A dissertation entitled

Rabies in Makhuduthamaga local municipality, Limpopo province, South Africa: Knowledge, attitude, and practises

submitted by

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in accordance with the requirements

for the degree

MASTER OF SCIENCE

in the subject

AGRICULTURE

at the

UNIVERSITY OF SOUTH AFRICA (UNISA)

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August 2023

ABSTRACT

Background: Although rabies in humans remains a major public health problem, the disease is preventable through canine vaccination and appropriate post-bite treatment. Several countries have successfully eradicated the disease by implementing mass vaccination programmes. The objectives of the study were to assess the knowledge, attitudes, practices, vaccination coverage, and factors associated with rabies vaccination coverage among selected households in Makhuduthamaga municipality, Limpopo Province, South Africa.

Methods: A cross-sectional study was conducted between May-June 2019 using structured interviewer questionnaires. A two-stage random sampling process was used to select first the geographical area (main places; n=17), followed by individual households (n=476). Invitation to participate in the study was extended to household heads (male or female) or, in their absence, any member of the household ≥ 18 years of age and living in the household. Only one person was interviewed per household. Descriptive statistics such as mean, frequencies, percent, standard deviation, and chi-square test were used to assess the knowledge, attitudes, practices, and vaccination coverage among the respondents in the study. The Binary Logistic Regression Model was used to analyse factors that were significantly associated with vaccination among pet owners. Statistical significance was assessed at p-value ≤ 0.05.

Results: Most of the respondents (58%) did not know what rabies is and only 5% of respondents said they would cleanse the wound before seeking medical assistance after being bitten by a dog. Overall, only 16% indicated that they had vaccinated their pets (dogs/cats) against rabies but none of the respondents (0%) had a vaccination card. There was a significant difference ($p<0.05$) in the proportion of respondents with vaccinated pets by “main place”, with Maololo having the highest number (83%) of respondents who indicated that their pets had been vaccinated against rabies, with six (n=6) main places having no respondents who indicated that their pets had been vaccinated against rabies. From the logistic regression analyses, the covariates, exposure to rabies prevention messages and knowledge about rabies were found to be strong predictors of pet vaccination.

Conclusion: While vaccination of pets against rabies in South Africa is mandated by law, the vaccination coverage in the study area of 16% was below the 70% recommended by the World Health Organization and needed to prevent rabies outbreaks. From one health point of view, these findings are of significant public health concern. Adequate attention should be given to the identified predictors of pet vaccination to ensure increased coverage and provision of municipal rabies programs to Makhuduthamaga residents.

Keywords: rabies, KAP analysis, knowledge of rabies, rabies vaccination, South Africa

KAKARETŠO

Bomorago: Le ge e le gore bolwetši bja marabe mo bathong bo sa dutše e le bothata bjo bogolo bja maphelo a setšhaba, bolwetši bo ka thibelwa ka go entela dimpša le kalafo ya maleba ya ka morago ga ge motho a lomilwe ke mpša. Dinaga tše mmalwa di fedišitše bolwetši bjo ka katlego ka go tsenya tirišong mananeo a go entela ka bontši. Maikemišetšo a nyakišišo ye e be e le go sekaseka tsebo, maikutlo, mekgwa, kakaretšo ya moento le mabaka ao a amanago le kakaretšo ya moento go entela bolwetši bja marabe gare ga malapa ao a kgethilwego ka mmasepaleng wa Makhuduthamaga, Profenseng ya Limpopo, Afrika Borwa.

Mekgwa: Nyakišišo ya kakaretšo ya makala e dirilwe gare ga Mei-June 2019 ka go šomiša dipoledišano tše di rulagantšwego. Tshepetšo ya go tšea mehlala ka go se kgethe ya magato a mabedi e šomišitšwe go kgetha pele tikologo (mafelo a magolo; n = 17) yeo e latetšwego ke malapa ka le tee ka le tee (n = 476). Taletšo ya go tšea karolo nyakišišong e katološeditšwe go dihlogo tša malapa (banna goba basadi) goba, ge di se gona, lelokong lefe goba lefe la lapa la mengwaga ye ≥ 18 ebile le dula ka lapeng. Go boledišanwe le motho o tee fela ka lapeng. Dipalopalo tše di hlalošago tša go swana le tša bogare, difrikhwentshi, phesente, phapogo ya maemo le teko ya *chi-square* di šomišitšwe go sekaseka tsebo, maikutlo le mekgwa le kakaretšo ya moento gare ga bakgathatema mo nyakišišong. Mohlala wa *Binary Logistic Regression* o šomišitšwe go sekaseka mabaka ao a bego a amana kudu le go entela gare ga beng ba diruiwaratwa. Bohlokwa bja dipalopalo bo ile bja hlahlobja ka p-boleng ≤ 0.05

Dipoelo: Bontši bja bakgathatema (58%) ba be ba sa tsebe gore bolwetši bja marabe ke eng gomme bakgathema ba 5% fela ba boletše gore ba tla hlwekiša ntho pele ba eya go nyaka thušo ya kalafo ka morago ga go longwa ke mpša. Ka kakaretšo, ke 16% fela yeo e laeditšego gore ba entetše diruiwaratwa tša bona (dimpša/dikatse) kgahlanong le bolwetši bja marabe eupša ga go le o tee wa bakgathatema (0%) yo a nago le karata ya moento. Go bile le phapano ye kgolo ($p < 0.05$) ka karolong ya bakgathatema bao ba nago le diruiwaratwa tše di entetšwego ka 'lefelo le legolo', moo Maololo e nago le palo ya godimodimo (83%) ya bakgathatema bao ba nago le diruiwaratwa tše di entilwego, eupša mafelo a magolo a tshela (n=6) ao a bontšhitšego gore ga go na bakgathatema bao ba bontšhitšego gore diruiwaratwa tša bona di entetšwe kgahlanong le bolwetši bja marabe. Go tšwa go ditshekatsheko tša *logistic regression*, khobariyeite, phihlelelo ya melaetša ya thibelo ya bolwetši bja marabe le tsebo ka ga bolwetši bja marabe di hweditšwe gore ke diponelapele tše maatla tša moento wa diruiwaratwa.

Mafelelo: Le ge go entela diruiwaratwa kgahlanong le bolwetši bja marabe ka Afrika Borwa go dumeletšwe ke molao, kakaretšo ya moento (16%) mo lekaleng la nyakišišo e be e le fase. Ka ge e le ka fase ga 70% yeo e šišinywago ke Mokgatlo wa Lefase wa Maphelo yeo e nyakegago go thibela go phulega ga bolwetši bja marabe, go tšwa go ntlha e tee ya maphelo, dikutullo tše ke hlobaelo ye kgolo go maphelo a setšhaba. Tlhokomelo ye e lekanego e swanetše go fiwa diponelapele tše maatla tše di

laeditšwego tša moento wa diruiwaratwa (Phihlelelo ya melaetša ya bolwetši bja marabe le tsebo ka ga bolwetši bja marabe) go kgonthiša kakaretšo ye e oketšegilego le kabo ya mananeo a masepala a bolwetši bja marabe go badudi ba Makhuduthamaga.

Mantšu a bohlokwa: bolwetši bja marabe, tshekatsheko ya KAP, tsebo ya bolwetši bja marabe, moento wa bolwetši bja marabe, Afrika Borwa

OPSOMMING

Agtergrond: Ofskoon hondsdolheid in mense steeds ’n reuse openbare gesondheidsuitdaging is, is die siekte voorkombaar deur honde in te ent en gepaste behandeling te verskaf onmiddellik na die persoon gebyt is. Etlike lande het die siekte suksesvol uitgeroei deurdat hulle massa inentingsprogramme van stapel gestuur het. Die doelwitte van hierdie studie was om die kennis, houdings, praktyke, strekwydte van inentings sowel as die faktore wat met die strekwydte van hondsdolheidinenting onder geselekteerde huishoudings in die Makhuduthamaga-munisipaliteit, Limpopo Provinsie, Suid-Afrika geassosieer word, te evalueer.

Metodes ’n Deursneestudie is tussen Mei en Junie 2019 onderneem deur middel van gestruktureerde vraelyste wat deur ’n vraesteller afgeneem is. ’n Tweefase ewekansige steekproefproses is gebruik om allereers die geografiese gebied (hoofplekke; n=17) gevolg deur individuele huishoudings (n=476) te selekteer. ’n Uitnodiging om deel te neem is aan die hoofde van huishoudings uitgereik (manlik of vroulik) of, in hul afwesigheid, aan enige lid van die huishouding wat ≥ 18 jaar is en deel is van die huishouding. Onderhoude is met slegs een persoon per huishouding gevoer. Deskriptiewe statistiek soos gemiddelde, frekwensies, persentasie, standaardafwyking en chi-vierkanttoets is gebruik om die kennis, houdings, praktyke en inentingstrekwydte van die respondente in die studie te evalueer. Die Binêre Logistieke Regressie-model is ingespan om faktore te analiseer wat beduidend met inenting onder troeteldiereienaars geassosieer word. Statistiese beduidenheid is op p-waarde ≤ 0.05 persent beraam.

Resultate: Die meeste van die respondente (58%) het nie geweet wat hondsdolheid is nie en slegs 5% van die respondente het genoem dat indien ’n hond hulle sou byt, hulle eers die wond sal ontsmet en daarna vir mediese hulp sal gaan. Oor die algemeen het slegs 16% aangedui dat hulle hul troeteldiere (honde en katte) teen hondsdolheid laat inent het, maar nie een van die respondente (0%) het ’n inentingskaart gehad nie. Daar was ’n beduidende verskil ($p<0.05$) in die proporsie respondente onder “hoofplek” met troeteldiere wat ingeënt is. Maololo het die grootste aantal (83%) respondente met ingeënte troeteldiere; daar is egter ses (n=6) hoofplekke wat hoegenaamd geen respondente gehad het wat aangedui het dat hulle troeteldiere teen hondsdolheid ingeënt is nie. Uit die logistieke regressie ontleding is bevind dat die kovariate, naamlik blootstelling aan boodskappe oor die voorkoming van hondsdolheid, en kennis oor hondsdolheid sterk voorspellers van troeteldierinenting is.

Gevolgtrekking: Hoewel die inenting van troeteldiere teen hondsdolheid in Suid-Afrika ’n wetlike vereiste is, is die strekwydte van inenting in die studiegebied (16%) baie laag. Die Wêreld Gesondheidsorganisasie se aanbevole inentingspersentasie vir die voorkoming van hondsdolheid is 70% en aangesien die persentasie vir die studiegebied so laag (16%) is, dui die bevindinge vanuit hierdie oogpunt op ’n opmerklike openbare gesondheidsgevaar. Voldoende aandag moet aan die geïdentifiseerde voorspellers van troeteldierinenting geskenk word (blootstelling aan boodskappe oor hondsdolheid en kennis oor hondsdolheid) om toenemende dekking

en voorsiening van munisipale hondsdolheidprogramme aan die inwoners van Makhuduthamaga te verseker.

Sleutelwoorde: hondsdolheid, KAP-analise, kennis oor hondsdolheid, inenting teen hondsdolheid, Suid-Afrika

DECLARATION

I, Bertha Makgwadi Nchabeleng (student number: 37122037), declare that the dissertation entitled "**Rabies in Makhuduthamaga local municipality, Limpopo province, South Africa: Knowledge, attitude, and practises**", which I hereby submit for the degree of Master of Science in Agriculture at the University of South Africa, is my own work and has never previously been submitted by me for a degree at this or any other institution.

I declare that where words from a written source have been used the words have been paraphrased and referenced and where exact words from a source have been used the words have been placed inside quotation marks and referenced.

I declare that I have not copied and pasted any information from the internet, without specifically acknowledging the source and have inserted appropriate references to these sources in the reference section of the dissertation.

I declare that my study was ethically approved and assigned ethics number 2018/CAES/125, and that during my study I have adhered to the Research Ethics Policy of the University of South Africa and have not acted out of these guidelines.

I declare that the content of my dissertation has been submitted through "Turn-it-in" analysis before the final submission for examination.

Student signature:  Date: 10/08/2023

ACKNOWLEDGEMENTS

I want to thank the following individuals and organizations for their contributions to my dissertation.

- My strength comes from my God, who made it possible for me to finish my study.
- My family and friends for supporting me especially my loving husband Kenneth for looking after our kids (Retang and Atile) while I was busy with the study.
- My thanks to my supervisors, Dr Oosthuizen and Prof Oguttu, for their direction, counsel, scientific backing, and planning of this dissertation.
- Unisa for partial funding this study. Without their contribution, this research study would not have been completed.
- Makhuduthamaga Local Municipality, Department of Agriculture and Rural Development (Veterinary Services) for allowing me to conduct the study in the area.
- To Kgoshi Letsiri Phaahla (Contrelesa Limpopo Chairperson) who assisted me in reaching out to the traditional leaders of the Main Places selected.
- To the traditional leaders of the Main Places selected for allowing me to do the study in their villages and community members who participated in the study.
- Ms RS Nchabeleng and Ms M Ntshehi for assisting with the interviewers and capturing of data.

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ABBREVIATIONS

BLRM	Binary Logistic regression model
CDC	Centres for Disease Control and Prevention
DALRRD	Department of Agriculture, Land Reform and Rural Development
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GARC	Global Alliance for Rabies Control
IEC	Information, Education and Communication
KAP	Knowledge, Attitudes and Practices
LMICs	Low- and middle-income countries
KZN	KwaZulu-Natal
MLM	Makhuduthamaga Local Municipality
NICD	National Institute of Communicable Diseases
OIE	World Organisation for Animal Health
PEP	Post-exposure prophylaxis
RCS	Rabies Case Surveillance
REB	Rabies Epidemiological Bulletin
SDM	Sekhukhune District Municipality
SPCA	Societies for the Prevention of Cruelty to Animals
STOP-R	Socio-cultural, Technique, Organization, Politics and Resources
UN	United Nations
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Background

Rabies infections amongst humans remain a major public health problem worldwide (Wilde 2016). It is estimated that rabies kills about 59, 000 people per year in Asia, Africa, and Latin America, and around 3.5 million people are exposed to post-exposure treatment (Adedeji *et al.* 2010). Animal bites are the most recognized mode of transmission (Bourhy, Kissi, and Tordo 1993; WHO 2005), and in South Africa, domestic canine, black-backed jackal, bat-eared fox, and yellow mongoose are the most recognised reservoirs of rabies viruses (Bingham 2005; Swanepoel 2004; Nel *et al.* 1997; Swanepoel 1993).

The rabies virus is capable of infecting all mammalian species including humans to cause a potentially fatal viral infection of the central nervous system (Msv, Carvalho, and Cardoso 2005). Therefore, rabies is among the most important viral zoonoses due to its associated public-health concerns, veterinary implications, and economic burden (Meltzer and Rupprecht 1998), especially as the reporting of rabies infections in animals is likely an underestimation (Coleman and Dye 1996; Swanepoel 2004, Nel 2013, Gan *et al.* 2023).

The rabies virus is a member of the *Lyssavirus* genus of the *Rhabdoviridae* family and is a bullet-shaped virus containing a single-stranded RNA genome (Ammar *et al.* 2009). There are two phylogroups (I & II) and seven genotypes of the virus namely: Genotype 1 (Rabies virus, RABV), Genotype 2 (Lagos bat virus, LBV), Genotype 3 (Mokola virus, MOKV) Genotype 4 (Duvenhage virus, DUVV), Genotype 5 (European bat lyssavirus 1, EBLV-1), Genotype 6 (European bat lyssavirus 2, EBLV-2) and Genotype 7 (Australian bat lyssavirus, ABLV) (Bourhy, Kissi, and Tordo 1993; WHO 2005). Four of these genotypes namely RABV, MOKV, LBV, and DUVV are endemic in South Africa, with RABV (genotype 1) being mainly responsible for rabies, although two cases of human rabies in South Africa were attributed to the genotype DUVV (Rupprecht *et al.* 2008).

In the past 20 years, there has been progress in understanding the epidemiology of rabies in Africa concluding that elimination of canine rabies is both feasible and cost-effective via mass vaccination of domestic dogs (Broban *et al.* 2018). Rabies is thus 100% vaccine preventable, and several countries have successfully eradicated rabies

by implementing mass vaccination programmes (WHO 2024). Notwithstanding this, the disease remains endemic in about 150 countries including South Africa (WHO 2021). Rabies remains a problem in South Africa and is found predominantly in four hot spots: Eastern Cape, KwaZulu-Natal, Limpopo, and Mpumalanga provinces (DALRRD 2021).

Countries that have been able to eradicate rabies did so by applying strict prophylactic measures through mass vaccination (Belotto *et al.* 2005; WHO 2005; Rupprecht *et al.* 2008; Lembo *et al.* 2010). However, such effort has not been successful in Africa because of the many wrong perceptions among other factors which include low prioritisation, epidemiological constraints, operational constraints, lack of resources, religious and cultural beliefs towards veterinary vaccinations (Belotto *et al.* 2005; Coetzee and Nel 2007; Kaare *et al.* 2009; Swanepoel 2004; Lembo *et al.* 2010; Matibag *et al.* 2007, 2009; Shite, Guadu, and Admassu 2015).

The World Health Organization recommends that action plans to control or eradicate rabies should combine socio-cultural, technical, organizational, political, and resource-oriented aspects (WHO 2016). Attitudes towards rabies and dog-keeping practices of populations at risk are influenced by the socio-cultural context. In fact, the social-ecological model recognizes the complexity of the socio-cultural system and emphasizes that individuals make decisions based on their knowledge and experience (individual level factors), interpersonal relationships (e.g., norms, families, and peers), organizations (e.g., health promotion and prevention activities of health services), their community (e.g., physical environment), and policies (e.g., national or state laws) (Bronfenbrenner 1994). Few studies have been conducted in the country that have assessed the knowledge, attitude, and practices towards rabies. For example, only one study that could be sourced was done in KZN (Letsoalo *et al.* 2023).

Therefore, the present study assessed the knowledge, attitudes, and practices (KAP) regarding rabies among residents in Makhuduthamaga Local Municipality (MLM), Limpopo province South Africa. The study also assessed factors that were associated with vaccination of dogs and cats (pets) in the study area. This information is useful in assisting relevant authorities and policymakers in formulating and designing rabies control/eradication policies that will be feasible and cost-effective.

1.2 Problem Statement

Rabies remains a significant public health concern in many parts of South Africa, including Limpopo Province, where several cases of dog-associated human rabies have been reported. However, despite the critical role of sufficient vaccination coverage in effectively eradicating and controlling dog and human rabies, there is a notable lack of evidence regarding the vaccination status of dogs and cats in Limpopo Province, South Africa. This dearth of information poses a challenge to implementing targeted and effective rabies control measures in the region.

Furthermore, there is a significant knowledge gap concerning the perceptions and attitudes of dog owners and residents towards rabies disease in MLM, Limpopo Province. Understanding the beliefs, practices, and concerns of these stakeholders is essential for designing comprehensive and context- specific rabies control policies that can effectively curb the spread of the disease and protect both human and animal health.

Therefore, this study aims to address these knowledge gaps by investigating the vaccination status of dogs and cats in Limpopo Province and assessing the attitudes perceptions, and practices of dog owners and residents in MLM towards rabies disease. By elucidating accurate and relevant information on vaccination coverage and community attitudes, this research seeks to contribute to evidence-based rabies control policy development in the province. Ultimately, the findings of this study will support the implementation of targeted interventions to improve vaccination rates in dogs and cats and enhance community awareness, thereby mitigating the burden of rabies and safeguarding the well-being of both human and animal populations in the region.

1.3 Aims and Objectives

1.3.1 Aims

The primary aim of this study was to comprehensively assess the knowledge level, attitudes, and practices (KAP) regarding rabies disease within the context of MLM. Additionally, the study sought to identify and understand the factors influencing the vaccination coverage of dogs and cats against rabies in the study area.

1.3.2 Objectives

To achieve the overall aims, the study was designed with the following specific objectives:

1. To assess the knowledge of rabies among residents of MLM:

   This objective aimed at gauging the level of awareness and understanding of rabies among the residents within the study area. By exploring their knowledge of rabies as a disease, its transmission, prevention, and potential consequences, the aim was to identify gaps in public awareness and knowledge.

2. To assess attitudes and practices of residents of the study area towards rabies in dogs and cats:

   Through this objective, the aim was to gain insights into the attitudes and behaviours of the residents concerning rabies in dogs and cats. Understanding their perceptions and beliefs towards the disease, including how they respond to potential rabies exposure, would provide crucial information for designing targeted awareness campaigns.

3. To describe the rabies vaccination coverage in the study area:

   This objective aimed to quantify the extent of rabies vaccination coverage among dogs and cats within the study area. By determining the proportion of vaccinated animals, it would be possible to evaluate the current level of compliance with vaccination programs and identify potential gaps in the coverage.

4. To investigate the factors significantly associated with rabies vaccination among dogs and cats in the study area:

To understand the determinants of rabies vaccination coverage, this objective aimed to identify the factors that influence pet owners' decisions to vaccinate their animals. Factors such as knowledge levels, access to veterinary services, awareness of vaccination programs, and socio-economic conditions were investigated to provide a comprehensive understanding of the barriers and facilitators of vaccination.

By achieving these specific objectives, this study contributes to the body of knowledge surrounding rabies control strategies, informs evidence-based policymaking, and provides valuable insights for designing targeted interventions to enhance rabies prevention and control measures in the MLM and, potentially, other similar rural settings in South Africa.

1.4 Hypotheses

The hypothesis for this study is that there are significant factors that predict the vaccination of pets by their owners in the study area. Specifically, it is expected that knowledge about rabies, exposure to rabies prevention messages, accessibility to rabies vaccination services, and the level of awareness about the importance of pet vaccination will significantly influence the likelihood of pet owners vaccinating their dogs and cats against rabies. Additionally, it is hypothesized that demographic factors such as age, education level, and income may also play a role in predicting pet vaccination rates in the study area. By investigating these factors, the study aims to uncover critical insights into the determinants of pet vaccination, which will inform the development of targeted strategies to improve vaccination coverage and enhance rabies control efforts in MLM, Limpopo Province, South Africa.

1.5 Research questions

To achieve the objectives of this study, which is based on the KAP model, the following research questions were addressed:

1. What is the level of knowledge of rabies as a disease among residents of MLM?

   This question aimed at assessing the residents' awareness and understanding of rabies, including its transmission, symptoms, and preventive measures.

2. What is the attitude of the residents of MLM towards rabies as a disease?

This question sought to explore the perceptions and beliefs of the residents regarding rabies, including their attitudes towards its seriousness, treatment, and impact on public health.

3. What practices towards rabies disease are prevalent among residents of the study area?

This question focused on understanding the behaviour and practices of the residents when dealing with potential rabies exposure, such as wound cleaning, seeking medical attention, and handling of rabid animals.

4. What is the level of rabies vaccination coverage among dogs and cats in the MLM?

This question aimed at quantifying the proportion of dogs and cats that have been vaccinated against rabies within the study area, providing insights into the current vaccination coverage.

5. What factors are significantly associated with the vaccination of dogs and cats in the study area?

This question sought to identify the factors that influence the decision-making process of pet owners regarding rabies vaccination, including factors such as knowledge levels, access to veterinary services, and awareness of vaccination programs.

By addressing these research questions, the study provides a comprehensive understanding of the KAP towards rabies disease in the MLM, as well as the factors influencing rabies vaccination coverage among dogs and cats. The findings from this study contribute valuable insights that can inform targeted public health interventions and policies aimed at improving rabies prevention and control in the study area and, potentially, in similar rural settings in South Africa.

1.6 Scope of the study

This research was conducted within the geographical boundaries of Limpopo Province, South Africa. However, the primary focus of the study was limited to MLM, one of the municipalities in Limpopo. The study employed a cross-sectional design and was conducted over a two month period, from May to June 2019.

To gather data, structured interviewer questionnaires were employed, with the assistance of trained and recruited data collectors. The study targeted households within 17 selected Main Places within MLM. Main Places were chosen as the sampling units to ensure representation across various areas within the municipality and to achieve a diverse and comprehensive understanding of the residents' KAP concerning rabies and pet vaccination.

The study provides valuable insights into the rabies-related perceptions and behaviours of residents in MLM and can serve as a foundation for formulating targeted interventions and public health policies specific to this local municipality, with the potential for broader implications in rabies control and prevention strategies in similar settings.

1.7 Benefits arising from the study.

This pioneering study holds significant value for various stakeholders and contributes to multiple areas of knowledge and policy development. Firstly, as the initial study of its kind in the study area, it fills a crucial information gap by providing comprehensive insights into the KPA of residents regarding rabies disease. By shedding light on the current state of awareness and behaviour toward rabies, this study lays the groundwork for further research and evidence-based interventions.

The findings of this study will be instrumental for policymakers and public health authorities in designing and implementing targeted and effective rabies control strategies specifically tailored to the rural settings of Limpopo Province in South Africa. Armed with a deeper understanding of the community's KAP towards rabies, decision-makers can prioritize resources, education campaigns, and vaccination initiatives to tackle the disease effectively.

Moreover, the information gathered from this study has the potential to raise public awareness about rabies and its prevention among residents, leading to increased vigilance and responsible pet ownership practices. By empowering individuals with knowledge about the disease and its transmission, the study may contribute to reducing the incidence of rabies cases in the study area.

Additionally, from an academic perspective, this study represents a significant milestone towards the fulfilment of the requirements for a master’s degree in

agriculture. It showcases the researcher's commitment to contributing to the field of agriculture and public health. The study's outcomes and recommendations will serve as a valuable resource for future researchers, guiding them in their endeavours to explore and address the complexities of rabies control and prevention in similar settings.

