research Excellence (ASPIRE), who is funded by a consortium of donors including the African Academy of Sciences (AAS) Alliance for Accelerating Excellence in Science in Africa (AESA), the New Partnership for Africa's Development Planning and Coordinating (NEPAD) Agency, the Wellcome Trust and the UK government.

And the Community Against Rabies Exposure (CARE) project coordinated by the Global Alliance for Rabies Control (GARC) through the UoG.

Objectives

To inform rabies prevention interventions with regards to obstacles related to dog ownership practices and rabies awareness in the community

Specific objectives:

1. Identifying factors associated with dog ownership

2. Identifying responsibilities of dog ownership and related child health risks in the household

3. Determine how factors associated with dog ownership and dog and child health care responsibilities present obstacles to interventions.

Methods

Study Design: Cross-sectional; mixed methods in six random selected villages

Quantitative: 1216 households were visited across villages

Qualitative: Open interviews and consultative workshops

Analyses: Both descriptive and multivariate analysis were used in estimating associations between variables (p-value ≤ 0.05)

Quantitative analysis, Generalized Linear Models (GLM) were used ($F_i = c + a_i$)

- Response variables were "dog ownership" and "number of dogs owned"
- Explanatory variables were livestock owned ("cattle", "sheep", "pig", "goat", "other livestock", "chicken", "cat"), "household size" and "village" .

Qualitative analysis: Information on household responsibilities for dogs, dog vaccination and child health in case of dog bites was collected during interviews.

Results

- Factors associated with dog ownership and the number of dogs owned are similar
- Only 11% of the 1216 households owned dogs.
- Larger households with livestock, namely pigs, sheep and cattle, are more likely to own dogs and a larger amount of dogs. This is not the case with chickens, cats or goats.
- There are significant differences between villages in terms of the probability that households own dogs at all and how many dogs they own

In open interviews, 53 heads of households gave information on responsibilities for dog vaccinations and decisions regarding child health.

- Mostly the father decides if a dog gets vaccinated (66%),
- In case a child gets bitten by a dog, the mother decides on the course of action in 69% of households with regards to the child's health.

- *"In our village, there are few dogs, because most of the people are Muslims, they are not keeping dogs." (village leader, Mamoyo village Tanzania)*
- *"When a child gets bitten by suspect animals, the mother is responsible for attending and seeking treatment in the health facility." (Nurse at Ulaya Ilakala village Tanzania)*
- *"During mass dog vaccination more children (<18 years) are responsible for bringing dogs than other age groups." (Livestock field officer, Kilosa district Tanzania)*

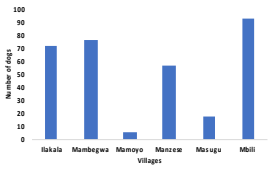

Fig. 1 Average dog ownership in the six study villages

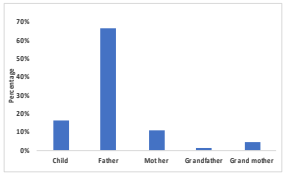

Fig. 2 Responsibility for dog vaccination

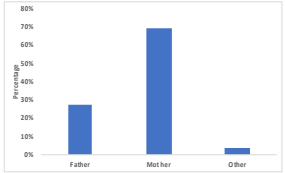

Fig.3 Decisions once a child get bitten

Conclusion

Understanding practices around dog ownership can help to direct resources to communities and households which keep dogs or which have an interest in keeping dogs. Dog ownership and number of dogs owned is linked to village, household size and livestock and thus is indicative of which households should be prioritised regarding rabies interventions. The decision as to whether dogs are vaccinated lies in the majority of households with the father while decisions on the course of action when a child is bitten by a dog lies mainly with the mother. Therefore, there is a discrepancy between the household members generally targeted by interventions (children & household heads) and the household members actually responsible for making decisions. The results from this study will help to understand the target group on the implementation of rabies prevention interventions in the community.

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