In summary, the benefits arising from this study are multi-faceted, ranging from bridging the information gap on rabies KAP in the study area to supporting evidence-based policy formulation and fulfilling the academic requirements for a master's degree. Ultimately, the study's insights have the potential to enhance rabies control efforts, protect human and animal health, and promote a safer and more informed community in the rural regions of Limpopo Province

1.8 Dissemination of the information

The dissemination of the findings from this study will follow rigorous data access and reporting policies to ensure ethical and responsible handling of the research outcomes. The primary aim is to share the valuable insights gained through this study with key stakeholders and the wider scientific and public health communities to maximize the impact of the research.

The Limpopo Department of Agriculture and Rural Development, being a crucial partner in rabies control and prevention efforts, will be among the key stakeholders to whom the results will be reported. By sharing the study's outcomes with this department, we seek to inform and influence policy decisions, ensuring that the findings are integrated into future rabies control strategies in the region. Through open and transparent communication, we aim to foster collaboration and knowledge exchange, ultimately contributing to improved public health outcomes in the study area.

Furthermore, the dissemination of the results will extend beyond the local level. The study's findings will be presented at relevant scientific conferences, providing a platform for engagement with experts and researchers in the fields of public health, zoonotic diseases, and agriculture. Sharing the research at these conferences will enable constructive feedback and open discussions, allowing for the validation and potential enrichment of the study's conclusions.

Additionally, the results will be targeted for publication in reputable scientific and public health journals. By disseminating the findings through peer-reviewed publications, we aim to reach a broader audience of researchers, practitioners, and policymakers both within South Africa and internationally. This will enhance the study's visibility and credibility, facilitating its incorporation into the global body of knowledge on rabies control and prevention.

To ensure wide accessibility of the information, efforts will be made to make the research findings publicly available through online platforms and institutional repositories. Open-access options will be explored to promote inclusivity and enable interested parties, including local communities, to access and benefit from the study's outcomes.

In conclusion, the dissemination of the information obtained from this study will adhere to stringent data access and reporting policies. Through reporting to key stakeholders, presentation at scientific conferences, publication in reputable journals, and open-access initiatives, the study's findings will be effectively shared with relevant professionals and researchers. In addition, the results of the study will be returned to community members during community meetings. By actively disseminating this knowledge, we strive to contribute to evidence-based decision-making, informed public health practices, and the advancement of rabies control strategies in the study area and beyond.

1.9 Outline of the study

The chapters of this study are structured in the following way:

Chapter 1: Study background: Provides research background on rabies. Also provides the problem statement, aim and objectives, hypothesis and research questions, the scope, limitations, and benefits of the study.

Chapter 2: Literature review: Provides an overview of rabies in South Africa and in other countries. Furthermore, it explains rabies as a disease, its monitoring and surveillance, prevention and vaccination, and elimination.

Chapter 3: Methodology: Focuses on the study area, method of sampling, data collection methods, and how data were analysed and interpreted.

Chapter 4: Results: Provides a summary of findings obtained from research

participants.

Chapter 5: Discussion: Explores and discusses the KAP towards rabies in the study area and the factors that were significantly associated with vaccination coverage.

Chapter 6: Conclusion and recommendations: Concludes by making recommendations based on the study's investigative results.

CHAPTER 2: LITERATURE REVIEW

Nearly all human rabies deaths occur in Asia and Africa where the disease is inextricably linked to poverty which negatively impacts the ability of these countries to achieve the UN sustainable development goals 1, 2, 3, respectively, to eradicate extreme poverty and hunger and to improve health by 2030 (Crowcroft and Thampi 2015). Thus, the WHO classifies rabies as a neglected tropical and zoonotic disease. Chronic underreporting and lack of interest on the part of politicians means that the real burden of the disease remains unknown (Crowcroft and Thampi 2015; WHO 2018).

2.1 Overview of Rabies

2.1.1 Overview of rabies worldwide

Rabies is a viral disease that leads to the death of infected hosts which are mainly animals and, in particular, all warm-blooded animals (Adedeji et al., 2010; WHO, 2018). Rabies is found globally, except in countries that have very stringent quarantine systems, and natural barriers such as rivers and mountains (Brunker et al., 2018; Rupprecht, 2023)

Amongst the zoonotic diseases that occur worldwide, rabies remains one of the most vital disease, and public fear and concern associated with it is mostly centred on dogs (Adedeji et al., 2010) Except for Antarctica (CDC 2020), the rabies virus reservoir species, comprising close to 30 species of hematophagous bats, terrestrial carnivores, and insectivorous bats, are distributed globally (Gilbert 2018).

The United States recorded an increase of 11.2% (n=97) in reported rabid animals from 2017 to 2018 (Ma *et al.* 2020). In 2018, wildlife accounted for 92.7% of all rabid cases in the US, with the major species being bats (33.0%), raccoons (30.3%), skunks (20.3%), and foxes (7.2%) (Ma *et al.* 2020). Among domestic animals, rabid cats contributed 4.9% and rabid dogs contributed 1.3% of the total rabid cases (Ma *et al.* 2020).

In Mexico, two human rabies cases that were connected to wildlife were recorded in 2018, with the first case having been transmitted by a fox and the other by a

hematophagous bat. However, Mexico has not recorded any human deaths caused by dogs since 2006. The last recorded death was recorded in 2005. The absence of human rabies deaths caused by dogs in Mexico was achieved after the country carried out an extensive program of vaccinating cats annually at no cost to the owners. In 2019, the WHO officially recognised Mexico as being free from human rabies deaths that were mediated by dogs (Ma *et al.* 2020).

In the 1940s during World War 2, rabies began to spread in Europe at a rate of 15-60 km every year (Robardet *et al.* 2019) because of a spillover from domesticated animals to wildlife. The spread of the virus was usually halted by rivers and mountains, but it was still mobile after several decades because of the construction of bridges. Countries such as Ireland, Sweden, and the United Kingdom have not reported cases of rabies caused by foxes (WHO 2018)

In 2018, the European Union (EU) analysed 21,707 animals for rabies. Only eight animal cases were recorded, two involving domestic animals and six involving wildlife. Under the guidance of the EU, the member states implemented programs aimed at rabies surveillance, which focussed on testing suspected animals. Furthermore, the EU member states engaged in monitoring the effectiveness of vaccination. These strategies led to a decrease in the number of rabies cases in the EU in the last 30 years and has, in turn, led to the elimination of rabies in Central and Western Europe. The disease is now restricted in Eastern Europe, and since 2016, it has been identified in countries such as Poland, Lithuania, Romania, and Hungary (Robardet *et al.* 2019).

As indicated, countries in Africa and Asia are more at risk of rabies infections. According to the WHO, more than 95% of human deaths associated with rabies take place in Africa and Asia (WHO 2021). In Angola, rabies continues to be a threat to public health and factors driving the increase in the number of rabies cases are common throughout Africa (Coetzee and Nel 2007). Ever since rabies was first identified in Kenya in 1912, its occurrence has fluctuated, with the main reservoir for rabies in the country being dogs. More recently, an endemic pattern of rabies has persisted in one area of Kenya to pose a threat to neighbouring countries (Kitala *et al.* 2000). One of the major problems faced by African countries is the cost of treatment and prevention of rabies (Knobel *et al.* 2005). The treatment and control of rabies is costly, and the required resources are usually inadequate and/or scarce (Knobel *et al.*

2005; Lembo *et al.* 2010).

2.1.2 Overview of rabies in South Africa

Canine rabies was first reported in the Cape Province of South Africa in 1892 and in the Limpopo Province in 1950. From there, it spread southwards to KwaZulu-Natal (KZN). This was followed by further outbreaks in 1964 and 1976 (Bingham 2005; Gummow, Roefs, and de Klerk 2010; Smith, Yager, and Orciari 1993). Since then, rabies has become a disease of increasing public health and veterinary importance and concern in South Africa (Gummow, Roefs, and de Klerk 2010). Dog-to-dog transmission of rabies was reported in the Eastern Cape and KwaZulu Natal during the 1980s and 1990s. However, since 2000, rabies in dogs has been reported in all the provinces in South Africa, except the Western Cape. Apart from dogs, the rabies virus in South Africa has been detected in reservoir species such as the black-backed jackal, bat-eared fox, and yellow mongoose (Brown 2011).

Rabies cases have also been reported in South African wildlife and species of livestock (Bishop *et al.* 2003; Gummow, Roefs, and de Klerk 2010; Swanepoel 1993) such as goats, cattle, donkeys, sheep, and horses (Barnard 1979). However, all these species only act as dead-end hosts, meaning that there is no subsequent human-to-human transmission and no human cases have been connected to any of these species (Barnard 1979).

Human rabies in South Africa is classified as a Category I notifiable medical condition. The National Reference Laboratory, which falls under the National Institute for Communicable Diseases (NICD), conducts testing of all "human" specimens suspected of containing human rabies. On Average, South Africa records between 5 and 30 cases of humans' rabies and the number of cases is in direct correlation with the occurrence of rabies in dogs around the country (Bishop *et al.* 2003; Weyer *et al.* 2011). Children and teenagers constitute over 70% of the reported cases in South Africa (Weyer *et al.*, 2020).

According to the National Institute of Communicable Diseases (NICD), South Africa recorded the highest number of human rabies cases in 2006 (Mogano 2022). Out of 57 laboratory-confirmed human rabies cases, the province of Limpopo had the highest number of victims (n=45). Mpumalanga had the second-highest number of cases

(n=7), followed by North-West with five (n=5) (Mogano 2022). Of the 57 cases of human rabies, dogs accounted for 75.4%. In 2006, a regional concentration of human rabies cases linked to dog attacks was noted in Limpopo Province; human cases continued to appear in this province (NICD 2021). Companion animals were the most infected with rabies in the province of Limpopo, where 1156 positive instances of the disease were confirmed in animal specimens between 2019 and 2022 (Mogano *et al.* 2024).

2.2 Transmission of rabies

Rabies can be transmitted between animals of the same or different species most often following injury or direct mucosal exposure from a bite, licking, and/or scratching by rabid animals. The rabies virus is mainly spread in saliva, but it cannot be transmitted through intact skin (Crowcroft and Thampi 2015). Although rare, there are reports of cases of transmission that have taken place involving other routes such as organ transplantation (Srinivasan *et al.* 2005), especially liver, kidney, and corneal transplants. Aerosol transmissions have also been documented in bat caves and laboratories which have high densities of aerosolized, viable virus particles (Johnson, Phillpotts, and Fooks 2006). Transmission of the virus can also happen through ingestion, especially in the wild, but few cases have been reported of humans contracting the disease in this manner (Afshar 1979).

2.3 Pathogenesis of rabies disease following exposure

Following infection, the rabies virus enters an eclipse phase when it replicates in non-neuronal tissues such as muscles. During this phase, the virus cannot be easily detected and does not stimulate an immune response (CDC 2003). After a few days or months, the virus then enters peripheral nerves and is transported to the central nervous system (Eidson *et al.* 2005). Subsequently the virus is distributed within the central nervous system cells, clinical signs start to develop. The rabies virus occurs virus occurs in saliva glands, nervous tissue, and cerebrospinal fluid. It has also been detected in other body tissues such as kidneys, lungs, adrenal glands, bladder, testes, ovaries, cornea, intestinal tract, and pancreas.

2.4 Rabies in dogs

Experimentally, the rabies virus can infect dogs through several routes involving nerve tissue, muscles, eyes, blood, and skin. However, the main route of infection in dogs is through bites, and dogs that are 4 months old are much more susceptible to contracting the virus compared to adult dogs (Morters *et al.* 2015). The incubation period of rabies in dogs tends to differ from 10 days to months. However, symptoms usually occur within twenty-one to eighty days after the dog has been exposed to the disease. It has also been noted that some dogs succumb to the disease after an observation period of 6 months.

Dogs that have been infected usually show clinical manifestations/symptoms that are commonly referred to as dumb or furious rabies where infected dogs may start to become excitable, and this is then followed by rapid depression and paralysis (Hampson *et al.* 2015). Affected dogs may snap at or bite any form of stimulus, and they may also attack inanimate objects, humans, and animals (Bishop *et al.* 2003). As the disease progresses, the infected dogs become hypersensitive to touch and they start eating unusual things (American Humane 2016). During the prodromal phase, the dog's disposition changes, becoming apathetic or increasingly alert with dilated pupils and increased muscle tone (Bishop *et al.* 2003).

The excitement stage is characterized by unusual restlessness, snapping at invisible objects, running aimlessly, watchful apprehensive looks and unprovoked aggressiveness (Schildecker *et al.* 2017). The dogs have difficulties in swallowing and their bark and growl change, and this a signal that the dog has entered a paralytic phase, whereby it will not be able to swallow water or eat (WHO 2016).

Among terrestrial animals, it has been noted that the spread of rabies disease is dependent on mechanisms such as the excretion of infectious virus through salivary glands and the penetration of infectious saliva into wounds. Among animals that have died from rabies disease, the virus has been found in salivary glands in 54 – 90% of cases. Experiments have also determined that excretion of the virus in infected dogs may occur 3 to 7 days before the presence of clinical symptoms (Beyene, Mourits, and Hogeveen 2017).

2.5 Rabies in cats

Cats that are not vaccinated are highly susceptible to contracting rabies, particularly if they are exposed to wild animals. The main signs of rabies amongst cats are changes in their behavior such as restlessness, aggressiveness and lethargy, weakness, disorientation, seizures, paralysis, and even sudden death.

Although they can produce antiviral immune responses, this usually occurs too late to prevent the disease from spreading (Johnson *et al.* 2006). Defense against the early phase of infection is usually provided by the cat's innate immunity, with interferons playing a vital role (Johnson *et al.* 2006)

The dumb form of cat rabies is characterized by paralysis and the prodromal stage characterized by vomiting, anorexia, fever, and diarrhea. The furious form presents as psychosis and paralysis (Frymus *et al.* 2009). Cats may also exhibit noticeable behavioral changes such as unfriendly behavior and increased vocalization (Frymus *et al.* 2009)

In the United States, rabies is reported in cats more often than in any domestic species (Blanton *et al.* 2011; Dyer *et al.* 2014). Unvaccinated cats that are free to roam outdoors have a higher risk of contracting rabies infection. This is because outdoor cats get into fights with infected wild animals or with infected cats or stray dogs. Although widespread vaccination programs have helped control rabies in domestic cats, wild cats remain a reservoir for the rabies virus (Roebling *et al.* 2014)

2.6 Rabies in humans

With the exception of certain areas of the South Pacific, human rabies remains a major global public health problem with almost all (95%) reported cases and deaths occurring in developing countries (WHO 2024). According to the FAO/WHO/OIE Yearbook of Animal Health for 2013, 87 countries and territories totalling some 2.4 billion people are affected by canine rabies.

Most developing countries currently spend most of their funds available to combat rabies on post-exposure treatment - involving 800 to 900 million patients per annum. At the same time, the proportion of vaccinated dogs barely exceeds 15%, a figure that is far too low to eradicate the disease. Thus, national statistics show that these

measures do not lead to a marked reduction in the number of cases of rabies in humans or the number of post exposure treatments (Cleaveland *et al.* 2014).

The incubation period of rabies disease in humans ranges from a few days to several years. Humans may exhibit non-specific prodromal signs that are visible in the early stages of being infected (Appolinario and Jackson 2015). These symptoms include headache, fever, pain, discomfort, and several sensory alterations that are visible on the point of entry. Several days after the onset of full-blown infection, confusion, and anxiety will start to appear and this will progress to abnormal behavior, insomnia, partial paralysis, difficulty in swallowing, and convulsions (CDC 2019). Survival of clinical cases is rare, and death usually occurs in 2 to 10 days. Although it is rare, Individuals who recover tend to suffer from a severe neurological deficit (Jackson *et al.* 2003). However, treatment of the disease in its early stages is effective and saves lives (Pieracci *et al.* 2019; Tarantola, Tejiokem, and Briggs 2019).

2.7 Rabies vaccines and prevention of rabies in humans

2.7.1 Rabies vaccine

More than a hundred years after the discovery by Loius Pasteur, immunotherapy applied as soon as possible after infection with rabies remains the only viable treatment or possible treatment of rabies for humans (Fooks *et al.* 2014). Currently, anti-rabies serum and human immunoglobulins are the essential supplements of the vaccine in cases of severe bites. However, subunit vaccines or those obtained by genetic recombination are potential human vaccines (Sirikun *et al.* 2018).

Viruses multiplied on chicken or duck embryos have progressively been replaced by viruses multiplied on cell cultures, before being inactivated and then concentrated (Appolinario and Jackson 2015). Among the cells used include human diploid cells WI-38 (United States and France) and MRC5 (Canada and France) or simian (United States) (Milligan and Barrett 2015). The primary cells of cattle (France), dog (Netherlands), hamster (USSR and China) or chickens (FRG) are also used. However, it is the recently authorized continuous lineage cells (Vero) that provide the least expensive products (Morrow 2013).

2.7.2 Prevention of rabies in humans

Prophylactic (preventive) treatment of rabies in humans is based on vaccination (WHO 2018). It involves administering an intramuscular or intradermal injection of an inactivated virus vaccine that is safe with few post-vaccination complications (WHO 2016; WHO 2018). Prophylactic vaccination consists of three separate injections lasting several days and can be carried out by a doctor, a vaccination center doctor, or an anti-rabies center. An antibody test is needed in the months following exposure to the vaccine to evaluate vaccine efficacy (Crowcroft and Thampi 2015).

According to the WHO, a rabies vaccine can be applied to subjects at risk before exposure or after exposure. If a person has been bitten or licked by an animal suspected of carrying rabies in an endemic area, they should be vaccinated to prevent the subject from developing the disease. This is especially important if in doubt of whether the animal is infected with the virus, vaccination must be carried out before the animal is diagnosed with rabies, dead, wandering and/or lost. Vaccination is effective when rabies remains dormant (no symptoms) (WHO 2016).

If the bite involves a wild animal belonging to an animal rabies reservoir (fox, bat, etc.) immunization is routine. The first injection must be done within 24 hours after the bite, even if the subject was already vaccinated against rabies. However, vaccination is not routine if it is a bite of a healthy animal that can be observed for 14 days (Crowcroft and Thampi 2015). Post exposure, the regimen recommended by the WHO consists of injecting 1 mL of vaccine on days 0, 3, 7, 14, and 30 after contamination (WHO 2016).

The second approach involves the vaccination of subjects before exposure. In the interest of purely preventing the disease, vaccination is recommended in people living in endemic areas and those who are exposed to the virus during the course of their work (professionally exposed) such as veterinarians, operators of rendering plants, hunters, butchers, taxidermists, game wardens, foresters, and speleologists (bats). Here two or three injections with a booster one year later are recommended, then every two to three years (Bishop *et al.* 2003).

Vaccination is also recommended for travellers, especially children, traveling through endemic areas for more than a month and away from rapid access to care in areas such as Asia, Sub-Saharan Africa, North Africa, and South America (Crowcroft and

Thampi 2015).

According to the National Association of State Public Health Veterinarians, Compendium of Animal Rabies Prevention and Control Committee (Brown *et al.* 2016), prevention of human rabies also includes:

- Information for travelers to endemic areas, particularly in countries where access to inactivated vaccine is difficult. In most of these countries, which happen to be developing countries, there is one dog (adopted or not) per ten inhabitants, and an average of one hundred dog bites are reported per 100,000 people annually.
- Avoiding contact with stray animals, especially dogs and cats.
  In the event of a bite, local cleansing of the wound using soap and detergent, accompanied by rinsing the bite wound with abundant water to remove the virus followed by application of antiseptic. In some cases, it is recommended to treat the bite wound by eliminating the flaps of skin. Application of anti-rabies serum to the skin could reduce the risk.
- The absence of suture (risk of spread of the virus deep around the stitches)
- Antibiotic treatment.
- Tetanus vaccination.

Governments keen to undertake an effective program to combat human and canine rabies need to do the following: firstly, specify their policies that relate to rabies. Secondly, provide comparative financial and technical data on the two main directions of such a program. The purpose of this is to help policymakers in the development of appropriate health policies.

The two main directions can be defined as follows:

- Strategy A: Prevent disease in humans through the multiplication and modernization of post-exposure treatment services. This assumes a maximum coverage rate of the population. This goal can be achieved through an extensive network of vaccination centers with appropriate storage facilities and stockpiles of highly active vaccines and anti-rabies immunoglobulin. Once assured, this high vaccination coverage rate must be maintained by the national health authorities if no measure of elimination of canine rabies is applied simultaneously.

- Strategy B: Eliminate canine rabies by fighting the disease in the animal reservoir. This strategy involves the vaccination of dogs throughout the country through mass campaigns or permanent vaccination systems and the proper management of dog populations.

2.7.3 Prevention of rabies in cats

Given the risk that cats pose to public health, any cat that has outdoor access, especially in endemic areas must be vaccinated to protect it from being infected if they are exposed to wildlife (Roebling *et al.* 2014; Tan, Stellato, and Niel 2020). The vaccines must be administered in line with government regulations, and this is dependent on epidemiological conditions. In nations that have no feline rabies, rabies vaccination must be administered when the cats travel to countries that have the disease.

Rabies in cats may be controlled by traditionally inactivated vaccines (WOAH 2018). According to Cliquet (2006), cats respond to vaccines more than dogs, and only 2.6% of cats develop the disease after vaccinations. Moreover, a small proportion of cats have been identified to have required another rabies vaccination in their lifetime. Rabies vaccination in cats that consists of double primary vaccinations within short intervals of 7 to 10 days and one-year booster, drastically reduces the number of cats that will contract the disease (Zanoni *et al.* 2010).

2.7.4 Prevention of rabies in dogs

Unlike in humans, post-exposure treatment for dogs exposed to the disease is prohibited because it is not effective. Killing of animals that exhibit clinical signs of the disease or those that have been in contact with rabid animals reduces the spread of the disease (Zanoni *et al.* 2010).

The other effective control strategy is mass immunization programs (Belsare and Gompper 2015). These vaccination approaches may be conducted bi-annually or annually, and they may be combined with immunization for young dogs (Taylor *et al.* 2017).

Another preventative method includes controlling stray dogs (WOAH 2020). Special measures that limit stray dogs must be implemented in several ecological and

anthropological conditions to help keep them safe from affected dogs (Taylor *et al.* 2017).

2.8 Eradication of rabies

While rabies as viruses cannot be completely eradicated, rabies in humans can be eliminated. This is supported by the evidence of its near eradication in the developed world. The most effective way to achieve this is through mass vaccination of dogs (Wilde *et al.* 2016).

Vaccination of dogs is the most effective way to achieve a significant and lasting reduction in the number of human deaths from rabies. In addition to national strategies developed by isolated countries, several regional strategies to eliminate human rabies transmitted by dogs already exist or are under development (Cleaveland *et al.* 2014). Progress towards international control and elimination of human rabies due to dogs has already been achieved (GARC 2014).

At the global level, the FAO, OIE and WHO have made rabies a priority disease (WHO 2015). In December 2015, an international meeting on rabies in Geneva, Switzerland, developed a scheme for the elimination of human rabies transmitted by dogs. This strategy aims to achieve zero human deaths due to canine rabies by 2030. It is organized around five pillars, abbreviated as STOP-R (WHO 2015).

S: Socio-cultural. This refers to the perception in at-risk populations of rabies and its relationships with dogs. Socio-cultural activities include rabies vigilance, responsible dog ownership, prevention and treatment of bites, and community involvement.

T: Technique. This includes effective vaccines as well as vaccination programs or strategies, logistical support, diagnosis, and surveillance.

O: Organization. Rabies is a very good model for the "One Health" approach and the different activities include promoting this concept of unique health, coordination, governance, monitoring, and evaluation.

P: Politics. Political will and support are essential for the elimination of rabies. This includes international support, a regulatory framework, and regional commitment.

R: Resources. Continued long-term support is needed for the ultimate elimination of rabies. This framework encourages investment in rabies control, as well as financial incentives for investment in rabies elimination for the benefit of the general public.

The main challenges and opportunities for controlling rabies are summarized in Table 2.1.

Table 2.1: Summary of the main challenges and opportunities for controlling rabies (Ducrotoy *et al.* 2015; GARC 2014)

Challenges	Opportunities
• The vicious cycle of neglected disease, lack of data and information leads to a lack of political commitment and lack of resources. • Low value of dogs in companies, low priority for the veterinary profession, despite rabies-related livestock losses. • Lack of commitment and coordination between the animal health sector (which requires the most important intervention) and the human health sector (which will benefit the most from the control measures).	• The elimination of human rabies transmitted by dogs is feasible by vaccinating dogs. • Even if rabies is fatal in 99.9% of cases, it is still preventable. • Rabies is an ideal model of the One Health Principle as it requires inter-sectoral collaboration. • The elimination of rabies has a global public interest. The goal of eliminating human deaths from rabies transmitted by dogs worldwide has been set for 2030. • There are active rabies platforms at the global and regional levels. • There are effective tools and platforms for advocacy, education, and communication (including the Rabies Control and Prevention Master Plan, World Rabies Day, "Let's Now End Rabies" campaign "and the GARC Education Platform)

It is widely acknowledged that rabies elimination needs implementation of One Health strategy, which includes experts in human, animal, and environmental health, as well as other relevant disciplines and sectors, in monitoring and controlling public health concerns and learning about how diseases spread among people, animals, plants, and the environment. (CDC 2018). To justify the One Health approach, Taib and Safii (2020) reviewed seventeen studies to analyse the effectiveness of rabies intervention and control strategies.

Public education, responsible dog ownership, a human-animal surveillance system, targeted dog vaccination, control of free roaming dogs, and a decentralized network for animal management, surveillance, and immunization were among the successful strategies. When all these strategies are combined with One Health, the response against rabies will result in a successful public health intervention (Taib and Safii 2020).

2.9 Surveillance and monitoring of rabies

To be able to control and prevent rabies, a surveillance and reporting system for rabies disease must be established and implemented so that rabies data are collected and reported regularly to assess progress. Detailed information on how to develop a surveillance system and a system for centralizing information is available in the Master Plan for Rabies Surveillance (Ortiz *et al.* 2018). According to these authors, rabies surveillance staff and investigative officers including sanitary veterinarians, para-veterinarians, field agents, wildlife guards, and medical personnel who work closely with field investigation staff, should be trained in the following tasks:

- Collection of basic epidemiological data such as animal rabies cases, bite cases, and human rabies cases.
- Communication of surveillance data to epidemiologists.
- Collection of animal samples for diagnosis, packaging and sending to laboratories for diagnosis.
- Epidemiological survey on human and canine rabies cases.

Epidemiologists should oversee:

- Gathering essential epidemiological data such as vaccination coverage, the incidence of animal rabies, human bites and human rabies cases, number of human vaccine doses used, and managing the database, analysing, and

interpreting the data to track the progress of the intervention.

- Send reports and disseminate information.
- Conduct epidemiological investigations of cases of human rabies and canine rabies.

The technical staff of the rabies diagnostic laboratories should be responsible for the following tasks:

- To apply the general protocols and procedures of the laboratory
- To ensure the maintenance of equipment (refrigerators/freezers, microscopes, etc.)
- To prepare/handle/store the reagents.
- To make the diagnosis of rabies using basic techniques.
- Save the data and notify the results of the laboratory.

2.10 Use of the KAP Model as a research framework

According to the WHO (2012), the KAP model is a rational model in health education that is based on increasing personal knowledge to influence behaviour change.

By assessing the current KAP of respondents, the researcher is able to determine whether participants are sufficiently informed on the principles and health benefits of vaccination to prevent rabies in order to accurately form an opinion towards this intervention. The respondents' degree of knowledge will also have an effect on their attitude toward rabies and vaccination, whether it be positive, negative, or neutral. According to Zhao and Zhao (2023), healthy behaviours are formed only when positive and accurate beliefs and attitudes are in place.

Therefore, it is vital that the researcher assess the respondents' current degree of knowledge in order to determine whether there is sufficient knowledge or a general lack of knowledge among them. If the latter happens to be the case, the findings in this study can act a foundation for the development of informational guidelines by health professionals, that can assist individuals in their search for information on rabies and vaccination, including its benefits and protocols that they can make an informed decision when presented with the option of vaccinating their pets against rabies and how to appropriately respond if someone in the community is bitten by an animal.

The KAP model has its roots in learning theory (Bandura 2014) as well as diffusion of innovation (Rogers, Singhal, and Quinlan 2014) and aims to identify a link between knowledge and behaviour (Hornik 1989). As indicated in Figure 2.1, the three interlinked elements that form the KAP model include knowledge, attitude, and practice.

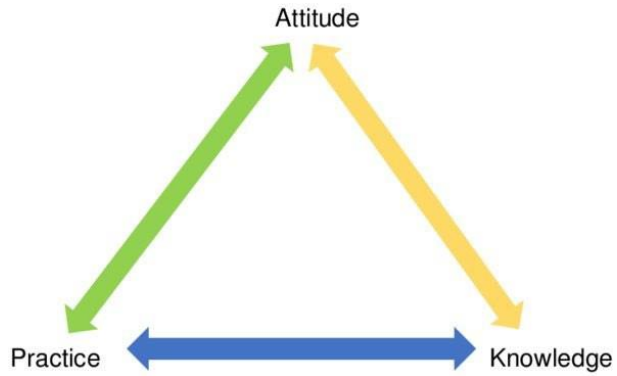

Figure 2.1: The three interacting elements of the KAP model. Adopted from Valente *et al.* (1998)

According to the KAP model, knowledge and information serve as the foundation of cultivating positive attitudes, and attitudes serve as the motivating factor for behavior change (Valente, Paredes and Poppe 1998).

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Study Area

The MLM is situated within the Sekhukhune District Municipality (SDM) of the Limpopo Province (Figure 3.1, 3.2). It is a Category B municipality bordered by the Capricorn District to the north, Elias Motsoaledi to the south, Fetakgomo – Greater Tubatse Local Municipality to the east, and Ephraim Mogale to the west (Figure 3.2). As one of the four municipalities comprising the Sekhukhune district, it encompasses approximately 16% of the district's total geographical area. The municipality is entirely rural, characterized by traditional land ownership practices, and spans an extensive land area of 2,096.60 square kilometers. In terms of socio-economic factors, MLM faces challenges such as a weak economic base, limited infrastructure development, substantial service delivery backlogs, dispersed human settlements, and elevated poverty levels (Municipalities of South Africa 2020).

According to Statistics South Africa (2011), there are 65 217 households in the municipality, with an average household size of 4,2 persons per household. Of the households, 25,9% have access to piped water either in their dwelling or in the yard, while 90,4% of households have access to electricity for lighting. In terms of demographics, the municipality has a population of 274 358 people and 65 217 households. Another important segmentation of the population is that the unemployment rate: 62,7% and the level of literacy for those with matric, aged 20 years and over is 20,5% and higher education is at 5,7% over 20-year-olds. The local economy primarily revolves around farming and agriculture, serving as the primary livelihood for the residents. Access to the municipality is mainly facilitated by the R570 road, which connects Makhuduthamaga to neighbouring towns and regions.

With its rural nature and unique set of challenges, MLM provides an essential context for this study. By examining the KAP towards rabies, as well as the factors influencing rabies vaccination coverage in this specific rural setting, the study aims to shed light on critical public health issues in the area.

Figure 3.1: Map of South Africa showing Limpopo Province where the study was conducted: retrieved or accessed (31/01/2024) from: www.dreamstime.com.

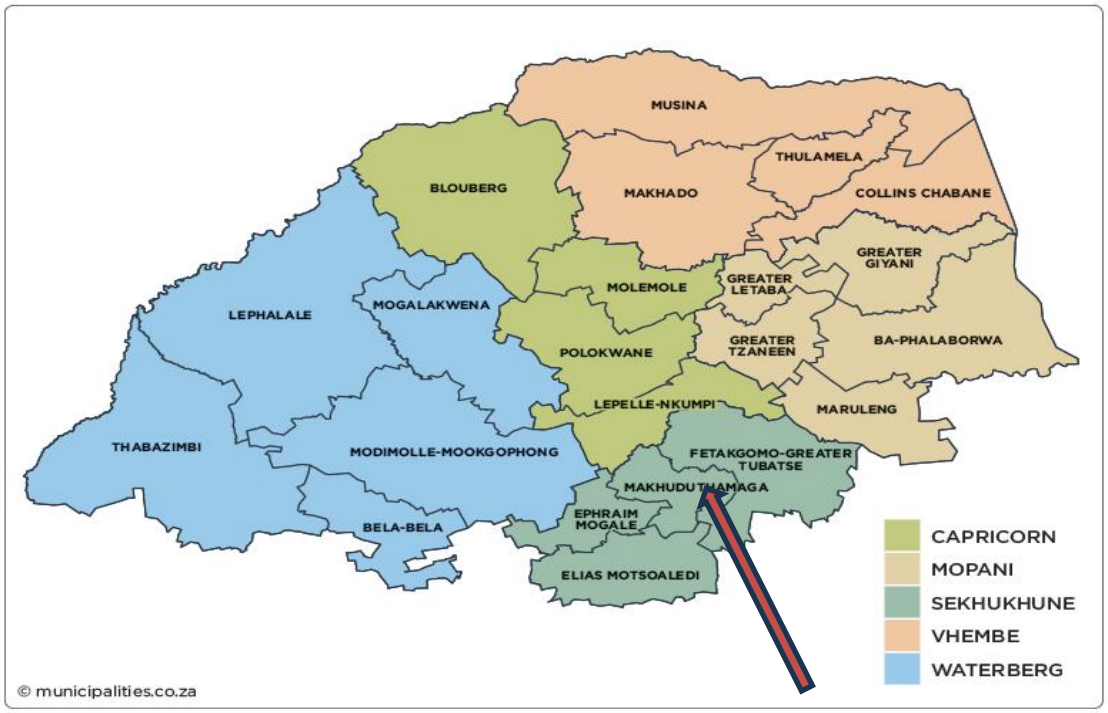

Figure 3.2: Map of the Limpopo Province showing the five (n=5) District Municipalities. Makhuduthamaga municipality found in Sekhukhune District Municipality District is where the study was conducted: retrieved or accessed (10/04/2024) from: https://municipalities.co.za/provinces/view/5/limpopo.

3.2 Study design

A cross-sectional study design was adopted for this study, which involved conducting face-to-face structured interviews using a slightly modified pre-tested questionnaire developed by Fenelon *et al.* (2017). The questionnaire was modified to make it relevant to the study area (Appendix 3). The changes on the questions are shown in Table 3.1 below:

Table 3.1: Modifications to Fenelon *et a.l* questionnaire

Study questionnaire	Fenelon questionnaire
• Sex of respondent	• What is your sex?
• What is the highest level of education you have completed?	• What is your level of education?
• How many people live in your household including yourself?	• How many people live in this household?
• Do you have pets/animals in the house?	• Do you have pets in the House?
• According to you which of the following animals might spread rabies?	• What are the animals according to you who might give rabies?
• Do you believe that rabies can be treated?	• Do you believe that rabies can be prevented?
• In your opinion, do you think the elimination of stray pets like dogs and/or cats can reduce the transmission of rabies in the communities?	• In your opinion, do you think the elimination of stray dogs can reduce the transmission of rabies in the communities
• Do you know in which institution the rabies vaccine for dogs is available in your area?	• Do you know in which institution the rabies vaccine is available in your area
• If you or your child is bitten by a dog. What will you immediately do?	• If you or your child is bitten by an animal suspected of rabies, what will you do?
• In your opinion, if you or your child is bitten by a dog. What will you do with the dog.	• In your opinion, if you or your child is bitten by an animal suspected of rabies. What will you do with this animal
• If in your community, you suspect someone has been bitten by a dog. Do you think it's necessary to alert local health authorities?	• If in your community, you suspect someone has been bitten by an animal suspected of rabies. Do you think it's necessary to alert local health authorities?
• Have you been bitten by a dog? **(**If "No," Skip to question 31)	• Have you been bitten by an animal at least once? If yes, what kind of animal? If no, proceed to the question.

	How many times
• Once you've been bitten by this dog. What did you do?	• Once you've been bitten by this animal. What did you do?
• Have you received a preventive treatment?	• Have you received a preventive rabies treatment?
• If you happen to be bitten by a dog, and the medication and or vaccine was not available and you had been referred to another institution, what will you do?	• If you have been bitten by a suspected animal of rabies, and the rabies vaccine was not available and you had been referred to another institution, what did you do?
• Have your dog(s)/cat(s) been vaccinated against rabies? (Household that own dog/cat)	• Have all animals have been vaccinated against rabies?
• If yes, can I see proof of vaccination? (Vaccination Certificate/Card)?	• If yes, when were they vaccinated?

New questions that were added to the current questionnaire are list below:

- How many children < 18 years live in your household?
- What is rabies? (If "Don't know", Skip to 22)
- Can rabies be transmitted to people? (If "No Skip to 22)

The questions that were not included on the study questionnaire from Fenelon's questionnaire are listed below:

- How many people are employed in this House?
- With what material is your home built with?
- What was the last time that you have been bitten by a dog or cat?
- Where were you bitten (place)?
- In what part of the body have you been bitten?
- Once you've been bitten, what did you do with the biting animal?
- Have one of your children or loved ones was bitten by an animal suspected of rabies at least once? If yes, what do you do?

3.3 Study population and sampling method

The target population encompassed all households in the study area, from which a sample was drawn using systematic random sampling to ensure a comprehensive and unbiased representation of residents. Therefore, the study population consisted of a representative sample of households within MLM.

MLM was chosen as the study area due to its notable human population density (n=274,358). In addition, it has also been closely linked to a high dog population among African communities, as demonstrated by previous research (Van Sittert *et al.* 2010).

By focusing on a diverse sample of households within Makhuduthamaga, this study aimed to capture a comprehensive understanding of the residents' KAP towards rabies, as well as the factors influencing pet vaccination coverage. The selected households were seen as a microcosm of the broader community, providing valuable insights into the prevailing rabies-related issues and vaccination practices in this rural municipality.

Employing a representative sample of households allowed for the extrapolation of findings to the larger population within MLM. The data collected from the selected households offered a valuable basis for making informed policy decisions and implementing targeted interventions to improve rabies prevention and control measures in the study area.

MLM is subdivided into 168 Main Places (Frith 2011). A two-stage random sampling strategy was employed. First 17 (n=17) (10% of 168) geographical areas (Main Places) were selected. In the second stage individual households (n=476) were randomly selected from within the Main Places using systematic random sampling.

Within each selected Main Place, systematic random sampling was employed to randomly select households. As described by Fenelon et al. (2017) the quotient of 476 (the total of households selected) and 17 main places was used to determine the number of households required from each Main Place**.** Therefore, a total of 28 (476/17) households per main place were recruited to participate in the study.

The sampling interval used in the systematic random sampling was calculated by dividing the total number of households in each Main Place by the required number of households (n=28) (Appendix 2). The interviewers started at a randomly selected household and then proceeded using the interval calculated by dividing the total number of households in each Main Place by the required number of households (n=28).

3.4 Sample size determination and selection

The sample size for this study was determined to ensure sufficient statistical power to detect significant differences in responses related to KAP toward rabies in the MLM. The sample size was determined by using the sample size table (Figure 3.3) (The Research Advisors 2006). Based on the total population (households; n= 65,217) in the study area and utilizing a 95% confidence level (Z=1.96) with a 5% margin of error (e=0.05), a population-level knowledge estimates of 50% was assumed due to the lack of prior information. With these parameters, a desired sample size of 382 households was calculated. To accommodate potential non-responses or ineligibility, the sample size was increased by 25%, resulting in a total sample size of 476 households.

Required Sample Size†

Population Size	Confidence = 95% Margin of Error				Confidence = 99% Margin of Error			
	5.0%	3.5%	2.5%	1.0%	5.0%	3.5%	2.5%	1.0%
10	10	10	10	10	10	10	10	10
20	19	20	20	20	19	20	20	20
30	28	29	29	30	29	29	30	30
50	44	47	48	50	47	48	49	50
75	63	69	72	74	67	71	73	75
100	80	89	94	99	87	93	96	99
150	108	126	137	148	122	135	142	149
200	132	160	177	196	154	174	186	198
250	152	190	215	244	182	211	229	246
300	169	217	251	291	207	246	270	295
400	196	265	318	384	250	309	348	391
500	217	306	377	475	285	365	421	485
600	234	340	432	565	315	416	490	579
700	248	370	481	653	341	462	554	672
800	260	396	526	739	363	503	615	763
1,000	278	440	606	906	399	575	727	943
1,200	291	474	674	1067	427	636	827	1119
1,500	306	515	759	1297	460	712	959	1376
2,000	322	563	869	1655	498	808	1141	1785
2,500	333	597	952	1984	524	879	1288	2173
3,500	346	641	1068	2565	558	977	1510	2890
5,000	357	678	1176	3288	586	1066	1734	3842
7,500	365	710	1275	4211	610	1147	1960	5165
10,000	370	727	1332	4899	622	1193	2098	6239
25,000	378	760	1448	6939	646	1285	2399	9972
50,000	381	772	1491	8056	655	1318	2520	12455
75,000	382	776	1506	8514	658	1330	2563	13583
100,000	383	778	1513	8762	659	1336	2585	14227
250,000	384	782	1527	9248	662	1347	2626	15555
500,000	384	783	1532	9423	663	1350	2640	16055
1,000,000	384	783	1534	9512	663	1352	2647	16317
2,500,000	384	784	1536	9567	663	1353	2651	16478
10,000,000	384	784	1536	9594	663	1354	2653	16560
100,000,000	384	784	1537	9603	663	1354	2654	16584
300,000,000	384	784	1537	9603	663	1354	2654	16586

Figure 3.3: Sample size Table. Retrieved from: http://research-advisors.com

All eligible households were invited to participate, and the household head was the primary target for the interview. If the head of the household was unavailable, any member of the household aged 18 years or older was interviewed. Only one person per household was interviewed. Participation was entirely voluntary, and consent was obtained from willing participants. If consent was not given or no eligible adult was present at the household, the interviewer moved to the next selected household.
Overall, the chosen sample size and sampling method allowed for a representative and diverse selection of households in MLM, providing robust data for the study's objectives.

3.5 Data collection

Data for this study were collected through a structured questionnaire that covered socio-demographic characteristics, vaccination coverage, knowledge, and awareness about rabies in the study area. The questionnaire included questions about means of transmission, signs of the disease, the cause of rabies, species affected by rabies, and attitudes and practices regarding actions taken against rabid animals and bitten humans and animals.

Prior to the main data collection, a pilot study was conducted in one Main Place to test the questionnaire's effectiveness and identify any potential gaps. Based on the pilot study’s results, some questions were re-phrased and modified to enhance the questionnaire's clarity and comprehensibility.

The data collection was carried out by trained interviewers who were recruited for this purpose. The principal researcher provided training to the interviewers during a pilot study that was done prior to the study on how to conduct structured interviews and to ensure that the participants' rights were respected throughout the process. Additionally, specific attention was given to the uniformity of question interpretation in Sepedi, the predominant dialect in the study area. This was essential to maintain consistent translation of the questions from English to ensure that the study respondents completely understood the questions.

Each interview took 30 to 45 minutes to complete, and the data collection process spanned a period of two months from May to June 2019. To confirm the vaccination status of dogs and cats in the community, dog owners were requested to show their

vaccination certificates as evidence of vaccination.

The structured questionnaire and well-trained interviewers allowed for comprehensive data collection and provided a detailed understanding of the residents' KAP related to rabies in the study area. The inclusion of vaccination certificates allowed for an accurate assessment of rabies vaccination coverage in MLM. The data collection process was carefully planned and executed to ensure reliable and valid data for the study's objectives.

3.6 Data management and analysis

3.6.1 Data management

All data collection was monitored and reviewed by the principal researcher. All questionnaires were first checked for completeness and accuracy before the data was captured. The data collected from the questionnaire survey were captured into Microsoft Excel spreadsheet. Data was cleaned and coded before being analysed using IBM Statistical Package for Social Science (SPSS) Statistics version 28. Statistical significance was assessed at 5%.

3.6.2 Definition of key variables

The outcome variable was vaccination (Yes = 1; No =0). Continuous variables that were collected in this study included: knowledge score (0-13), age and number of people residing in the home. The knowledge for each respondent was calculated out of thirteen points which was then converted to percentage. Respondents with a knowledge score of sixty percent (60%) and above was considered knowledgeable (Coded 1) and those who scored below 60% were considered not to be knowledgeable (coded 0). The vaccination coverage was determined by computing the percentage of respondent who self-reported vaccination of their dogs as a percentage of the total sample.

3.6.3 Data analysis

Descriptive statistics were used to summarize the categorical variables, and presented as frequencies, percentages, means, and standard deviations to provide an overview of the study sample. The rabies knowledge scores, the age and the number of people

residing in the home were analysed as continuous variables.

The normality of the rabies knowledge score was assessed using the Kolmogorov-Smirnov test below, revealing a significant deviation from a normal distribution (p=0.00). The Kolmogorov-Smirnov (K-S) test is based on the empirical distribution function (ECDF). Given *N ordered* data points ***Y1, Y2, ..., YN***, the ECDF is defined as EN=n(i)/N, where *n(i)* is the number of points less than Yi and the Yi are ordered from the smallest to the largest value (a step function increased by 1/N at the value of each data point). Consequently, the Kruskal-Wallis test (i.e., pooling the observations from the k samples into one combined sample, keeping track of which sample each observation comes from, and then ranking lowest to highest from 1 to N, where N = n1+n2 + ... + nk) was employed to compare the differences in rabies knowledge scores between the Main Places.

Attitudes of residents towards rabies were presented as proportions for each Main Place, and the Chi-square test of association (**$X^2 = \Sigma [(Oi - Ei)^2 / Ei$**], where Oi is the observed frequency and Ei is the expected frequency) was used to compare these proportions across the Main Places. Similarly, vaccination coverage was presented as proportions, and differences among the Main Places were assessed using the Chi-square test.

To determine the factors significantly associated with vaccination, a Binary Logistic Regression Model (BLRM) was fitted to the data, with the vaccination as the outcome variable. BLRM is a form of regression which is used when the dependent variable is a dichotomy, and the independent variables are of any type. The impact of predictor variables is usually explained in terms of odd ratios. Logistic regression applies maximum likelihood estimation after transforming the dependent a logit variable (the natural logs of the odds of the dependent occurring or not). Thus, the logistic regression calculates the changes in the log odds of the dependent variable.

The main advantage of the BLRM over other models of discrete and limited dependent variables is that it allows the analysis of decisions across two categories, allowing the determination of choice probabilities from different categories. In addition, its likelihood function, which is globally concave, makes it easy to compute. In BLRM, a single outcome variable Y_i *(i=1, ..., n)* follows a Bernoulli probability function that takes on the value 1 with probability P_i and 0 with probability $1\text{-}P_i$. $P_i/1\text{-}P_i$ and is referred to as the

odds of an event occurring. P_i varies over the observations as an inverse logistic function of a vector X_i, which includes a constant and K explanatory variables. The Bernoulli probability function can be expressed as:

$$Y_i \Theta Bernoulli(Y_i / P_i) \quad (1)$$

or

$$In\left[\frac{P_i(Y_i=1)}{1-P_i(Y_i=1)}\right] = In\ (Odds) = \alpha_0 + \sum_{k=1}^{k}\beta_k X_{ik} \quad (2)$$

In the study, *Y*i represents vaccination of pets. Those respondents who self-reported to have vaccinated their pets were classified with a value of 1, while those who self-reported that they did not vaccinate their pets were classified with the value of 0. The covariates used for the model are presented in Table 3.1. Equation (2) above is referred to as the log odds and also the Logit and by taking the antilog of both sides, the model can also be expressed in odds rather than log odds, i.e.

$$Odds = \left[\frac{P_i(Y_i=1)}{1-P_i(Y_i=1)}\right] = exp\left[\alpha_0 + \sum_{k=1}^{k}\beta_k X_{ik}\right] \quad (3)$$

or

$$= e^{\alpha+\sum_{k=1}^{k}\beta_k X_{ik}} = e^{\alpha_0} * \prod_{k=1}^{k} e^{\beta_k X_k} = e^{\alpha_0} * \prod_{k=1}^{k}\left(e^{\beta_k}\right)^{X_k} \quad (4)$$

In this study, the parameters of the model were estimated by maximum likelihood. The recommended test for the overall fit of a logistic regression model is the Hosmer and Lemeshow test, also called the Chi-Square test which is considered more robust than the traditional chi-square test particularly if continuous covariates are in the model or sample size is small.

An initial univariable analysis was conducted to select variables for inclusion in the multivariable model, using a less strict cut-off of p<0.20 to avoid excluding potential variables associated with vaccination. Backward selection was then used to assess confounding in the final model. If the removal of a variable resulted in a change in the effect measure by 10% or more, it was considered a confounder and retained in the model, even if it was not significantly associated with the outcome (p>0.05).

The Hosmer and Lemeshow test evaluated whether the final model fit the data well

(i.e., p>0.05). The association between predictor variables and pet vaccination was reported as odds ratios.

By using a combination of descriptive statistics, non-parametric tests, and binary logistic regression, the data analysis provided a comprehensive assessment of the factors influencing rabies knowledge, attitudes, practices, and vaccination coverage among residents in the MLM. The statistical methods used in this study ensured robust and valid results to address the research questions and objectives effectively.

3.7 Ethics clearance

To uphold the highest standards of research ethics, the study obtained the necessary approvals before its commencement. The research was granted ethical clearance from the Ethics Committee of the College of Agriculture and Animal Health at the University of South Africa (UNISA), with approval reference number 2018/CAES/125 (Appendix 4). This ensured that the study adhered to the ethical guidelines and principles set forth by the university.

Additionally, authorization to conduct the survey on dog and cat owners in Sekhukhune Municipality District was obtained from the Department of Agriculture and Rural Development in Limpopo, specifically from the Nebo Government Offices. This step ensured that the research was conducted with official permission and within the boundaries of legal and administrative requirements.

Furthermore, the study sought and obtained consent from the tribal leaders of the Main Places that were sampled. This ensured that the research had the support and approval of local community leaders, thus fostering a respectful and collaborative approach with the communities.

The data collection methods employed in the study posed no risk to the respondents or the interviewers, as no biological specimens were collected. Additionally, the study participants were assured that all personal identifying information was omitted from the data collection process to ensure respondent confidentiality and privacy.

Prior to administering the questionnaire, all respondents were provided with verbal information about the aims and objectives of the study. They were informed about the voluntary nature of their participation and were assured that they could withdraw from

the study at any point during the interview without repercussions.
Moreover, respondents were informed that all information gathered from the study would be treated with absolute confidentiality, thus ensuring the protection of their privacy and data security.

By adhering to these rigorous ethical considerations, the study demonstrated its commitment to maintaining the welfare and rights of the participants while gathering valuable information to address the research objectives.

CHAPTER 4: RESULTS

4.1 Introduction

This chapter presents the key findings obtained from the analysis of the collected data. The results are structured in a systematic manner, beginning with the presentation of participants' biographical and demographic data. Subsequently, the section focuses on the respondents' knowledge and awareness levels regarding rabies. The main results of the study are then presented in alignment with the predefined study objectives.

By organizing the findings in this manner, the chapter provides a comprehensive overview of the participants' characteristics and their level of knowledge about rabies. Moreover, it enables a clear understanding of how the study objectives were addressed through the data analysis. The subsequent sections delve into specific aspects of the study, shedding light on the participants' attitudes, practices, and vaccination coverage with regards to rabies. The structured presentation of the results aims to provide readers with a coherent and cohesive understanding of the study outcomes and their implications.

4.2 Biographic and Socioeconomic Data

Table 4.1 below provides a comprehensive summary of the demographic information collected from all the residents who participated in the study.

Gender, heads of households, and age of respondents:

The study found that 38% (n=182) of the respondents were males, while the majority, constituting 62% (n=294), were females. Additionally, a significant proportion of households, accounting for 55% (n=264), were headed by females. Most of the respondents, 85% (n=405), fell within the age group of above 40 years old.

Education and employment status of respondents:

Regarding educational attainment, most respondents, 37% (n=177), had completed only a secondary education, while a smaller percentage, 4% (n=21), possessed a

tertiary qualification. In terms of employment, the study revealed that a considerable proportion (41%; n=197), of the residents were unemployed, and 37% (n=175) were pensioners. A smaller percentage, comprising 21% (n=99) of respondents, were employed, and 1% (n=5) identified themselves as students.

Income level of the respondents:

A substantial majority, accounting for 67% (n=319) of the participating households, reported earnings below R3500 per month. Additionally, 21% (n=100) fell within the income range of R3500 to R9 999, while only 8% earned above R10 000.

Table 4.1: Demographic profile of the respondents who participated in the study.

Variables	n	%
Household head type		
Male head	152	32
Female head	264	55
Other	60	13
Sex		
Male	182	38
Female	294	62
Age groups		
Below 30	34	7
30-39	37	8
40-49	101	21
50-59	112	24
60-69	105	22
70 and older	87	18
Education		
None	58	12
Primary	91	19
Secondary	177	37
Matric	129	27
Tertiary	21	4
Occupation		
Unemployed	197	41
Pensioner	175	37
Employed	99	21
Student	5	1
Monthly household income		
None	7	1
< R3500	319	67
> R3500 - R9 999	100	21
>R10 000	38	8
Won't Answer	12	3

Age of the study participants:

The participants age, as shown in Table 4.2 ranged from 22 to 86 years (Median = 59 years; Range = 64).

Table 4.2: Median age of the study participants (n=476) who completed the questionnaire

	Statistic	**Std. Error**
Median	59.0	
Minimum	22.0	
Maximum	86.0	
Range	64.0	
Skewness	-0.2	0.4
Kurtosis	-1.0	0.7

Number of people living in the household:

The average number of people living in the households in the studied area are presented in Table 4.3 and on average, there were five (n=5) occupants per household (Median = 5, Range = 6), with an average of about two (n=2) children below the age of 18 years per household (Median = 2, Range = 5).

Table 4.3: Number of people living in the household (n=476)

	People in the household		**Children <18 years**	
	Statistic	**Std. Error**	**Statistic**	**Std. Error**
Median	5.0		2.0	
Minimum	2.0		0.0	
Maximum	8.0		5.0	
Range	6.0		5.0	
Skewness	0.1	0.4	0.2	0.4
Kurtosis	-1.0	0.7	-0.8	0.7

Households with pets/animals:

The results of households with pets/animals in the study are presented in Figure 4.1 below. The results show that, the majority of households (60%) had pets/animals while about 40% of them do not have pets/animals.

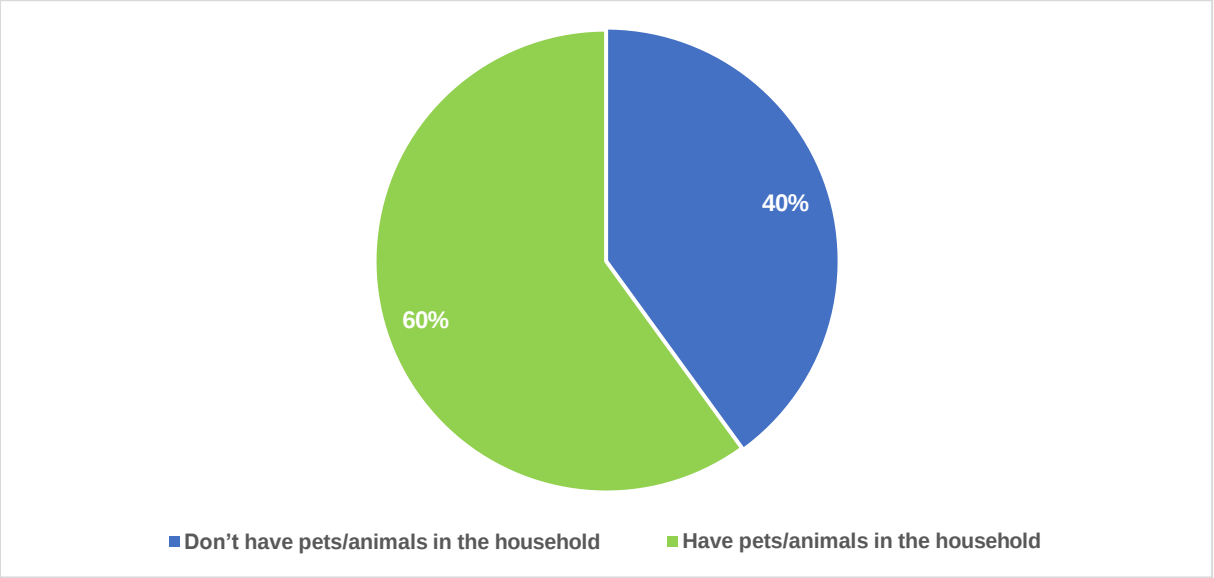

Figure 4.1: Percentage of households with pets/animals (n=476)

Type and number of pets in the household:

Figure 4.2 and Table 4.4 provide a comprehensive overview of the types and number of pets in the households of the study area. Figure 4.2 illustrates the distribution of pets per household. Among the households with pets and animals, a substantial 80% were found to own dogs and/or cats, reflecting the significant presence of these common pets in the study area. Additionally, 58% of households reported having other types of pets, showcasing the diversity of pet ownership beyond dogs and cats. Interestingly, 38% of the households belonged to the category of multiple pet owners, who owned both dogs and/or cats alongside other types of pets.

Table 4.4 further breaks down the number of pets per household, presenting the mean and standard deviations. The average number of pets per household was calculated to provide a clear picture of the typical pet ownership patterns in the study area.

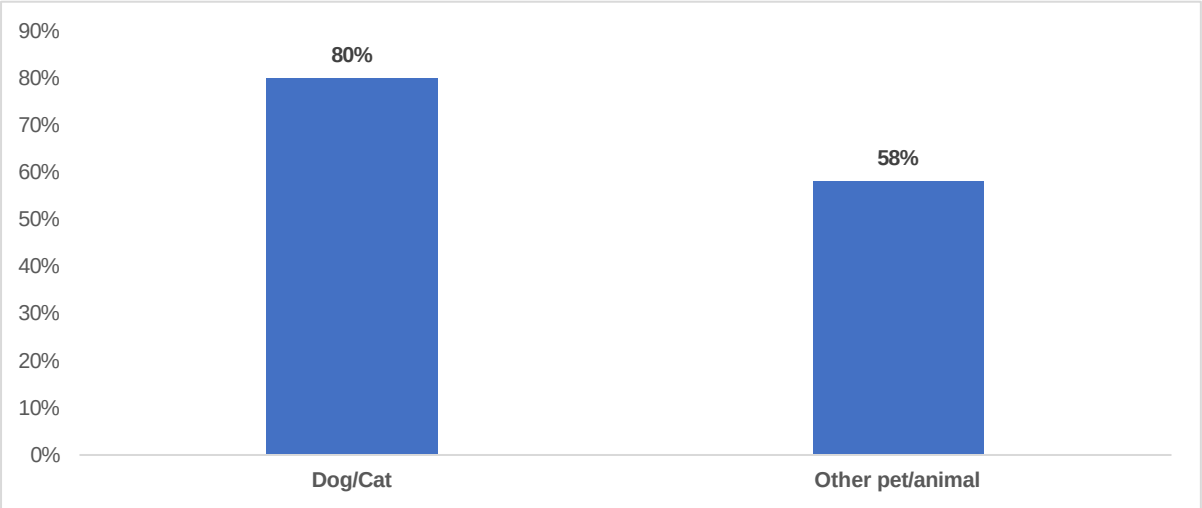

Figure 4.2: Average number of households with pets and their type (n=287)

According to results reported here, the median number of dogs per household was 1 (range 1-7) while the median number of cats kept per household was also 1 (range: 1-3).

Table 4.4: Number of pets per household (n=287).

	Dogs		**Cats**	
Median	1.0		1.0	
Minimum	1.0		1.0	
Maximum	7.0		3.0	
Range	6.0		2.0	
Skewness	3.8	0.4	1.9	0.4
Kurtosis	19.1	0.7	2.3	0.7

4.3 Knowledge about rabies

Overall, the percentage of respondents who had knowledge about rabies was 42% (95% CI = 31%–53%) against 58% (95% CI = 49%–67%) who did not know what rabies is (Figure 4.3).

Among all the Main Places surveyed, Ga-Mosehla stood out with the highest percentage (83%) of respondents who displayed a commendable level of knowledge about rabies (Table 4.5). On the other hand, Ga-Moloi recorded the lowest proportion (12%) of individuals considered knowledgeable about rabies.

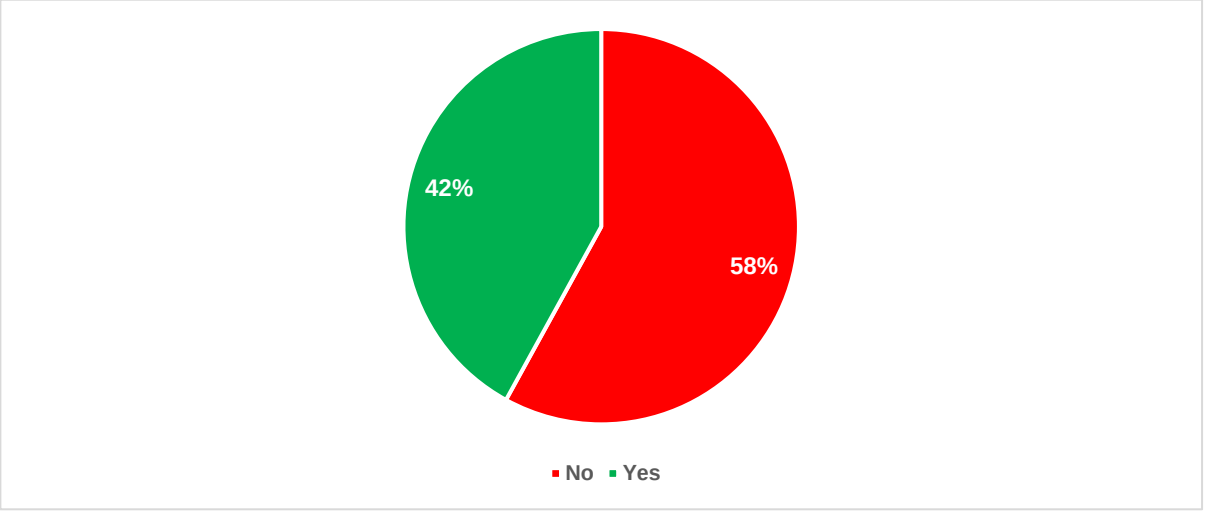

Figure 4.3: Division of respondents according to their knowledge of rabies (n=476).

Table 4.5: Proportions of respondents who were knowledgeable about rabies (n=200).

Main Place	Total (n)	Knowledge of rabies	
		Yes	No
		% (n)	% (n)
Ga-Mosehla	18	83.3% (15)	16.7% (3)
Brooklyn	8	62.5% (5)	37.5% (3)
Ga-Molepane	17	52.9% (9)	47.1% (8)
Polaseng	10	50.0% (5)	50.0% (5)
Jane Furse	17	47.1% (8)	52.9% (9)
Maololo	17	47.1% (8)	52.9% (9)
Dinotsi	13	46.2% (6)	53.8% (7)
Maswiakae	7	42.9% (3)	57.1% (4)
Lekgwareng	10	40.0% (4)	60.0% (6)
Tswatago	11	36.4% (4)	63.6% (7)
Masakeng	9	33.3% (3)	66.7% (6)
Mashwanyaneng	12	33.3% (4)	66.7% (8)
Ngwaritsi	9	22.2% (2)	77.8% (7)
Ga-Seopela	10	20.0% (2)	80.0% (8)
Mohlarekoma	10	20.0% (2)	80.0% (8)
Mosate B (Ga-Masemola)	5	20.0% (4)	80.0% (1)
Ga-Moloi	17	11.8% (2)	88.2% (15)

A detailed response to the questions used for the interview are itemized below

Two hundred respondents (n = 200; 42%) reported knowing what rabies is. When the 200 were asked to describe rabies, 35% of the respondents characterized it as an abnormal and aggressive change in behaviour. On the other hand, 7% of the residents considered rabies to be a contagious and fatal viral disease as reported earlier, 58% of the respondents did not know what rabies was (Figure 4.4).

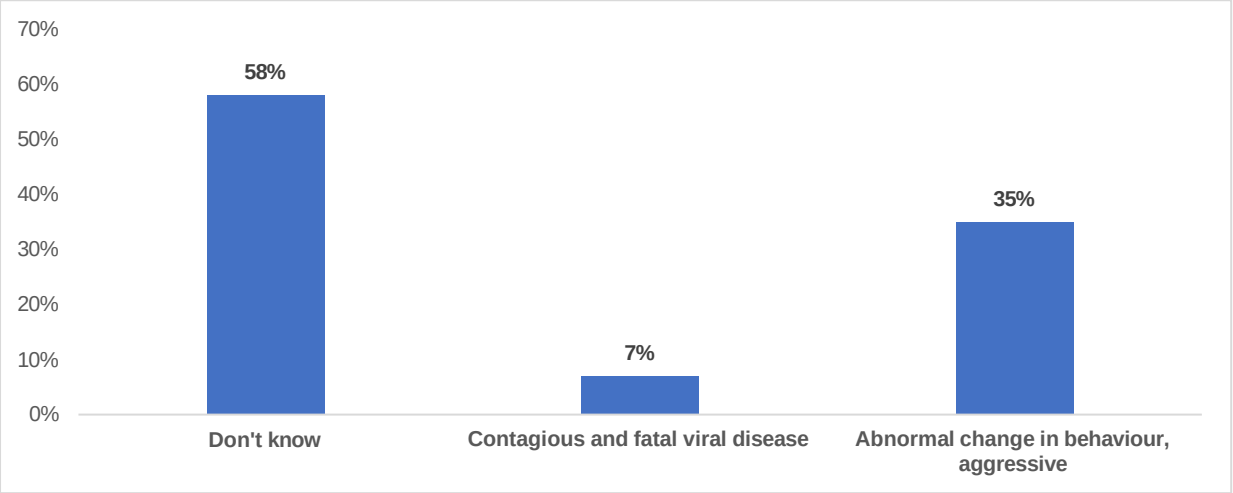

Figure 4.4: Distribution of the respondents according to how they describe rabies (n=476).

Up to 87% of the participants who described rabies said only dogs spread rabies against 1% who said only cats spread rabies. The remaining 12% said both dogs and cats can spread rabies disease (Figure 4.5).

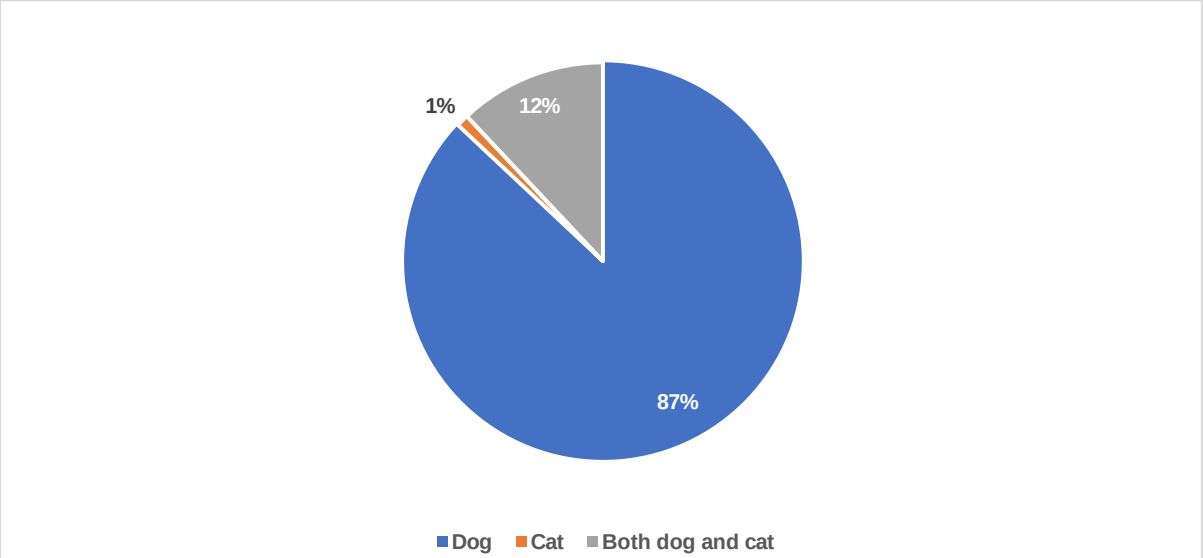

Figure 4.5: Household responses to animals that can spread rabies (n=199)

Because one respondent chose not to respond, there were 199 respondents rather than 200 in Figure 4.5 and 4.6. The majority of the respondents (94%) knew that rabies could be transmitted to people. Only an exceedingly small percentage (1%) said rabies could not be transmitted to people. Meanwhile 5% did not know if rabies could be transmitted to people or not (Figure 4.6).

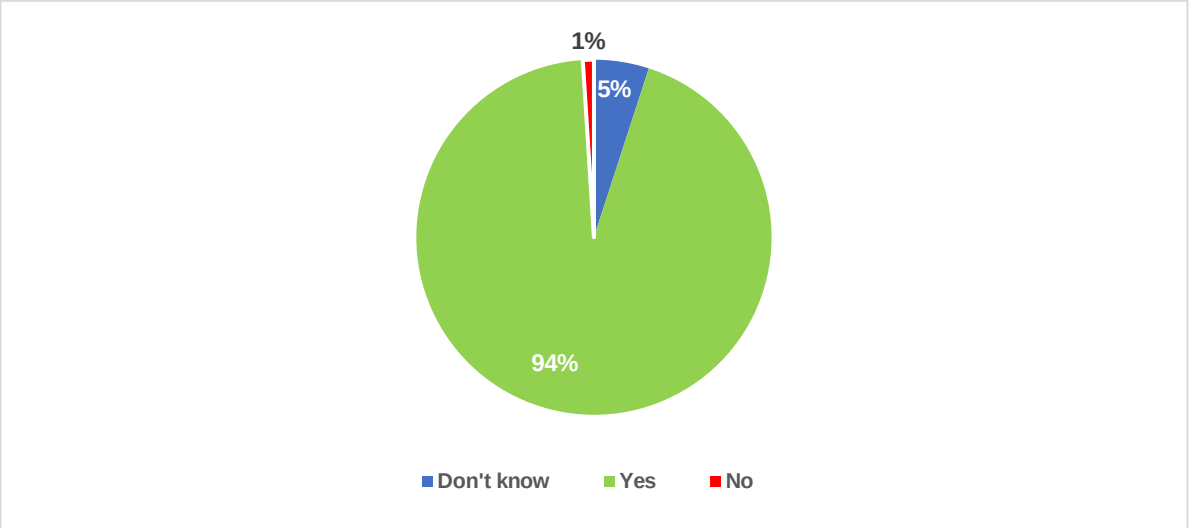

Figure 4.6: Household responses to transmission of rabies to humans (n=199)

Among the residents who indicated that rabies could be transmitted to people, the majority (69%) said it was transmitted through a bite or scratch by an animal, 17% said it was through direct contact with animal saliva and 13% said it was through both (Figure 4.7). Three respondents declined to answer any of the questions in Figure 4.7– 4.11; the total number of responders was 187 instead of two hundred.

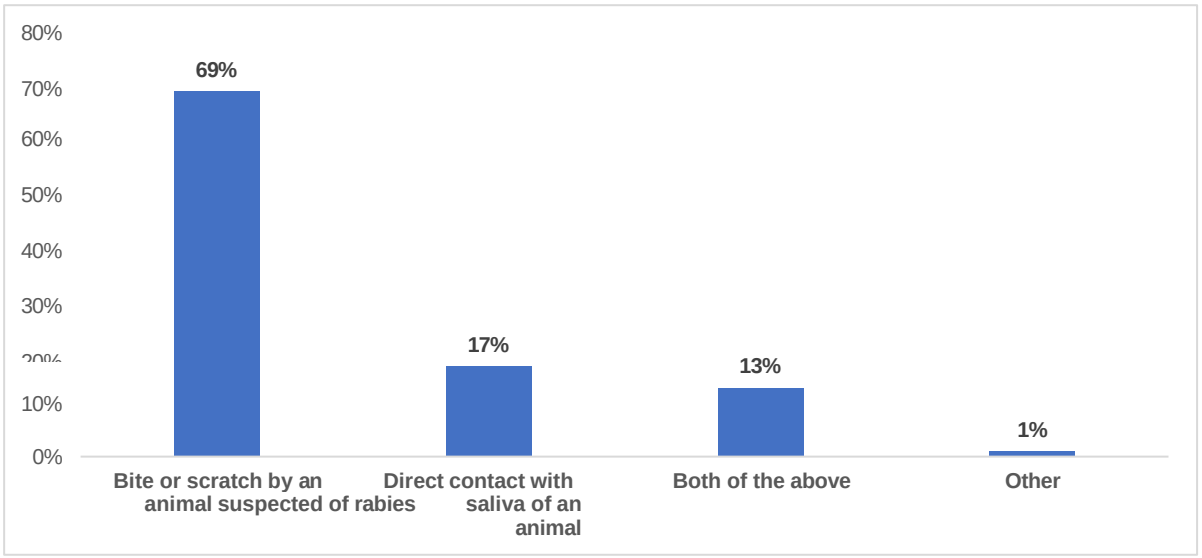

Figure 4.7: Responses indicating routes of rabies transmission (n=187)

The percentage of residents who believed rabies could be treated was 84% while 12% said it could not be treated and 4% were not sure (Figure 4.8).

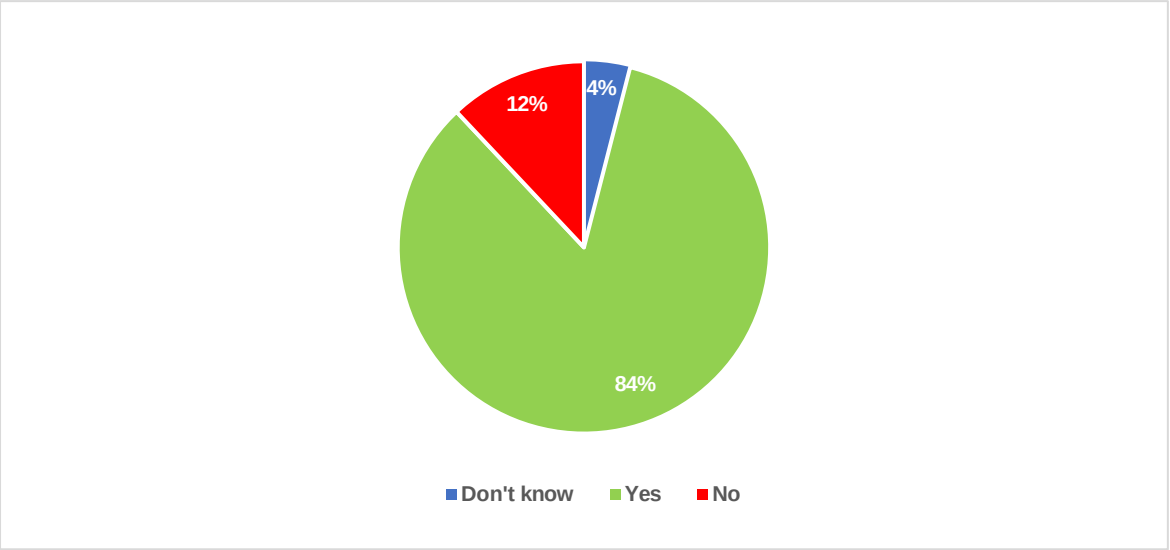

Figure 4.8: Responses to rabies treatment (n=187)

The percentage of residents who believed vaccination of animals could prevent rabies was 92% against 4% who did not believe so and another 4% who indicated that they did not know (Figure 4.9).

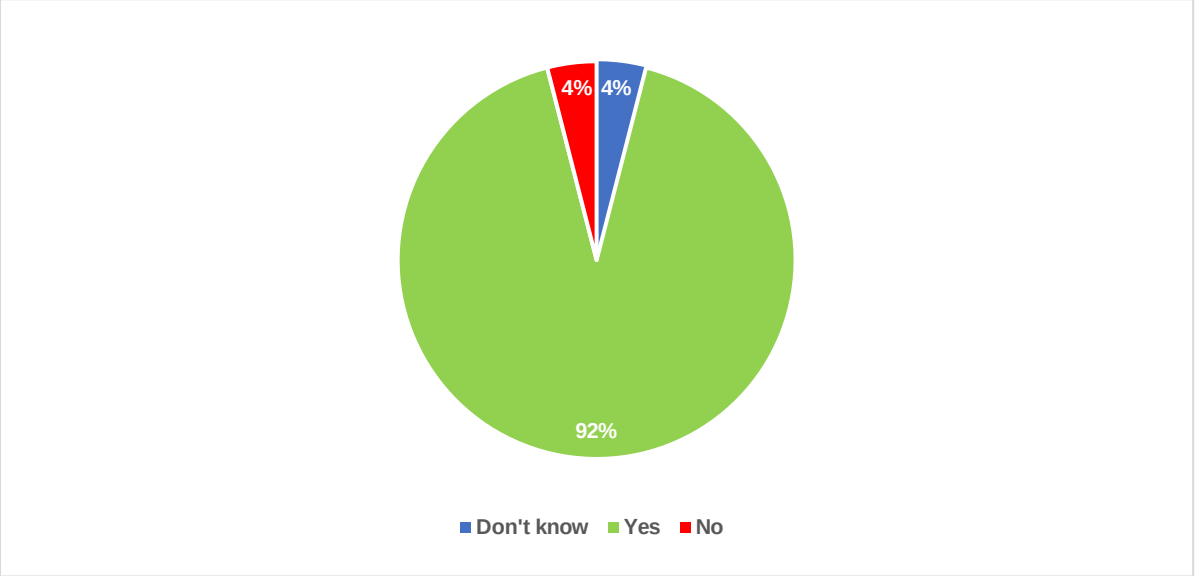

Figure 4.9: Responses as to vaccination of animals preventing rabies in humans (n=187)

Most (76%) residents believed that rabies was curable while 15% said it was not curable and 9% did not know (Figure 4.10).

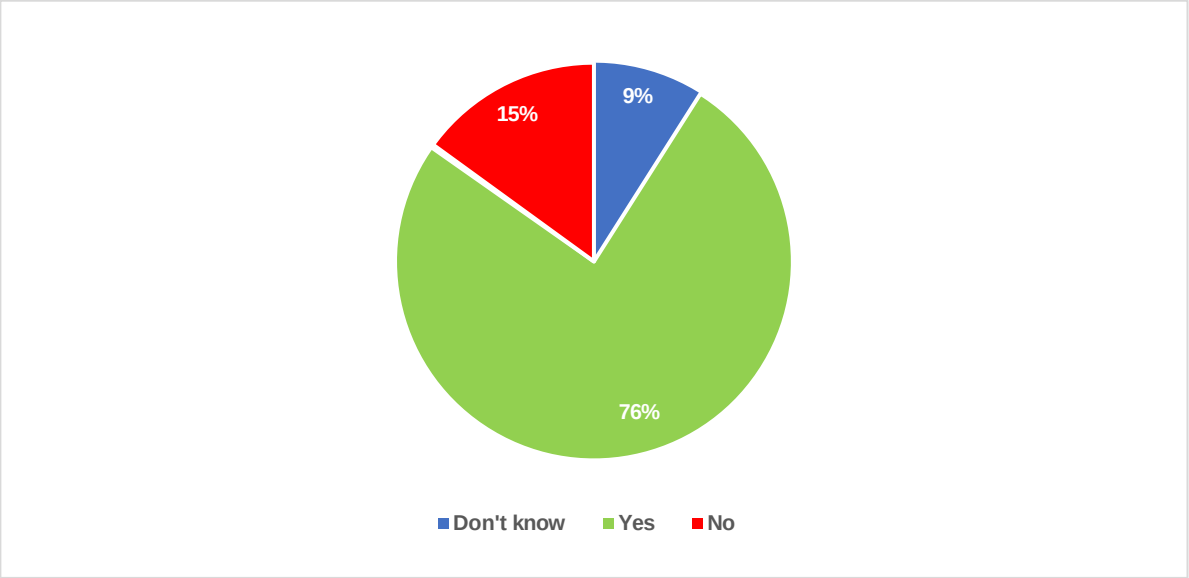

Figure 4.10: Responses as to whether rabies is curable or not (n=187).

The majority (92%) of the respondents answered that the administration of adequate prophylactic treatment at a hospital or a clinic could prevent the development of rabies in a person bitten by an animal, while 8% disagreed with this statement (Figure 4.11)

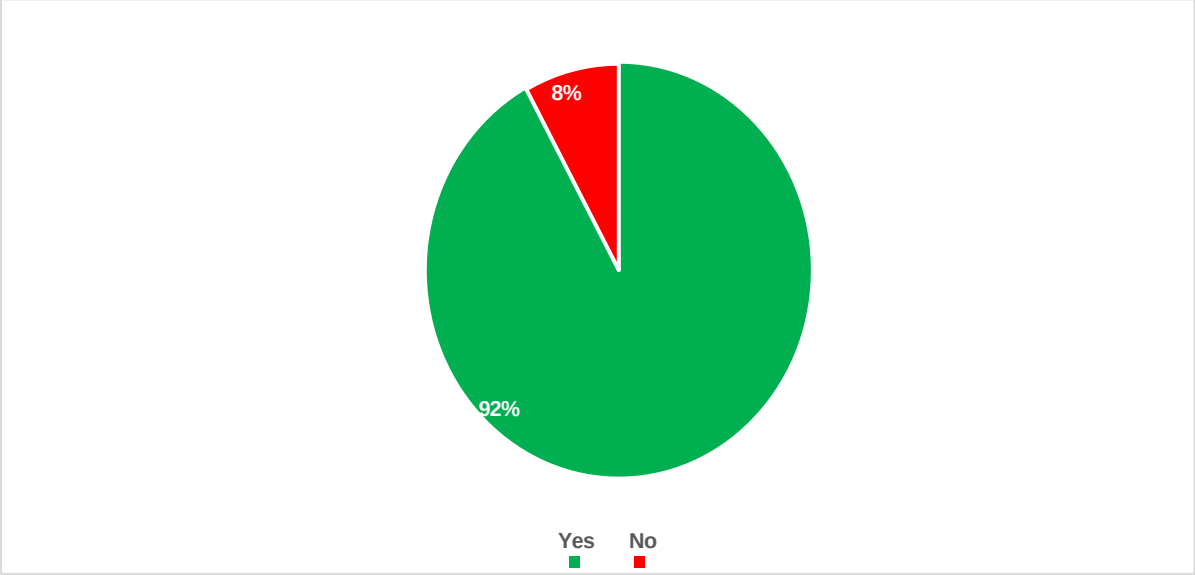

Figure 4.11: Proportion of views on administration of prophylactic treatment (n=187).

In Figure 4.12 and 4.13, four respondents declined to respond (n=186). All the respondents (100%) felt the elimination of stray pets such as dogs and/or cats could reduce the transmission of rabies in the communities (Figure 4.12).

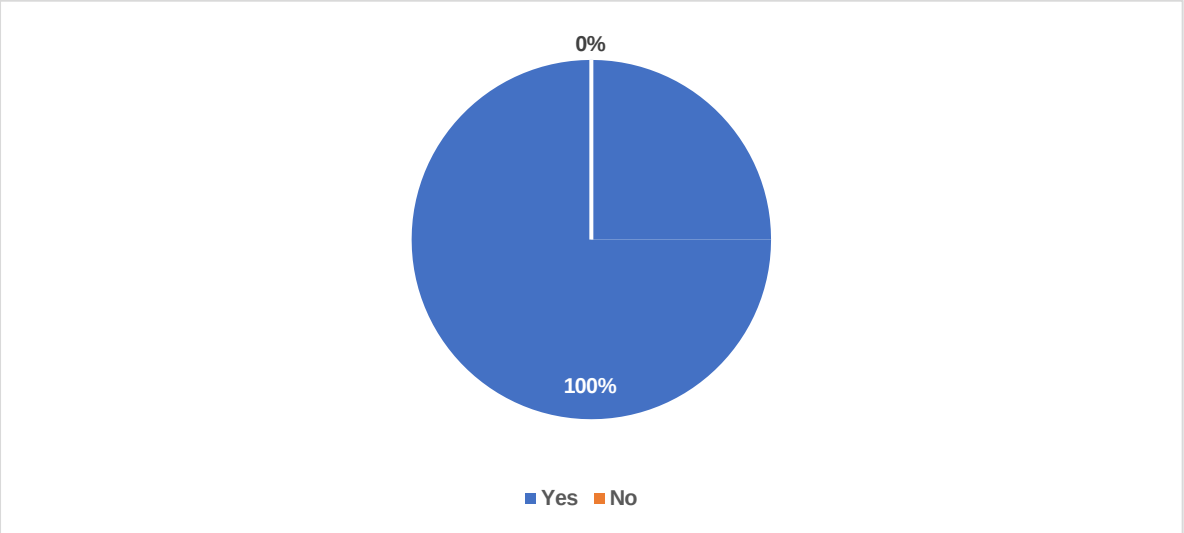

Figure 4.12: Views on elimination of stray pets such as dogs/cats (n=186)

The majority of the respondents (84%) did not know the institution in their area were they could obtain a rabies vaccine for dogs (Figure 4.13).

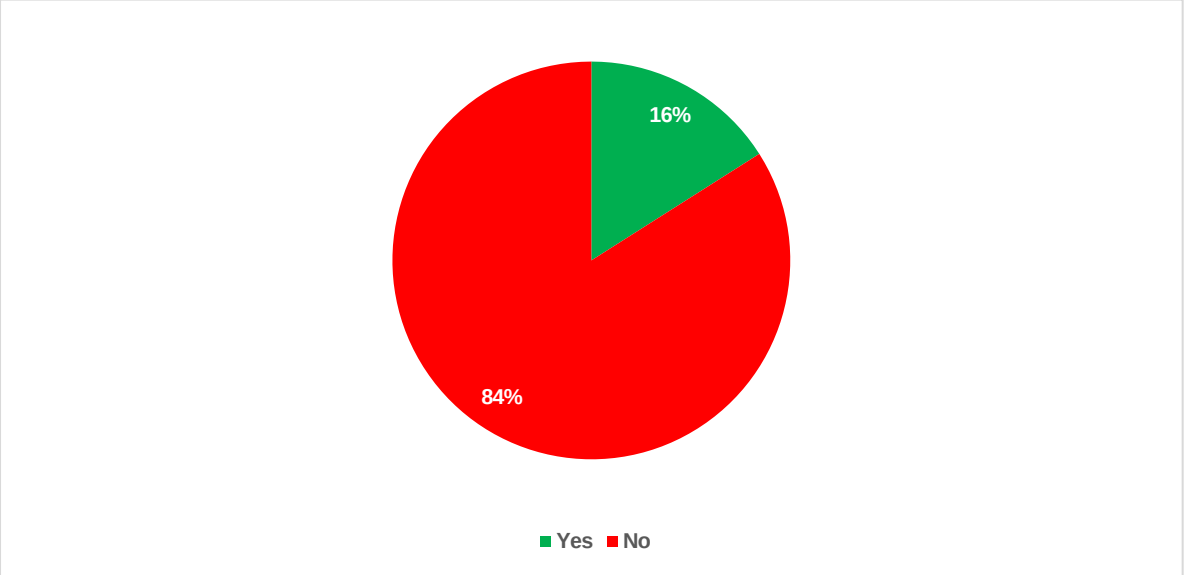

Figure 4.13: Proportion of respondents aware of institutions providing vaccines (n=186).

Among the residents who were aware of the institution in their area where a rabies vaccine for dogs could be obtained, a significant majority (55%) identified the veterinary clinic as the primary source (Figure 4.14). A notable proportion of respondents (14%) also mentioned that rabies vaccines for dogs could be obtained from medical practitioners. Similarly, 14% of the respondents indicated that veterinary services were another avenue for obtaining rabies vaccines.

A minority of respondents (7%) mentioned that rabies vaccines for dogs could be obtained from the Society for the Prevention of Cruelty to Animals (SPCA) and Koöperasie Winkel (co-operative shop).

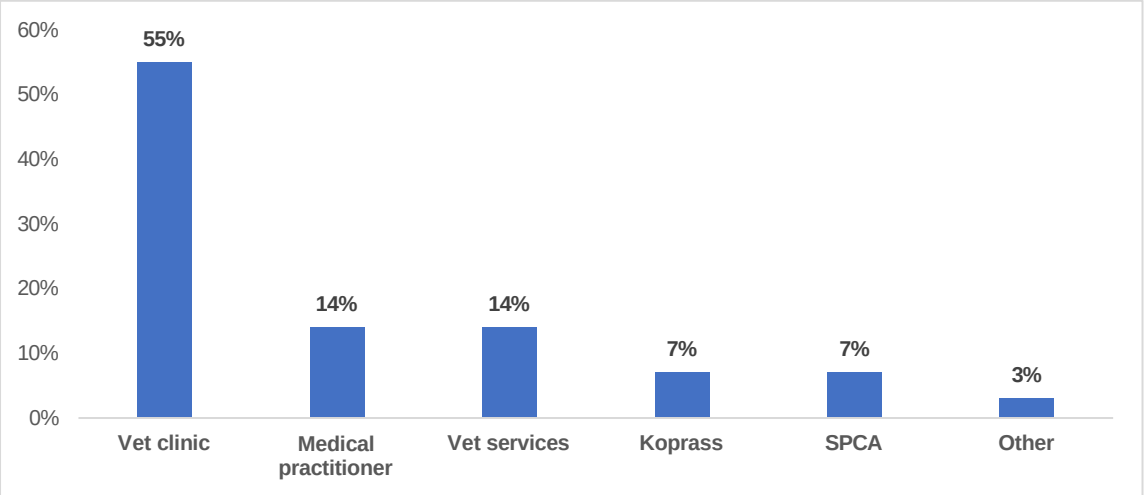

Figure 4.14: Percentage of responses based on where to access a rabies vaccine (n=99).

4.4 Attitude and practices towards rabies

In the event of a child being bitten by a dog, 92% of the residents indicated that they would immediately look for help at a clinic or hospital. Only 5% indicated that they would wash the wound immediately and 2% indicated that they would do nothing about it. The remaining 1% of respondents said that they would cut off the animal fur, burn it, and apply it to the wound. (Figure 4.15)

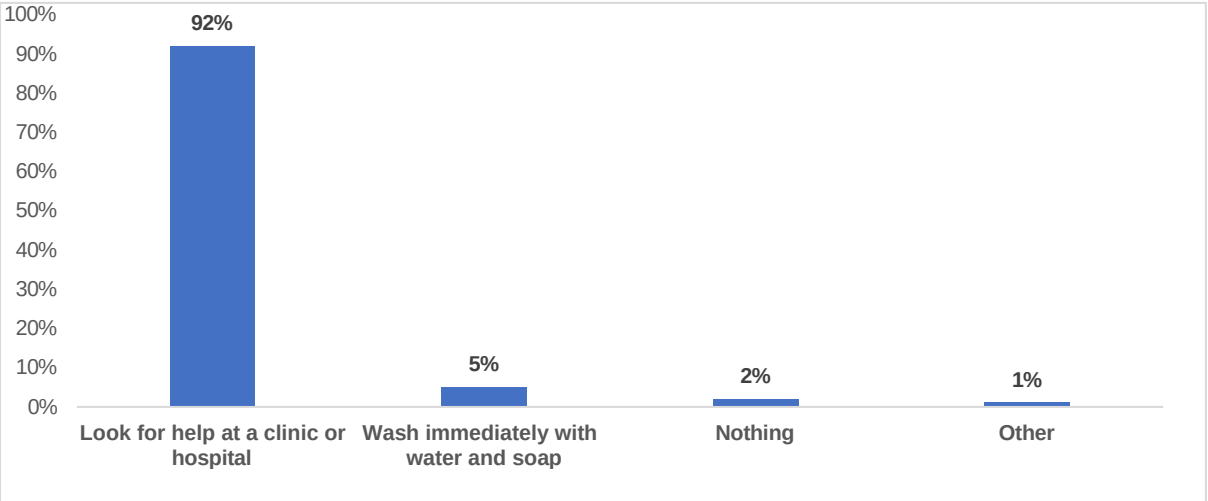

Figure 4.15: First response in event of a child being bitten by a dog (n=476)

About three quarters (65%) of the respondents indicated that they would resort to killing the dog if they or their child was bitten by a dog while 8% would take the animal to the vet. Extremely few respondents indicated that they would check if the animal has been vaccinated (1%) or observe the animal for signs of rabies (1%) (Figure 4.16).

Other actions mentioned by some respondents (25%) included tying up the dog, leaving a note at the gate (beware of the dogs), tying it to the tree and not feeding it until it dies, poisoning it, giving it to farmers/someone, selling it, calling SPCA/police, abandoning it in the bushes/rivers, informing agriculture/veterinary officials, and purchasing medicine/vaccine. Other respondents stated that they would discuss appropriate action with their neighbours, while others stated that they would do nothing to the dog.

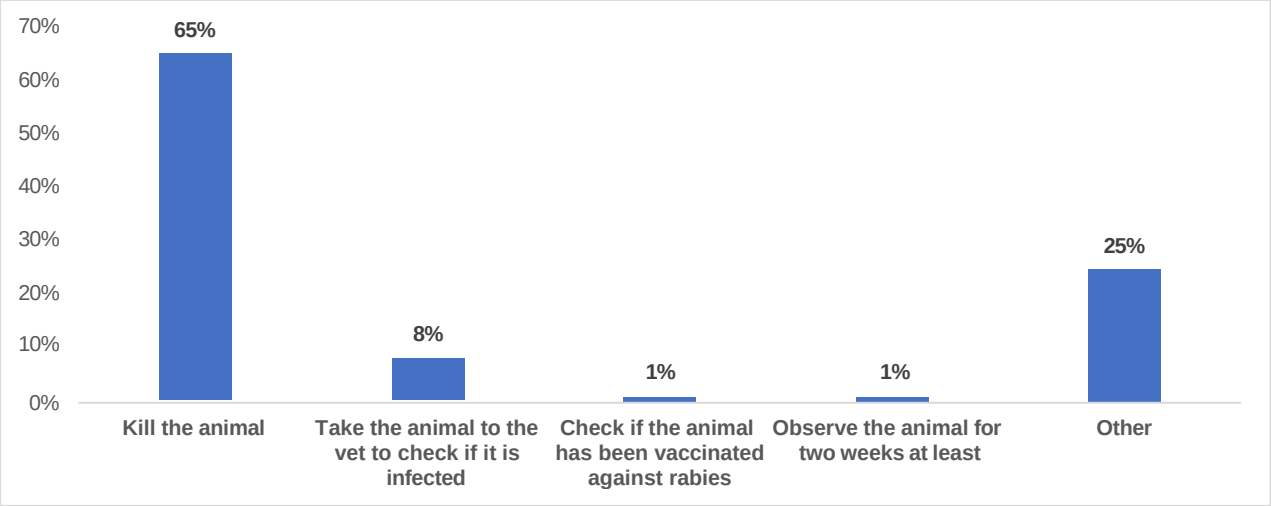

Figure 4.16: Action to be taken on dogs after being bitten (n=475)

Most of the residents (83%) indicated that they would alert local health authorities if they suspected someone had been bitten by a dog. However, 7% of the respondents stated they would not take any action, and additionally 10% were unsure about what they would do (Figure 4.17).

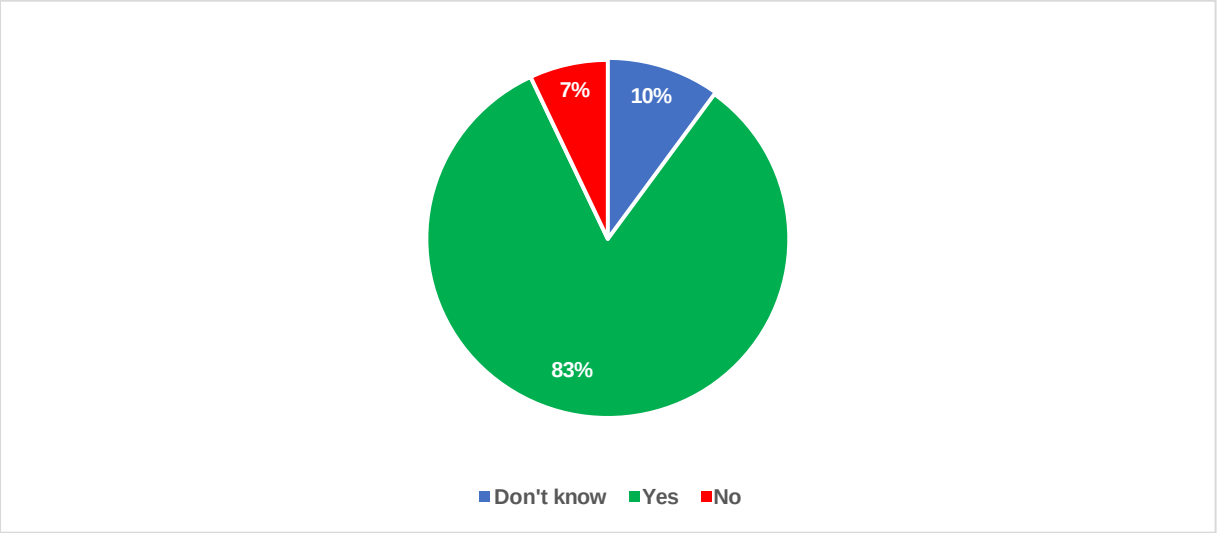

Figure 4.17: Alert local health authorities if they suspect someone had been bitten by a dog (n=474)

Half of the residents never discussed rabies prevention with their families or neighbours. However, 42% did so sometimes and only 8% indicated that they often did discuss rabies with their family members (Figure 4.18).

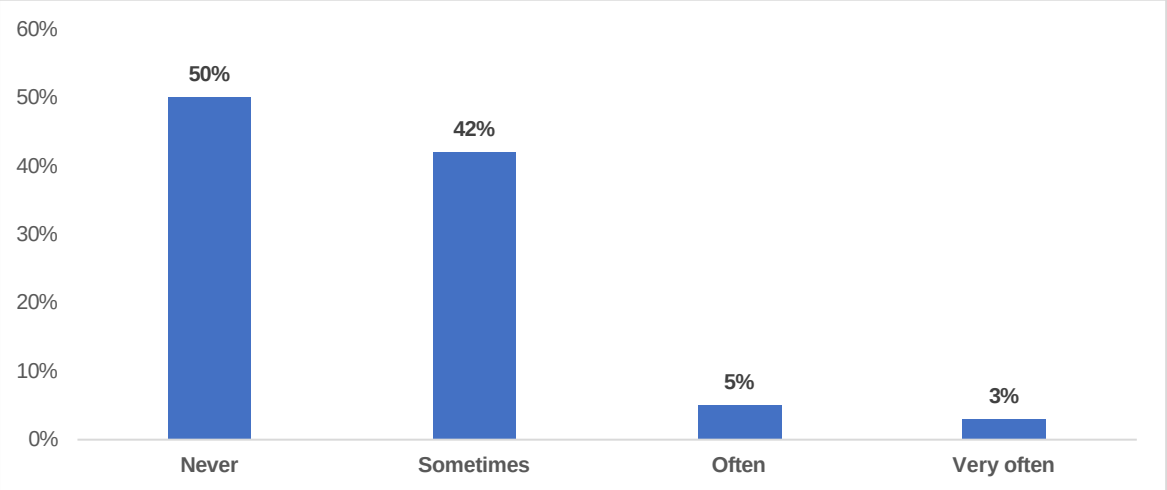

Figure 4.18: Discussion of rabies prevention with family and neighbours (n=211)

A total of 16% of the study participants had been bitten by a dog before, while 84% had not been bitten by a dog (Figure 4.19).

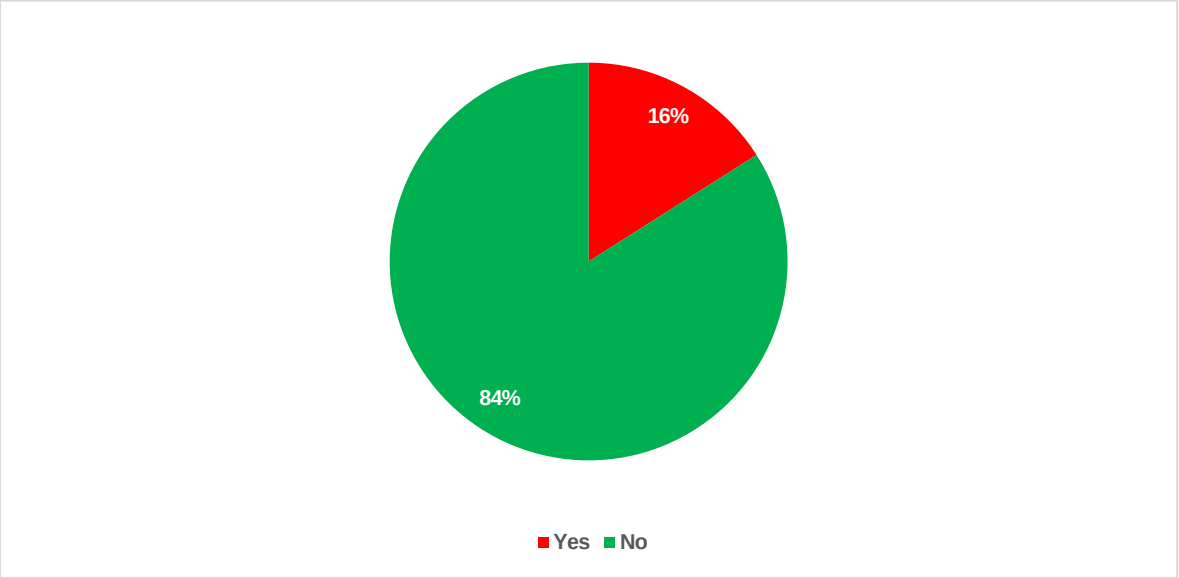

Figure 4.19: History of being bitten by a dog (n=473)

Among residents who had been bitten by a dog before, 45% sought medical assistance, 17% immediately washed the bite wound with water and soap but as many as 24% did nothing about it (Figure 4.20). Of these, 14% mentioned other practices such as cutting the fur of the animal, burning the fur, and applying the ashes on the wound being the main practice, using saliva and pasting on the wound, using toothpaste to treat the wound and using traditional medicine.

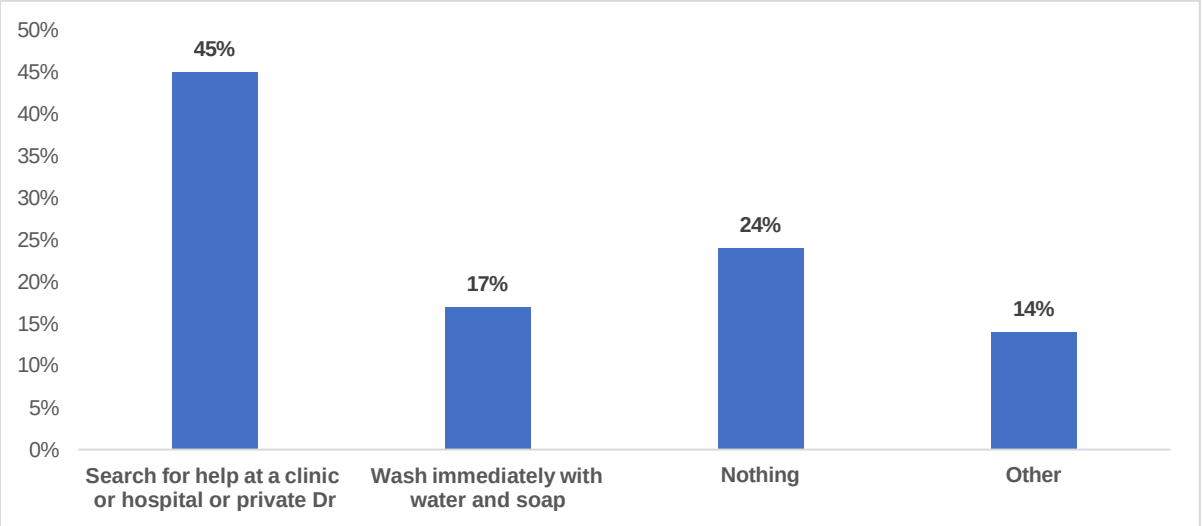

Figure 4.20: Action taken after being bitten by a dog (n=76)

Among those who had been bitten by a dog before, only 46% indicated that they had received preventive rabies treatment. The rest (54%) did not go to receive preventive rabies treatment following a dog bite (Figure 4.21).

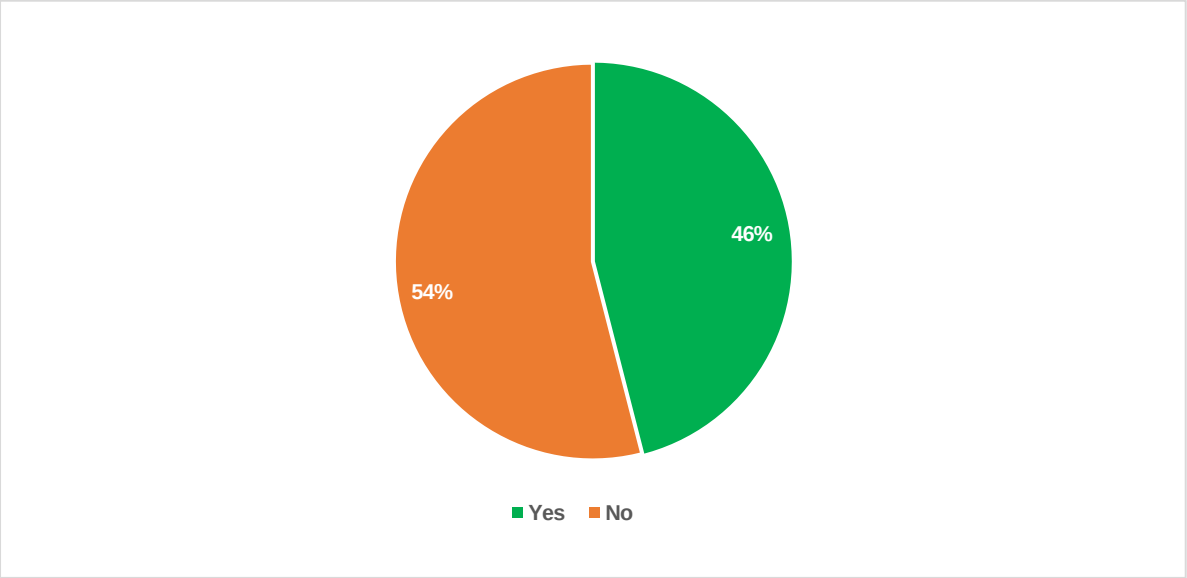

Figure 4.21: Receiving of preventive rabies treatment (n=70)

Among those who had received preventive rabies treatment after being bitten by a dog, 75% had received all doses of the treatment. The rest (25%) did not complete the dose (Figure 4.22).

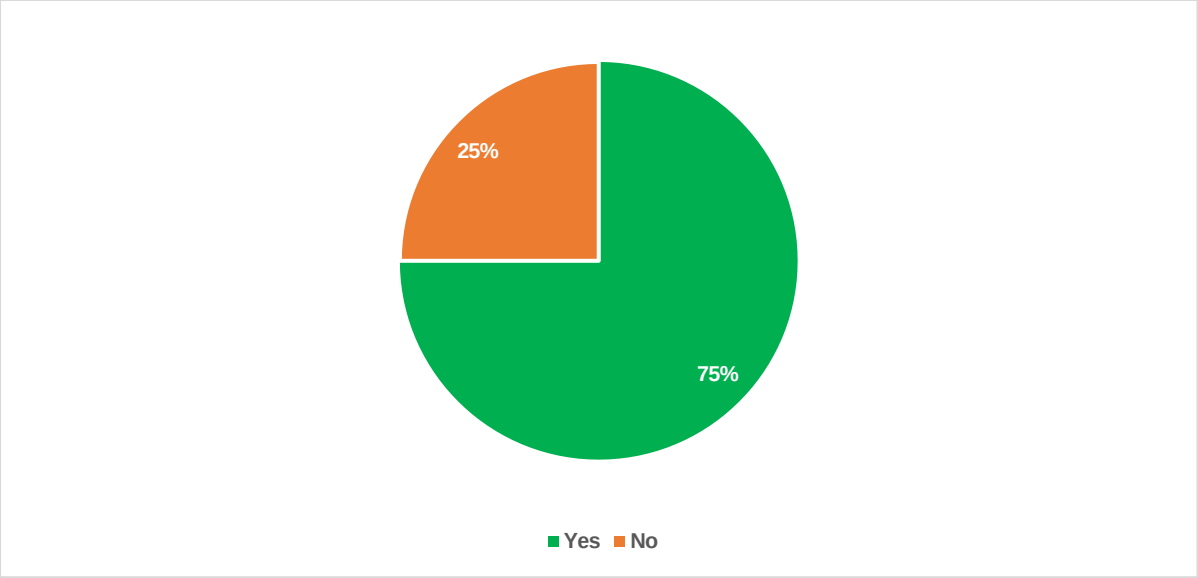

Figure 4.22: Receiving of all doses of rabies treatment (n=32)

Reasons given by respondents for failing to receive all doses of post exposure treatment included the hospital being out of stock (33%) and thinking that it was not necessary to take all the doses (45%) (Figure 4.23). The reason mentioned under other (11%) was that the individual who was bitten healed in two days and so did not need further treatment.

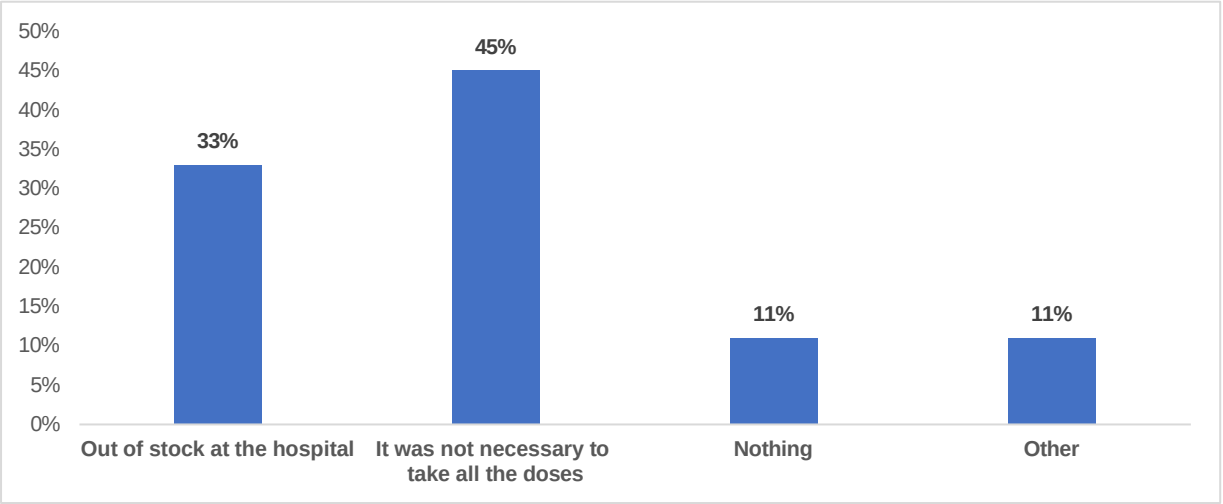

Figure 4.23: Reasons for not completing all doses of rabies treatment (n=9)

If they had to be referred to another hospital for medication following a dog bite, the majority (87%) indicated that they would go for the sake of getting the vaccine, while 8% indicated that they would opt to go back home without getting the vaccine (Figure 4.24). Under the category of other, some respondents (3%) mentioned that they must be given the name of the medication they will buy, they must be transported to another clinic/hospital, they will wait for availability at the local clinic/hospital, use other treatment and lastly that it will depend on whether they have money or not to transport themselves to that other hospital.

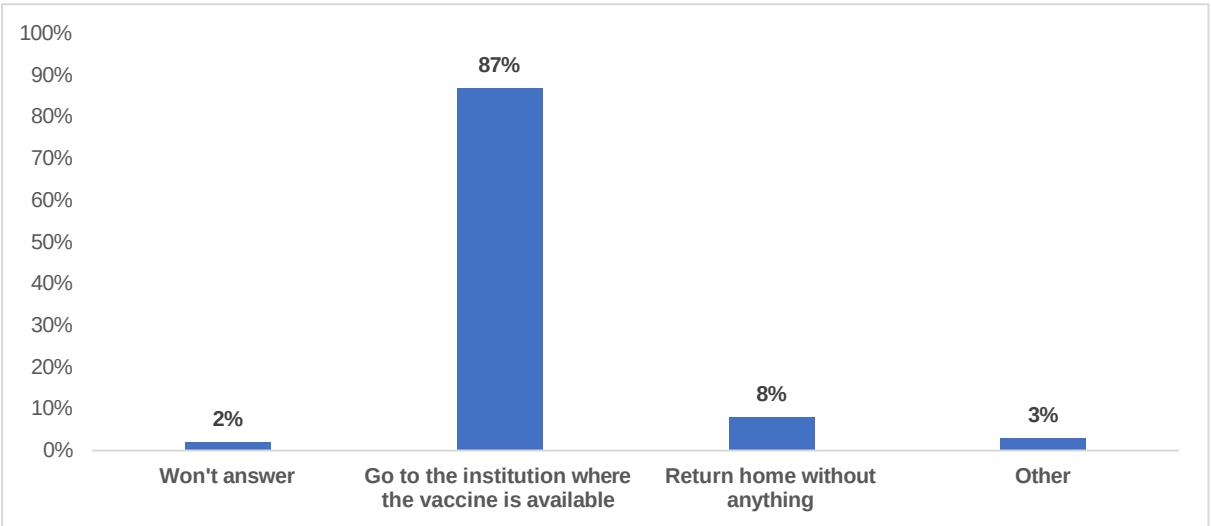

Figure 4.24: Action to be taken by respondents in a situation where the local institution does not have vaccine and they are referred to another institution (n=472).

4.5 Interventions against Rabies

Just above two thirds (68%) of the residents had not been exposed to rabies prevention messages in the media over the past year. Only 32% of the respondents indicated that they had heard messages about rabies prevention over the past year (Figure 4.25).

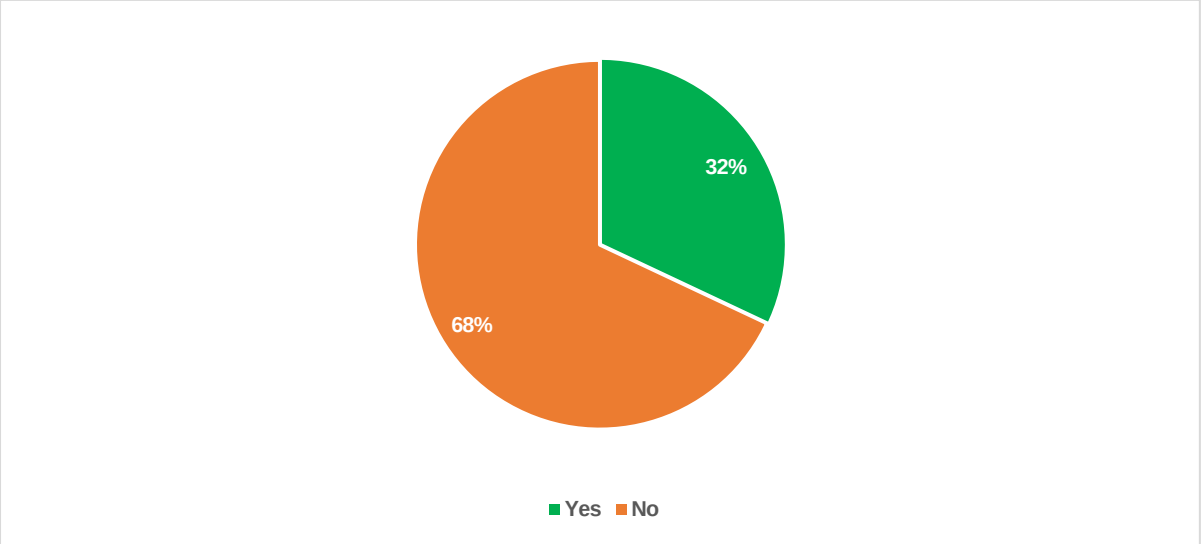

Figure 4.25: Proportion of respondents who indicated that they had been exposed to rabies prevention messages on media within the past year (n=476).

Concerning hearing messages about rabies in the past 30 days, 3% of residents indicated that they had heard about rabies on the radio, while 2% had heard about rabies through veterinary services officials. The majority (95%) indicated that they had not been exposed to information about rabies in the last 30 days (Figure 4.26).

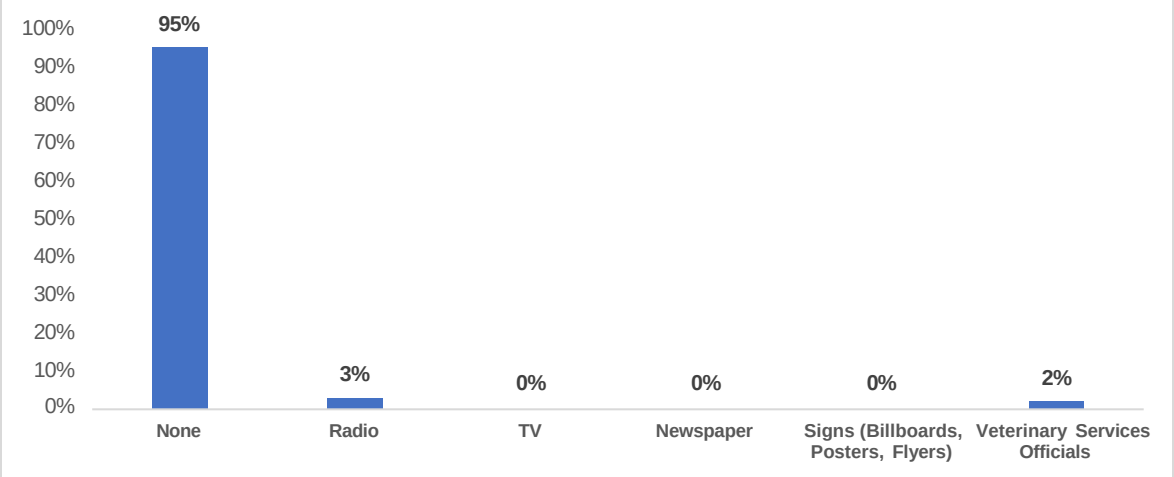

Figure 4.26: Proportion of respondents exposed to communication on rabies within the last 30 days (n=476)

As shown in Figure 4.27, veterinary services officials (40%) and TV (44%) were the most preferred ways of receiving information on the prevention of rabies. Billboards, posters, and flyers are not popular methods of receiving messages on the prevention of rabies. 2% under other mentioned schools and community meetings such as kgorong (Chief's place).

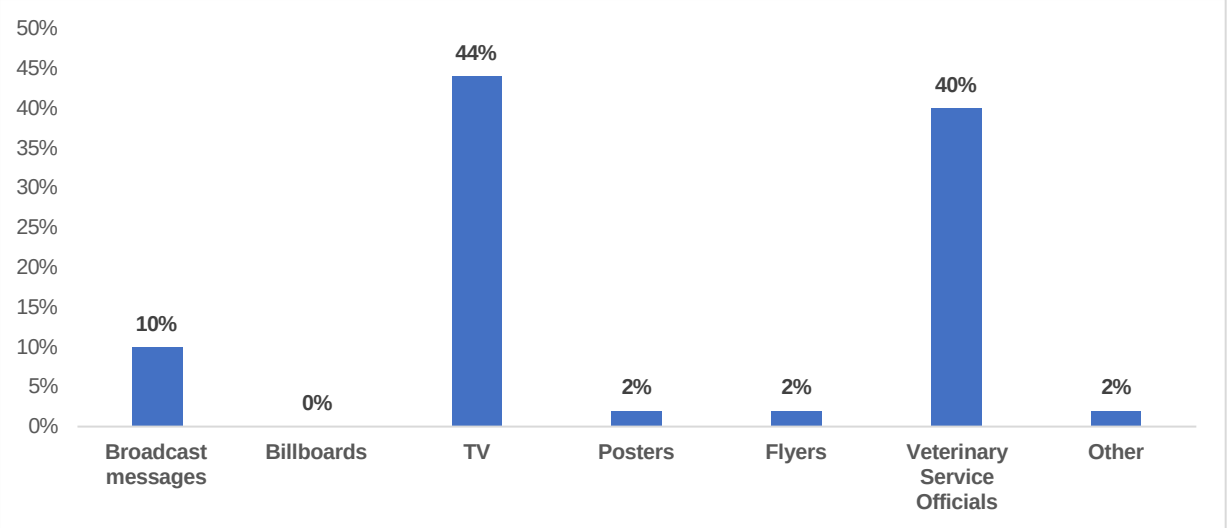

Figure 4.27: Preferred channels for receiving information on rabies prevention (n=475).

4.6 Factors associated with vaccination.

Up to 83% (95% CI = 78% - 88%) of the residents with pets in their households had not had their dogs and/or cats vaccinated against rabies. Only 16% (95% CI = 4% - 28%) had done so and 1% were not sure (Figure 4.28).

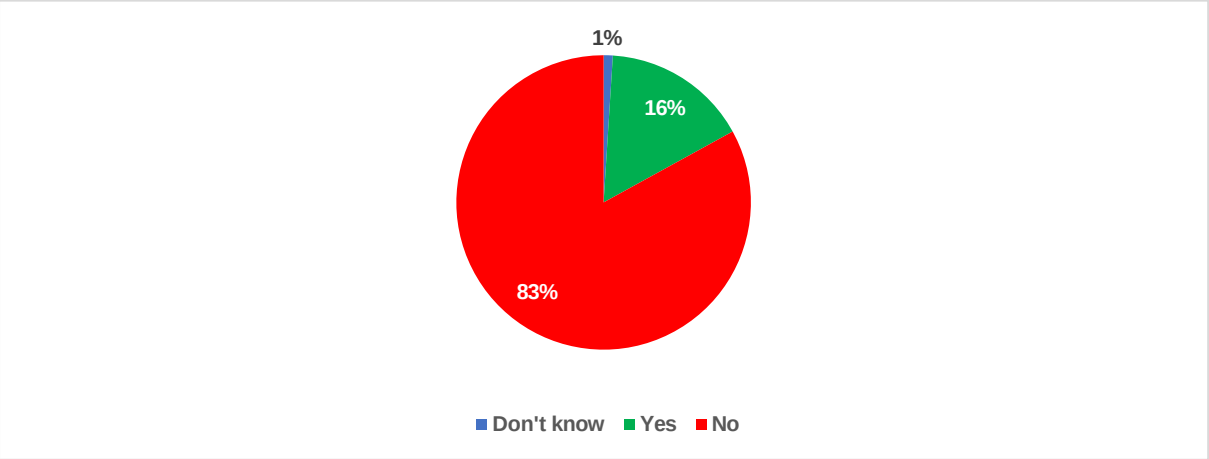

Figure 4.28: Percentage of households in the study population that had vaccinated their pets (n=234).

Out of the 16% of the respondents who indicated that their pets had been vaccinated against rabies (Figure 4.29), none of them was able to show proof of the vaccination. Forty one percent (41%) of the respondents, who indicated that their pets had been vaccinated, said that they had lost the vaccination certificates, while the remainder (59%) indicated that they did not have proof for the vaccination of their pets.

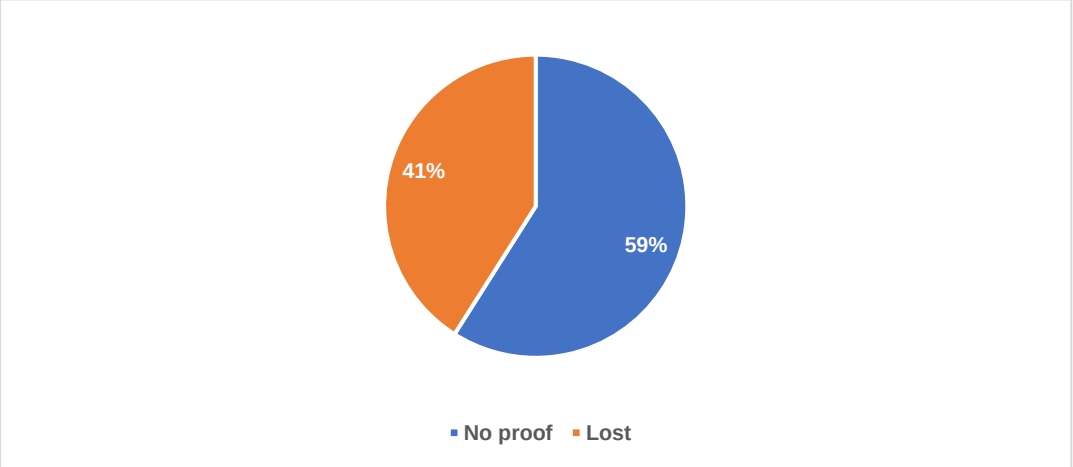

Figure 4.29: Percentage of households in the study population that indicated that their pets had been vaccinated (n=36).

There were differences in pet vaccination between the Main Places with Maololo (83%) having the highest number of households with vaccinated dogs/cats followed by Lekgwareng (40%) (Table 4.6). Meanwhile, in six of the Main Places, none of the respondents had vaccinated his/her dog/cat against rabies (Table 4.6).

Table 4.6: The proportion of residents by Main Place that indicated that their dogs/cats had been vaccinated against rabies (vaccination coverage) (n=234)

Main Place	Total (n)	Pets vaccinated against rabies		
		Yes % (n)	No % (n	Don't know %(n)
Maololo	18	83.3 (15)	11.1 (2)	5.6 (1)
Lekgwareng	10	40.0 (4)	50.0 (5)	10.0 (1)
Masakeng	20	20.0 (4)	80.0 (16)	0.0 (0)
Ga-Mosehla	6	16.7 (1)	83.3 (5)	0.0 (0)
Ngwaritsi	13	15.4 (2)	84.6 (11)	0.0 (0)
Dinotsi	14	14.3 (2)	85.7 (12)	0.0 (0)
Mosate B (Ga-Masemola)	8	12.5 (1)	87.5 (7)	0.0 (0)
Mashwanyaneng	17	11.8 (2)	88.2 (15)	0.0 (0)
Brooklyn	18	11.1 (2)	88.9 (16)	0.0 (0)
Ga-Molepane	19	10.5 (2)	89.5 (17)	0.0 (0)
Jane Furse	11	9.1 (1)	81.8 (9)	9.1 (1)
Ga-Seopela	15	0.0 (0)	100 (15)	0.0 (0)
Ga-Moloi	13	0.0 (0)	100 (13)	0.0 (0)
Maswiakae	13	0.0 (0)	100 (13)	0.0 (0)
Mohlarekoma	17	0.0 (0)	100 (17)	0.0 (0)
Polaseng	15	0.0 (0)	100 (15)	0.0 (0)
Tswatago	7	0.0 (0)	100 (7)	0.0 (0)

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There were significant differences in the vaccination of pets by household head type (p=0.01), age group (p=0.01), and household income (p=0.01). But there were no significant differences according to sex, education, or occupation (p>0.05). (Table 4.7)

Table 4.7: Vaccination coverage by owner demographics (n=234)

	n	Pets vaccinated against rabies (%)			Sig.
		Yes % (n)	No % (n)	Don't know % (n)	
Household head type					0.01
Male head	90	22.2 (20)	77.8 (70)	0.0 (0)	
Female head	111	13.5 (15)	85.6 (95)	9 (1)	
Other	33	3.0 (1)	90.9 (30)	6.1 (2)	
Sex					0.06
Male	103	20.4 (21)	79.6 (82)	0.0 (0)	
Female	131	11.5 (15)	86.3 (113)	2.3 (3)	
Age group					0.01
Below 30	14	0.0 (0)	92.9 (13)	7.1 (1)	
30-39	17	0.0 (0)	94.1 (16)	5.9 (1)	
40-49	48	8.3 (4)	91.7 (44)	0.0 (0)	
50-59	41	22.0 (9)	78.0 (32)	0.0 (0)	
60-69	64	28.1 (18)	71.9 (46)	0.0 (0)	
70 and older	50	10.0 (5)	88.0 (44)	2.0 (1)	
Education					0.83
None	33	9.1 (3)	87.9 (29)	3.0 (1)	
Primary	48	16.7 (8)	83.3 (40)	0.0 (0)	
Secondary	86	16.3 (14)	82.6 (71)	1.2 (1)	
Matric	57	14.0 (8)	84.2 (48)	1.8 (1)	
Tertiary	10	30.0 (3)	70.0 (7)	0.0 (0)	
Occupation					0.25
Unemployed	95	7.4 (7)	90.5 (86)	2.1 (2)	
Pensioner	104	20.2 (21)	78.8 (82)	1.0 (1)	
Employed	26	26.9 (7)	73.1 (19)	0.0 (0)	
Self employed	8	12.5 (1)	87.5 (7)	0.0 (0)	
Student	1	0.0 (0)	100 (1)	0.0 (0)	
Household income					0.01
None	1	0.0 (0)	100 (1)	0.0 (0)	
< R3500	161	11.2 (18)	88.2 (142)	6 (1)	
> R3500 - R9 999	50	22.0 (11)	76.0 (38)	2.0 (1)	
>R10 000	16	37.5 (6)	62.5 (10)	0.0 (0)	
Won't Answer	6	16.7 (1)	66.7 (4)	16.7 (1)	

The percentage of owners whose pets had been vaccinated against rabies was significantly higher among those who were considered to be knowledgeable about rabies (39%) compared to those without the knowledge of rabies (17%) (p=0.01) (Table 4.8).

Table 4.8: Vaccination coverage according to knowledge of rabies (n=120)

	Vaccination coverage		95% CI		P-value
	n	%	Lower	Upper	
Knowledgeable about rabies	83	39	29%	49%	0.01
Not knowledgeable about rabies	117	17	10%	24%	

The results of the multivariable binary logistic regression model revealed interesting associations between certain factors and the vaccination of pets in the study area (Table 4.9).

Among the eight variables initially considered, education and previous history of being bitten by a dog did not show significant associations with pet vaccination and were subsequently dropped from the initial univariable logistic regression model (were dropped from the next step in the modelling).

However, six variables, namely age group, sex, occupation, household income, exposure to rabies prevention messages, and knowledge about rabies, remained as covariates in a multivariable binary logistic regression model (Table 4.9). The results of the adjusted odd ratios for vaccination of pets are presented in Table 4.10.

Exposure to rabies prevention messages was found to be a strong predictor of pet vaccination. Respondents who had been exposed to such messages were seventeen times more likely to vaccinate their dogs and cats compared to those who had not been exposed (OR: 16.827; 95% CI: 2.151-131.641) (Table 4.9 & Table 4.10).

Additionally, knowledge about rabies was also significantly associated with pet vaccination. Owners who demonstrated knowledge about rabies were 3 times more likely to have their pets vaccinated compared to those who lacked this knowledge (OR=3.233, 95% CI: 1.331 – 7.850) (Table 4.9 & Table 4.10).

Table 4.9 Variables in the Equation – First model

Covariates	Sig.	Exp(B)	95% CI for Exp(B)	
			Lower	Upper
Age group	.758			
Age group (1)	.999	127408232.616	0.000	
Age group (2)	.999	224749332.414	0.000	
Age group (3)	.966	.931	.037	23.722
Age group (4)	.741	.607	.032	11.638
Age group (5)	.146	.288	.054	1.542
Sex (1)	.235	2.137	.610	7.490
Occupation	.221			
Occupation (1)	.785	.626	.022	18.038
Occupation (2)	.248	.128	.004	4.188
Occupation (3)	.141	.080	.003	2.316
Household Income	.499			
Household Income (1)	.596	2.209	.118	41.505
Household Income (2)	.939	1.126	.053	23.701
Household Income (3)	.680	.444	.009	21.048
Exposure to rabies prevention messages (1)	**.006**	**24.307**	**2.444**	**241.770**
Knowledgeable about rabies (1)	**.002**	**7.715**	**2.060**	**28.892**
Constant	.744	2.254		

Table 4.10: Adjusted odds ratio for vaccination of pets#.

Covariates	**Sig.**	**Exp(B)**	**95% CI**	
			Lower	**Upper**
Knowledgeable about rabies (1)	.010	3.233	1.331	7.850
Exposure to rabies prevention messages (1)	.010	16.827	2.151	131.641
Constant	.958	1.017		

*p<0.05, Exp (B) = adjusted odds ratio (OR)
#The model was a good fit to the data (Hosmer and Lemeshow = 2.210, p=.346)

CHAPTER 5: DISCUSSION

This study provides the first assessment of KAP towards rabies in the MLM. It also sheds light on the vaccination coverage status and factors associated with pet vaccination in the study area. The findings reveal important insights into the gaps and opportunities for improving rabies control efforts.

The study found that just under half of the respondents (42%) were aware of rabies as a disease. While this level of awareness is relatively low, it is important to note that most respondents who were aware of rabies demonstrated knowledge of its transmission to humans via a bite (94%) and the preventability of the disease (84%). However, a small percentage of respondents (14%) indicated that the vaccine for animals can be obtained from medical practitioners, suggesting a lack of information about access to rabies vaccines for pets. This highlights the need for improved dissemination of information regarding the availability and sources of rabies vaccines.

Another important finding is the poor practice of wound treatment after a dog bite. Only 5% of the respondents indicated that they would wash the wound immediately before seeking medical help. Similarly, a significant proportion of respondents (24%) who had been bitten by a dog reported doing nothing after the incident. These findings underscore the need for education and awareness campaigns emphasizing the importance of immediate wound cleaning and seeking healthcare post-bite. Proper wound treatment is crucial in preventing the onset of rabies and reducing the risk of infection.

In terms of vaccination coverage, the study revealed that only an exceedingly small percentage of respondents (16%) had vaccinated their pets against rabies. This falls far below the 70% coverage recommended by the WHO to prevent animal-to-human transmission (Coleman and Dye 1996). However, there was a significant association between the level of vaccination coverage and knowledge of the disease. Residents who were considered knowledgeable about rabies were more likely to vaccinate their pets compared to those who lacked knowledge. Again, this highlights the importance of education in promoting responsible pet ownership and the need for targeted efforts to improve knowledge and awareness about rabies.

Additionally, the study found a significant association between the level of vaccination

coverage and exposure to rabies communication messages. Respondents who had been exposed to such messages were seventeen times more likely to vaccinate their pets compared to those who had not been exposed to these messages. This highlights the effectiveness of communication campaigns in providing information (knowledge) to promote behaviour change (attitude) leading to an increase in vaccination coverage (practice). It underscores the importance of leveraging various communication channels, such as television and engagement with veterinary services officials, to disseminate rabies-related information more effectively.

Comparisons with a study conducted in rural villages of Sri Lanka reported higher levels of knowledge (94.5%), more positive attitudes, and better indicators of rabies prevention practices (Matibag *et al.* 2009). The respondents in the current study who had knowledge were lower at 42%. This difference can potentially be attributed to the utilization of information and education campaign (IEC) materials in Sri Lanka, which most respondents found to be useful (Matibag *et al.* 2009). The use of targeted educational materials and campaigns can significantly contribute to enhancing KAP toward rabies prevention (Ngigi and Busolo 2018).

However, in the present study, a strikingly low percentage of people (5%; n=24) considered wound cleaning as beneficial, the findings from Sri Lanka revealed a contrasting result. In Sri Lanka, most participants (77.1%) recognized the importance of adequate wound washing after dog bites (Matibag *et al.* 2009). This stark contrast highlights the limited understanding of the importance of rabies prevention measures among the respondents in the current study.

Moreover, the overall dog vaccination rate was generally low in the study area, with only 16% (n=36) of respondents reporting that they had vaccinated their pets against rabies. However, there was variation in the vaccination rate among different Main Places. Maololo had the highest number of vaccinated pets, with 83% (n=15) of respondents indicating that their pets had been vaccinated, followed by Lekgwareng with a vaccination rate of 40% (n=4). On the other hand, six Main Places (35%; n=6) reported zero vaccination coverage. This pattern of uneven coverage is consistent with the findings of a KAP study conducted in Ethiopia, which also reported low vaccination coverage of 20% in some areas and zero coverage in others (Jemberu *et al.* 2013). Lack of awareness about dog vaccination campaigns and limited access to

vaccines were cited as reasons for the low coverage in the Ethiopian study. Similar explanations may apply to the findings of the present study, as most (84%; n=156) respondents who were aware of rabies did not know about the institutions that provide rabies vaccines.

Interestingly, during the study data collection, respondents revealed that a rabies case had recently been reported in Maololo, prompting officials from the State Veterinary Services to have a rabies vaccination campaign in the area and vaccinating the community pets. However, despite this intervention, the proportion of knowledgeable respondents in Maololo was still low (47%) compared to Ga-Mosehla, which had the highest number of knowledgeable respondents (83%). This suggests that although a vaccination campaign was conducted following the outbreak, the community members were not adequately educated about the disease and its prevention measures. This may be ascribed to the methods adopted by health officials. Normally during vaccination campaigns, officials choose a suitable site in communities such as schools, where they set up a vaccination tent/gazebo/mobile unit for vaccinations. Most official cars in the health and veterinary units are fitted with loudspeakers and sirens which they can use while they drive around communities to inform them to bring their pets for vaccination at the selected spot. Other means of spreading information about vaccination may involve the distribution of pamphlets, or by informing school children or residents at community meetings. In addition, officials may conduct door-to-door visits, but this is normally associated with farm areas where houses are far apart.

Knowledge about rabies

Knowledge about rabies is an important aspect to assess when understanding the preparedness and preventive measures taken by communities. In this study, it was found that most respondents (42%; n=200) had limited awareness of rabies as a disease. This finding is lower compared to other KAP studies conducted in various parts of the world, where the knowledge about rabies was reported to be higher, such as in Ethiopia (64%), Tanzania (96%), Nigeria (82%), and India (96%) (Edukugho *et al.* 2018; Guadu, Shite and Chanie 2012; Sambo *et al.* 2014; Tiwari *et al.* 2019). The lack of community awareness regarding rabies is likely the main reason for the lower-than- expected knowledge observed in this study when compared to other relevant studies. This lack of awareness about rabies could pose a risk to both human

and animal health, as it may lead to delayed recognition of rabid animals and hinder the adoption of preventive measures.

When asked to describe rabies, the respondents in this study provided varied responses. Approximately 35% (n=167) categorized rabies as an abnormal change in behaviour or aggression, while 7% (n=33) described it as an infectious and fatal viral disease. These findings are consistent with a study conducted in Ethiopia, where 100% of respondents were aware of what rabies is, but only 16% recognized that rabies is caused by a virus, and like our study, the majority described it as madness (Yalemebrat, Bekele, and Melaku 2016).

Among those who were aware of rabies, the majority (87%; n=173) mentioned dogs as the primary spreader of the disease. Only 12% (n=24) mentioned both dogs and cats as potential spreaders, while 1% (n=2) believed cats were the sole spreaders of rabies. None of the other animals such as cows, horses, bats, mongooses etc. were mentioned as potential spreaders. This finding contrasts with the results reported in other studies conducted in Ethiopia and Rwanda, where respondents were aware that other animals besides dogs and cats can also spread rabies (Guadu, Shite and Chanie 2012; Ntampaka Id *et al.* 2019).

A significant proportion of respondents who were aware of what rabies is (94%; n=187) demonstrated a high level of awareness that rabies is a zoonotic disease, meaning it can be transmitted from animals to humans. This figure is higher compared to reports from Tanzania and Ethiopia, which reported awareness levels of 70% and 56%, respectively (Bihon, Meresa, and Tesfaw 2020; Sambo *et al.* 2014). It is encouraging to see a high level of awareness among respondents regarding the zoonotic nature of rabies, as this knowledge is essential for taking appropriate preventive measures.

Regarding the transmission routes of rabies, most respondents (69%, n=137) correctly identified animal bites as the main route of transmission from animals to humans. This result aligns with research conducted in Ethiopia, where 75% of respondents believed that animal bites were the primary method of transmitting rabies to humans (Ali, Ahmed, and Sifer 2013). Additionally, 17% of respondents in this study mentioned that direct contact with the saliva of an animal suspected of having rabies could lead to infection. It is worth noting that 13% of respondents recognized that both direct contact

with saliva and animal bites were potential methods of transmission. This level of understanding demonstrates commendable awareness among respondents, as rabies is primarily transmitted to humans through bites from rabid animals, but exposure can also occur through the contamination of open wounds or mucous membranes with rabid animal saliva.

Improving knowledge about rabies is crucial for promoting preventive practices and reducing the risk of transmission (Shite *et al.* 2015). Public health authorities and relevant stakeholders should focus on educational campaigns that emphasize the zoonotic nature of rabies, the importance of prompt medical attention after animal bites, and the significance of proper wound cleaning. By addressing gaps in knowledge and providing accurate information about rabies transmission and prevention, communities can be better equipped to protect themselves and their pets from this deadly disease.

The study revealed that a significant percentage of respondents (84%; n=157) believed that rabies could be treated, while 12% (n=22) expressed the belief that it could not be treated, and 4% (n=7) were unsure. Moreover, most responders (92%; n=172) believed that administering sufficient preventative care could prevent a person bitten by an animal from contracting rabies, while 8% (n=15) disagreed. Vaccination has immediate cost and practical implications but in the longer term is more cost effective than post-exposure treatment. These findings are similar to those reported in Ethiopia, where 86% of respondents stated that rabies can be treated, emphasizing the importance of immediate medical intervention and post-exposure treatment as effective preventive measures (Ali, Ahmed and Sifer 2013).

In contrast to a study conducted in Ethiopia, where 91% of participants believed that the disease cannot be cured once clinical symptoms appear, most participants in this study (76%; n=142) who were aware of rabies believed that the condition could be cured (Addis *et al.* 2019). This finding aligns with a similar conclusion drawn from a study in Haiti, where more than half of the participants believed that rabies could be cured even after symptoms appeared (Fenelon *et al.* 2017). However, it is important to note that once clinical indications of rabies emerge, the disease is virtually untreatable (Crowcroft and Thampi 2015). Therefore, most respondents in this study lacked significant knowledge about the treatment of rabies.

Approximately 92% (n=172) of the study participants agreed that pet immunizations could prevent rabies in humans. Similarly, community research conducted in Haiti found that most participants (80%) were aware that vaccinating pets is important for preventing human disease (Fenelon *et al.* 2017). In contrast, a study in Chad reported a lower percentage of respondents (35%) who were aware that vaccinating dogs helps prevent rabies in humans (Mbilo *et al.* 2017). The high level of agreement among respondents in this study regarding the role of pet immunizations in preventing rabies transmission highlights the importance of promoting and implementing vaccination programs as a crucial preventive measure (Lavan *et al.* 2017).

In the survey, every respondent who was aware of rabies expressed the belief that managing stray dogs is an effective way to prevent and control the disease within the MLM. This finding is consistent with the results from Sri Lanka, where most participants supported rabies control initiatives that prioritize reducing stray dog populations (Matibag *et al.* 2009). Managing stray dogs plays a vital role in preventing the spread of rabies, as stray dogs are often the main source of the disease in communities (Shite *et al.* 2015). This underscores the importance of implementing strategies such as vaccination campaigns, spaying/neutering programs, and responsible pet ownership to address the issue of stray dog populations and effectively control rabies transmission.

Enhancing knowledge and understanding of rabies treatment options, the significance of pet immunizations, and the importance of managing stray dog populations can greatly contribute to rabies prevention efforts. It is imperative for public health authorities and relevant stakeholders to conduct educational campaigns that provide accurate information on these aspects of rabies prevention, empowering communities to take proactive measures in reducing the incidence of rabies cases and protecting public health.

This KAP analysis revealed that a significant proportion of respondents (84%; n=167) who were aware of rabies did not know where to obtain rabies vaccines or where to vaccinate their pets. This lack of knowledge likely contributes to the poor vaccination coverage observed in the study. While most participants expressed a willingness to vaccinate their pets, this cannot be achieved if the public is unaware of the organizations that stock vaccines or the locations to where they can take their animals

for vaccination. In contrast to our survey, a study conducted in India found that 91% and 76% of respondents were aware that vaccines were available and provided free of charge in the public sector (Joice, Singh and Datta 2016).

Respondents who were aware of the locations where vaccines could be obtained or administered mentioned various options such as vet clinics, government veterinary services, co-operative shops, and the SPCA. Most than half of the respondents (55%, n=186) identified veterinary clinics as the primary source, this finding suggests that veterinary clinics play a crucial role in providing access to rabies vaccines for dogs in the study area. However, upon further probing, some respondents (14%; n=14/99) expressed uncertainty when asked about the specific places where they could obtain vaccines for their animals. Interestingly, a few respondents mentioned medical practitioners as individuals who vaccinate animals, indicating a potential confusion or lack of clarity regarding the appropriate sources for rabies vaccination.

These findings emphasize the importance of improving public awareness and education regarding the availability and accessibility of rabies vaccines. It is crucial to inform the public about specific locations, such as veterinary clinics or government veterinary services, where they can reliably obtain vaccines for their pets (Cleaveland *et al.* 2014). Additionally, clarifying misconceptions, such as the role of medical practitioners in animal vaccination, is essential to ensure accurate information reaches the public.

Efforts should be made to strengthen communication channels and disseminate information through various channels, including community outreach programs, public service announcements, and collaboration with local veterinary services (Ngigi and Busolo 2018). By increasing awareness about where to obtain vaccines and where to go for pet vaccinations, the vaccination coverage can be improved, ultimately reducing the risk of rabies transmission, and protecting both human and animal health.

Attitudes and practices towards rabies

It is commendable that most respondents (92%; n=438) in this study expressed their willingness to seek medical attention from a health facility after being bitten by a dog. This is a crucial step in reducing the risk of developing rabies. However, it is important to note that only a small percentage (5%; n=24) of respondents stated that they would

wash the wound before seeking medical attention. This finding aligns with a study conducted in Tanzania, where a similar percentage of respondents (5%) mentioned washing the wound before seeking medical attention (Sambo *et al.* 2014). In contrast, a study in Ethiopia reported that a significant proportion (92.4%) of respondents said they would cleanse their wounds with soap and water, indicating a higher level of adherence to proper wound-cleaning practices (Gebremeskel *et al.* 2019). This difference could be attributed to the higher level of rabies knowledge (81%) indicated in the Ethiopian study.

Regarding the attitudes towards animals that have bitten respondents or their family members, the majority (65%; n=309) expressed a willingness to kill the dog, while only a few mentioned wanting to know if the animal was infected (8%; n=38), if it had been vaccinated for rabies (1%; n=5), or if it had rabies after a two-week observation period (1%; n=5). A similar pattern was observed in Haiti, where most respondents (47%) stated they would kill an animal that had bitten them or their family members (Fenelon *et al.* 2017). In addition, a small percentage of respondents in both studies mentioned alternative actions such as observing the animal for signs of disease or checking its vaccination status.

It is concerning that a notable proportion of respondents (25%; n=119) in the current study mentioned abandoning animals that had bitten them in bushes or rivers or giving them away to other people. This approach is problematic as it can contribute to an increase in rabies cases among both humans and animals. Similarly, in a study conducted in Mozambique, a high percentage of respondents (96.5%) stated that they would either kill or expel animals exhibiting rabies-like behaviour from their homes or neighbourhoods, while a small percentage (3.5%) mentioned taking no action (Mapatse *et al.* 2022).

On a positive note, a significant percentage of respondents (83%; n=395) indicated that they would notify the authorities in cases of bite contracts. This is a responsible attitude as it allows for appropriate measures to be taken to address cases of rabies and prevent further spread if the animal is rabid. A study in Nigeria reported a similarly high level of reporting (88%) of dog bites to the appropriate authorities (Edukugho *et al.* 2018). In contrast, a study conducted in the Philippines showed a lower reporting level (18%) (Gebremeskel *et al.* 2019).

These findings highlight the need for comprehensive education and awareness campaigns that promote proper wound-cleaning practices, responsible attitudes towards animals that have bitten individuals, and the importance of reporting bite incidents to the authorities. By addressing misconceptions, promoting responsible actions, and improving knowledge, it is possible to enhance attitudes and practices towards rabies prevention and control, ultimately reducing the burden of this deadly disease (Ngigi and Busolo 2018)

Half of the respondents who were aware of what rabies is (50%; n=100) mentioned that they engage in discussions with their families and neighbours about rabies prevention. This finding aligns with studies conducted in Ethiopia (84%) and Rwanda (39%), which found that neighbours and family members were the primary sources of rabies information for respondents (Kabeta *et al.* 2015; Ntampaka *et al.* 2019). These discussions within the community can play a significant role in raising awareness and promoting preventive measures against rabies.

In this study, 16% (n=76) of the surveyed participants reported having been bitten by a dog before. This percentage is lower than that reported in a related study conducted in Ethiopia, where 42% of participants stated that they had been bitten by a dog. Similarly, a study in Mozambique reported that 18% of respondents recalled a family member being bitten by a dog (Mapatse *et al.* 2022) These variations could be attributed to differences in the study populations and geographical locations.

Among the respondents who had been bitten by a dog, 45% (n=34) sought medical attention, while 17% (n=13) stated that they merely used soap and water to clean the bite wound immediately. It is concerning that 24% (n=18) of the respondents who had been bitten by a dog reported doing nothing after the incident. In contrast, a study conducted in Mozambique found that a lower percentage (12%) of bite victims sought medical assistance after being bitten (Mapatse *et al.* 2022). Additionally, a study in India revealed that people favoured home remedies like applying chili, as 47% of the participants strongly believed in traditional medicine (Joice, Singh and Datta 2016).

Furthermore, only 46% (n=32) of those who had been bitten by a dog stated that they had received prophylactic rabies therapy, while the remaining 54% (n=39) did not undergo such treatment. Some participants in the study believed that applying dog

saliva to a wound would aid in healing because dogs often lick their wounds to clean and heal them. Similarly, low rates of receiving prophylactic rabies therapy were identified in research conducted in Ethiopia, where bite victims preferred consulting traditional healers (Kabeta *et al.* 2015)

These findings emphasize the need for comprehensive education and awareness campaigns to not only emphasize rabies prevention but also to describe proper actions to take after a dog bite. Promoting timely medical attention, proper wound cleaning, and seeking appropriate prophylactic rabies therapy are essential in reducing the risk of rabies transmission. Additionally, efforts should be made to address misconceptions and traditional beliefs that may hinder the adoption of effective preventive measures (Jakasania, Mansuri, and Dixit 2017; Sosa 2016).

Only 75% (n=24) of the respondents who had been bitten by a dog completed all the prescribed doses of post-exposure treatment as advised by the WHO (2015). It is concerning that some bite victims abandoned their medical care. Reasons provided by respondents for not receiving all the prescribed doses included the hospital being out of stock (33%; n=8) and the perception that it was not important to take all the doses (45%; n=11). It is important to emphasize the importance of completing the full course of treatment at recommended intervals for optimal effectiveness (Pieracci *et al.* 2019).

Interestingly, most respondents (87%; n=414) stated that having to travel to locations farther away from the nearest health facility would not hinder them from receiving post-bite treatments. Only a small percentage (8%; n=38) of respondents felt that the distance could discourage them from traveling. This contrasts with a study by Mapatse *et al.* (2022), who mentioned that long distances to the nearest health centres for notification and treatment of bite wounds can overshadow respondents' willingness to exhibit good attitudes towards rabies.

Vaccinating dogs in large numbers is recognized as the most effective way to control rabies and prevent human deaths (Broban *et al.* 2018). However, only 16% (n=37) of respondents reported having previously vaccinated their pets, highlighting the lack of rabies control programs in the study area. Despite the awareness of the necessity for dog vaccinations and the eagerness expressed by most respondents to vaccinate their

dogs, the low vaccination rate suggests a lack of effective implementation of rabies control programs. Similar low vaccination rates have been observed in studies conducted in Nepal (14-17%) and Ethiopia (5%), while higher vaccination rates were reported in Nigeria (94%) and the Philippines (71%) (Davlin *et al.* 2014; Edukugho *et al.* 2018; Massei *et al.* 2017; Ntampaka *et al.* 2019).

In South Africa, it is common practice for authorities to provide pet owners with a certificate or card as proof of rabies vaccination for their animals, particularly in case of a dog bite. However, among the 16% (n=37/234) of pet owners who mentioned that their animals had received the vaccine, none of them were able to produce the documentation. Some respondents stated that they never received the card or certificate after vaccination. A similar survey conducted in Sri Lanka found that more than half (60%) of the participants were unable to produce a vaccination card or certificate as proof of immunization. This could be attributed to a lack of understanding regarding the importance of keeping records or could be indicative of low vaccination coverage in the research areas (Broban *et al.* 2018).

These findings highlight the need for improved accessibility and availability of post-exposure treatment, as well as the implementation of effective rabies control programs that prioritize dog vaccinations. Additionally, efforts should be made to ensure that pet owners receive proper documentation after their animals are vaccinated to facilitate tracking and verification of immunization records.

Interventions against rabies

The study findings indicate that a significant proportion of respondents (32%; n=152) had heard of rabies in the past year. However, it is worth noting that some respondents mentioned hearing about rabies a long time ago, particularly in the eighties when they used to take their livestock to dip tanks. This suggests a lack of recent and ongoing awareness campaigns and education efforts related to rabies. The gaps identified in KAP regarding rabies in this study may be directly linked to a low level of support and attention given by the national government to rabies control measures.

Regarding the sources of knowledge about rabies, official sources such as the radio (3%; n=14) and veterinary services personnel (2%; n=10) were mentioned by respondents. However, it is concerning that most respondents (95%; n=452) reported

not having heard any messages about the disease in the previous 30 days. This indicates a lack of regular communication and dissemination of information about rabies prevention in the study area.

When asked about their preferred sources for receiving information on rabies prevention, respondents primarily mentioned TV (44%; n=209) and veterinary services officials (40%; n=190). This highlights the importance of utilizing mass media platforms such as television to reach a wider audience and engaging with veterinary professionals who can play a crucial role in delivering accurate and up-to-date information about rabies prevention measures (Ngigi and Busolo 2018). Interactions at intra- and interpersonal levels, through mass media, community engagement information and communication can increase knowledge, influence attitudes, norms, and cultural practices, and result in changes in health problems (Ngigi and Busolo 2018).

Logistic regression analyses

Six variables, namely age group, sex, occupation, household income, exposure to rabies prevention messages, and knowledge about rabies were the covariates with vaccination of pets among the respondents. The variables age group, sex, occupation, and household income did not have a statistically significant association with pet vaccination. However, exposure to rabies prevention messages was found to be a strong predictor of pet vaccination. Respondents who had been exposed to such messages were seventeen times more likely to vaccinate their dogs and cats compared to those who had not been exposed (OR: 16.827; 95% CI: 2.151-131.641) (Table 4.12 & Table 4.13). This enhances the confidence in the reliability of the results obtained from the binary logistic regression analysis. This finding underscores the importance of effective communication and public awareness campaigns about rabies prevention in encouraging responsible pet ownership and vaccination practices.

Additionally, knowledge about rabies was also significantly associated with pet vaccination. Owners who demonstrated knowledge about rabies were three times more likely to have their pets vaccinated compared to those who lacked this knowledge (OR=3.233, 95% CI: 1.331 – 7.850) (Table 4.12). This indicates that a well-informed pet owner is more likely to recognize the risks of rabies and prioritize vaccination to protect their pets and themselves from the disease. This suggests that

good knowledge on rabies leads to good attitude and practice in prevention of rabies (Valente *et al.* 1998)

Limitations of the study

This study was conducted exclusively within the geographical boundaries of MLM, which, as a result, limits the generalizability of the findings to other regions or municipalities in South Africa. Nonetheless, the insights and knowledge gained from this research can serve as a valuable reference for similar settings and contribute to the formulation of relevant strategies in rabies control and prevention efforts across different areas.

As with any cross-sectional survey, this study is subject to several limitations that may impact the accuracy and robustness of the results. One of the primary limitations of the present study lies in the sampling method used, in that an equal number of households was sampled within each main place, irrespective of the size of the main place, which means that households in smaller main places had a greater chance of being selected than households in larger main places, which could have introduced sampling bias.

Additionally, cross-sectional surveys are prone to various biases, such as response bias, where participants may provide socially desirable responses, and recall bias, which can affect the accuracy of responses related to past experiences or events. Efforts were made to minimize these biases using trained data collectors and standardized interview protocols, but they cannot be entirely eliminated.

Another limitation of the study is the constraint in resources, including time and funding, which influenced the sample size and data collection scope. While efforts were made to collect data from a diverse range of households, it was not feasible to include all households in the municipality. Therefore, the findings might not fully capture the perspectives of every resident.

In conclusion, despite these limitations, this study on the KAP of residents in MLM regarding rabies and pet vaccination contributes to the existing body of knowledge on rabies control in South Africa and offer valuable lessons for similar research in other regions.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

Summary and conclusions in relation to study aim and objectives of the study:

The aim of this study was to assess the knowledge level, attitudes, and practices related to rabies among residents of MLM and to describe the rabies vaccination coverage in the study area. Additionally, the study aimed to investigate the factors associated with rabies vaccination among dogs and cats in the municipality.

The achievement of these objectives is discussed below, along with specific data from the study:

Study objective 1: Assessment of knowledge of rabies:

The first study objective of the study was to assess the knowledge level of rabies among residents of MLM. The findings revealed that only 42% of the respondents were aware of what rabies is. Most respondents who knew about rabies displayed limited understanding of critical aspects, such as the transmission of rabies to humans and the importance of proper wound treatment after a dog bite. Furthermore, only 14% of respondents knew that rabies vaccines for pets could be obtained from veterinary services, indicating a lack of information about access to rabies vaccines in the study area. These data underscore the urgent need for targeted awareness-raising campaigns and educational interventions to improve the knowledge of rabies and its prevention among residents.

Study objective 2: assessment of attitudes and practices towards rabies:

The second study objective aimed to assess the attitudes and practices of the residents towards rabies in dogs and cats. The study found that while most respondents displayed a positive attitude towards seeking medical attention after a dog bite (92%), there were concerning practices related to wound cleaning and post- bite treatment. Only 5% of respondents mentioned washing the wound immediately after a dog bite, while 24% reported doing nothing after being bitten. There are households that do not have access to clean water in South Africa. The KAP model assumes that knowledge positively influences an individual's attitude and attitude in turn influence

practices or behaviour in households without water, even if they have good attitudes towards wound washing it will not necessarily lead to an increase in wound washing unless they have access to clean water. Additionally, 54% of respondents who were bitten by a dog did not complete their post-exposure treatment, with reasons including the hospital being out of stock (33%) and the perception that it was not essential to take all the doses (45%). Moreover, some respondents indicated a willingness to kill (65%) or abandon (25%) dogs that bit them or their family members. These data reveal potential areas for intervention, highlighting the necessity for targeted behavioural change initiatives to promote proper wound care, encourage timely medical attention after a bite, and discourage harmful practices towards animals.

Study objective 3: Description of rabies vaccination coverage:

The third study objective focused on describing the rabies vaccination coverage in the study area. The study revealed a low vaccination coverage of only 16% among pets (dogs and cats). This coverage is significantly below the 70% threshold recommended by the World Health Organization to prevent rabies outbreaks effectively. Furthermore, the lack of proper documentation for vaccinated animals raises concerns about the accuracy of reported vaccination rates. Of the 16% of pet owners who reported their animals as vaccinated, none could produce vaccination cards or certificates as proof. These data underscore the necessity to improve access to vaccination services, implement regular vaccination campaigns, and establish proper record-keeping practices to increase vaccination coverage in the municipality.

Study objective 4: investigation of factors associated with rabies vaccination:

The final study objective sought to investigate the factors significantly associated with rabies vaccination among dogs and cats in the study area. The study identified exposure to rabies prevention messages and knowledge of the disease as the two most critical factors associated with vaccination coverage. Respondents who had been exposed to rabies communication messages were seventeen times more likely to vaccinate their pets compared to those who had not received such information. Additionally, residents with a higher level of knowledge about rabies were more likely to vaccinate their pets (39% vs. 17%). These data highlight the importance of comprehensive awareness campaigns and educational initiatives to promote

vaccination practices and protect both human and animal health.

Overall, this study has successfully achieved its objectives by providing valuable insights into the KAP towards rabies in MLM. Moreover, the study revealed vaccination coverage and the determinants of vaccination in the area. The specific data from the study has highlighted the need for targeted interventions, including awareness-raising campaigns, behavioural change initiatives, and improved access to vaccination services, to enhance community understanding of rabies and its prevention. By addressing the identified gaps and promoting responsible pet ownership, these interventions can contribute significantly to reducing the burden of rabies in the municipality and safeguarding the health and well-being of both residents and their pets. Focussing on the value of using the KAP model establishes what and how informational guidelines could empower community members to make an informed decision on rabies, rabies prevention and treatment of rabies.

Recommendations:

The findings of this study underscore the urgent need for targeted interventions to address the gaps in KAP related to rabies in MLM. The low levels of awareness about rabies among residents highlight the importance of implementing comprehensive awareness- raising campaigns to educate the community about the disease, its transmission, and effective prevention measures. These campaigns should emphasize the significance of responsible pet ownership, including the vaccination of pets against rabies.

It is evident that there is a lack of knowledge among residents regarding the animals that can spread rabies, treatment options, and the potential for a cure. This calls for tailored educational initiatives that provide accurate and accessible information to dispel misconceptions and ensure that residents have a clear understanding of the disease and its management.

In a study in KZN, South Africa, a One Health strategy was adopted, which resulted in increased vaccination campaign participation, demand for post-exposure prophylaxis, and sample submission for surveillance after improving rabies public awareness. The implementation of the Prevention and Elimination Program in Bohol also resulted in a high rabies knowledge of 94%. By addressing these knowledge gaps, communities will be better equipped to take appropriate preventive measures and seek timely medical

attention following a dog bite or potential rabies exposure.

To improve community practices, it is essential to disseminate clear messages about immediate wound cleaning with soap and water after a bite, as well as the importance of seeking medical attention and adhering to the full course of post-bite treatment. These messages should be delivered through various channels, including community health centres, veterinary services, and public awareness campaigns, to ensure widespread dissemination and understanding.

The low vaccination coverage observed in the study area is a critical concern for public health. Despite the availability of free vaccination services, the coverage rate falls significantly below the recommended threshold of 70% set by the World Health Organization. To increase vaccination coverage, concerted efforts are needed to address barriers such as limited awareness of vaccination services and the absence of proper documentation for vaccinated animals. Collaborative initiatives involving government agencies, healthcare providers, and veterinary services should be established to enhance access to vaccination, promote regular vaccination campaigns, and improve record-keeping practices.

The study findings highlight the importance of exposure to rabies prevention messages and knowledge of the disease as significant factors associated with vaccination coverage. Therefore, it is crucial to prioritize community-wide education programs and awareness campaigns that provide accurate and up-to-date information on rabies prevention. By increasing exposure to these messages and promoting knowledge about the disease, residents will be empowered to make informed decisions regarding pet vaccination and take proactive measures to protect themselves and their communities.

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APPENDICES

Appendix 1: Sample distribution by Main Place

Main Place	N	Percentage
Brooklyn	28	6
Dinotsi	28	6
Ga-Mosehla	28	6
Ga-Seopela	28	6
Ga-Molepane	28	6
Ga-Moloi	28	6
Jane Furse	28	6
Lekgwareng	28	6
Maololo	28	6
Masakeng	28	6
Mashwanyaneng	28	6
Maswiakae	28	6
Mohlarekoma	28	6
Mosate B (Ga-Masemola)	28	6
Ngwaritsi	28	6
Polaseng	28	6
Tswatago	28	6
Total	476	100%

Appendix 2: Households skip intervals in selected Main Places

Main Places	Households	Calculation	Skip Intervals
Brooklyn	484	484/28 = 17.28	17
Dinotsi	162	162/28 = 6	6
Ga-Masemola (Mosate B)	314	314/28 = 11.21	11
Ga-Molepane	362	362/28 = 12.93	13
Ga-Moloi	1504	1504/28 = 53.71	54
Ga-Mosehla	3521	3521/28 = 125.75	126
Ga-Seopela	543	543/28 = 19.39	19
Jane Furse	1732	1732/28 = 61.86	62
Lekgwareng	342	342/28 = 12.21	12
Maololo	121	121/28 = 4.32	4
Masakeng	38	38/28 = 1.36	1
Mashwanyaneng	201	201/28 = 7.18	7
Maswiakae	980	980/28 = 35	35
Mohlarekoma	572	572/28 = 20.43	20
Ngwaritsi	1126	1126/28 = 40.21	40
Polaseng	521	521/28 = 18.61	17
Tswatago	259	259/28 = 9.25	9

Appendix 3: Rabies KAP Community Assessment Survey Questionnaire

Rabies KAP Community Assessment Survey Questionnaire

Interview Date: __ __ / __ __ / __ __ __ __ (DD/MM/YYYY)

Interviewer Name: _____

Main Place: _____ Household Number: __ __ __

Respondent Status: ☐ Male head of household ☐ Female head of household ☐ Other adult

_____

DEMOGRAPHIC INFORMATION

No	Questions	Answers
1.	What is your age?	Year of Birth:
2.	Sex of respondent	Male
		Female
3.	What is the highest level of education you have completed?	
4.	What is your occupation?	
5.	How many people live in your household including yourself?	
6.	How many children < 18 years live in your household?	
7.	What is your monthly household income?	
8.	Do you have pets/animals in the house?	Yes
		No
9.	If Yes, what kind?	Dog
		Cat
		Other (specify)
10.	How many	Dog(s)
		Cat(s)

KNOWLEDGE ABOUT RABIES

No	Questions	Answers
Q11.	What is rabies? **(If "Don't know", Skip to 22)**	Contagious and fatal viral disease.
		Abnormal change in behaviour, aggressive.
		Other (specify)
		Don't Know
Q12.	According to you which of the following animals might spread rabies?	Dog
		Cat
		Both of the above
		Other (specify)

		Don't Know
Q13	Can rabies be transmitted to people? **(If "No", Skip to 22)**	Yes
		No
		Don't Know
Q14.	According to you, how is rabies transmitted?	Bite or scratch by an animal suspected of rabies.
		Direct contact with the saliva of an animal suspected of rabies.
		Both of the above
		By consuming raw meat of animals
		Other (specify)
		Don't Know
Q15.	Do you believe that rabies can be treated?	Yes
		No
		Don't know
Q16.	Do you believe that vaccination of animals (dogs, cats) could prevent rabies in humans?	Yes
		No
		Don't know
Q17.	Do you think that rabies is a curable disease?	Yes
		No
		Don't know
Q18.	In your opinion, the administration of adequate prophylactic treatment (vaccine and rabies serum) can prevent a person bitten by an animal suspected of rabies from developing rabies?	Yes
		No
Q19.	In your opinion, do you think the elimination of stray pets like dogs and/or cats can reduce the transmission of rabies in the communities?	Yes
		No
Q20.	Do you know in which institution the rabies vaccine for dogs is available in your area?	Yes
		No
Q21.	If answered Yes, which institutions?	

ATTITUDES AND PRACTICES TOWARDS RABIES

No	Questions	Answers
Q22.	If you or your child is bitten by a dog. What will you immediately do?	Look for help at a clinic or hospital
		Wash immediately with water and soap
		Nothing
		Other (specify)
Q23.	In your opinion, if you or your child is bitten by a dog. What will you do with the dog.	Kill the animal
		Take the animal to the vet to check if it is infected

		Check if the animal has been vaccinated against rabies
		Observe the animal for two weeks atleast
		Other (specify)
Q24.	If in your community, you suspect someone has been bitten by a dog. Do you think it's necessary to alert local health authorities?	Yes
		No
		Don't know
Q25.	Do you usually talk or discuss with your family or neighbours about the prevention of rabies **(Respondents that know rabies)**	Sometimes
		Often
		Very often
		Never
Q26.	Have you been bitten by a dog? **(If "No", Skip to question 31)**	Yes
		No
Q27.	Once you've been bitten by this dog. What did you do?	Search for help at a clinic or hospital or private Dr
		Wash immediately with water and soap
		Nothing
		Other (specify)
		Won't answer
Q28.	Have you received a preventive treatment?	Yes
		No
		Don't know
Q29.	Have you received all doses of the treatment?	Yes
		No
Q30.	If no, what is the reason you have not completed all doses of treatment?	Abandonment
		Out of stock at the hospital
		It was not necessary to take all the doses
		Nothing
		Other (specify)
Q31.	If you happen to be bitten by a dog, and the medication/vaccine was not available and you had been referred to another institution, what will you do?	Go to the institution where the medication is available
		Return home without anything
		Other(specify)
		Won't answer
Q32.	Have your dog(s)/cat(s) been vaccinated against rabies? **(Household that own dog/cat)**	Yes
		No
		Don't know
Q33.	If Yes, can I see proof of vaccination? (Vaccination Certificate/Card)?	Seen
		Lost
		No proof

INTERVENTIONS AGAINST RABIES

No	Questions	Answers
Q34.	During the last year, have you seen or heard messages on prevention of rabies on the radio, television, newspaper or signs?	Yes
		No
Q35.	During the last 30 days, how did you hear about rabies?	Radio
		TV
		Newspapers
		Signs (Billboards, Posters, flyers)
		Veterinary Services Officials
		None
Q36.	In your opinion, what are the best ways to receive new information on the prevention of rabies for you and your family?	Broadcast messages
		Billboards
		TV
		Posters
		Flyers
		Veterinary Services Officials
		Other

Appendix 4: Ethics Approval Letter: College of Agriculture and Environmental Sciences

UNISA university of south africa

CAES HEALTH RESEARCH ETHICS COMMITTEE

Date: 08/10/2018

NHREC Registration # : REC-170616-051
REC Reference # : 2018/CAES/125
Name : Ms BM Nchabeleng
Student #: 37122037

Dear Ms Nchabeleng

Decision: Ethics Approval from 04/10/2018 to 30/09/2019

Researcher(s): Ms BM Nchabeleng
37122037@mylfe.unisa.ac.za

Supervisor (s): Prof J Oguttu
joguttu@unisa.ac.za; 011-471-3353

Mr J Oosthuizen
oostej@unisa.ac.za; 011-471-2984

Working title of research:

Knowledge, attitudes and practices of the residents of Makhuduthamaga local municipality towards rabies

Qualification: MSc Agriculture

Thank you for the application for research ethics clearance by the CAES Health Research Ethics Committee for the above mentioned research. Ethics approval is granted for a one-year period. After one year the researcher is required to submit a progress report, upon which the ethics clearance may be renewed for another year.

Due date for progress report: 30 September 2019

Please note the points below for further action:

1. The researcher did not consider possible risks to her own safety during data collection. The Committee advises that the researcher be accompanied by someone during field visits, and that she keeps her supervisors informed of her movements at all times.
2. The researcher indicates in section D.4.6.9 of the application form that any published work from this research will be provided to the Department and the local municipality as feedback. Will any feedback be provided to the community itself from which the

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participants will be recruited? The researcher is requested to consider whether academic publications is the best method of feedback to this community.

3. What is the purpose of asking for the monthly household income of the participants (question 7 in the questionnaire)? This can be a sensitive question to participants. If the information is important to the research, the researcher should consider rephrasing the question. For instance, if the aim behind it is to ascertain whether non-vaccination of animals is due to financial constraints, the researcher can rather ask a question about the reasons for non-vaccination, and list financial constraints as one of the options. If it is important for the research to know the level of income more specifically, the researcher is advised to rather provide ranges of income for the participants to select from.
4. The questionnaire should be edited before distribution. Questions 26 to 29 in particular can be confusing to participants as they are currently phrased.

*The **low risk application** was **reviewed** by the CAES Health Research Ethics Committee on 04 October 2018 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original

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research. Secondary use of identifiable human research data require additional ethics clearance.

7. No field work activities may continue after the expiry date. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **2018/CAES/125** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Prof EL Kempen
Chair of CAES Health REC
E-mail: kempeel@unisa.ac.za
Tel: (011) 471-2241

Prof MJ Linington
Executive Dean : CAES
E-mail: lininmj@unisa.ac.za
Tel: (011) 471-3806

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Appendix 5: Approval Letter: Makhuduthamaga Local Municipality, Department of Agriculture and Rural Development, Veterinary Services

University of South Africa
PO Box 392
Unisa
0003

Makhuduthamaga Local Municipality
Private Bag X434
Jane Furse
1085

Dear Sir/Madam

REF: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am a registered Master of Science student in the Department of Agriculture and Animal Health at the University of South Africa.

The proposed topic of my research is **KNOWLEDGE, ATTITUDES AND PRACTICES OF THE RESIDENTS OF MAKHUDUTHAMAGA LOCAL MUNICIPALITY TOWARDS RABIES.**

The objectives of the study are:

a) Assess the knowledge about rabies among residents of Makhuduthamaga local municipality.
b) Assess the attitudes of the residents of Makhuduthamaga local municipality towards rabies in dogs.
c) To assess rabies vaccination coverage in the study area.
d) Investigate the factors that influence the coverage of rabies vaccination among dogs in the study area.

I hereby seeking your consent to conduct a research in your area of jurisdiction.

Should you require any further information, please do not hesitate to contact my supervisor or me. Our contact details are as follows:

STUDENT NAME: Bertha Nchabeleng, nchabbm@unisa.ac.za , 060 995 3034

SUPERVISOR: Prof James Oguttu, joguttu@unisa.ac.za , 011 471 3353

Appendix 6: Approval Letter: Chairperson of the Congress of Tradition Leaders of South Africa, Limpopo

University of South Africa
PO Box 392
Unisa
0003

The Village Master/Head
Makhuduthamaga
Limpopo Province
South Africa

Honourable Chief

REF: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am a registered Master of Science student in the Department of Agriculture and Animal Health at the University of South Africa.

The proposed topic of my research is **KNOWLEDGE, ATTITUDES AND PRACTICES OF THE RESIDENTS OF MAKHUDUTHAMAGA LOCAL MUNICIPALITY TOWARDS RABIES.**

The objectives of the study are:

a) Assess the knowledge about rabies among residents of Makhuduthamaga local municipality.
b) Assess the attitudes of the residents of Makhuduthamaga local municipality towards rabies in dogs.
c) To assess rabies vaccination coverage in the study area.
d) Investigate the factors that influence the coverage of rabies vaccination among dogs in the study area.

I hereby seek your consent to conduct a research in the villages of Makhuduthamaga local municipality.

Should you require any further information, please do not hesitate to contact my supervisor or me. Our contact details are as follows:

STUDENT NAME: Bertha Nchabeleng, nchabbm@unisa.ac.za , 060 995 3034

SUPERVISOR: Prof James Oguttu, joguttu@unisa.ac.za , 011 471 3353

Your permission to conduct this study will be highly appreciated.

Chief/Head/King's Full Name: Letsiri Phaahla

Chief/Head/King's Signature: _____ Date signed: 29.09.2018

KGOSHI LETSIRI PHAAHLA
PHAAHLA MAKADIKWE
TRADITIONAL COUNCIL
2018 -09- 29
BOX 1, MAKADIKWE, 1062
SIGNATURE: .....

Official Stamp

Researcher's Signature _____

Appendix 7: Participant Consent Form

UNISA university of south africa

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number:
Research permission reference number:

July 06, 2018

Title: Knowledge, attitudes and practices (KAP) among the residents of Makhuduthamaga Local Municipality towards rabies

Dear Prospective Participant

My name is Bertha Makgwadi Nchabeleng, I am doing research under the supervision of Prof James Oguttu, a professor in the Department of Agriculture & Animal Health. My study will lead to the award of MSc (Agricultural Science) Degree from the University of South Africa. We are inviting you to participate in a study titled "Knowledge, attitudes and practices (KAP) among the residents of Makhuduthamaga Local Municipality towards rabies".

WHAT IS THE PURPOSE OF THE STUDY?

I am conducting this research to assess community knowledge, attitudes and practices towards rabies, also to assess rabies vaccination coverage across the community. This study will extend to factors influencing the coverage of rabies vaccination among dogs and cats in the area.

WHY AM I BEING INVITED TO PARTICIPATE?

As a household within the municipality with pets (dogs and cats) or living among community that owns these pets, we ask you to participate in the study to help researcher with information regarding your knowledge, attitudes and practices towards rabies.

Permission to conduct the study was obtained from tribal and municipal offices respectively. Information about the number of households was obtained the Statistics South Africa's website. The total number of households to participate for this study will be approximately 400 from selected communities of the Makhuduthamaga Local Municipality.

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WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves the use of questionnaires, which will be administered during face to face interviews.

The following areas will be included in the questionnaires:

- Demographic information
- Knowledge of the disease
- Treatment and attitude
- Prevention practices
- Interventions against rabies

The expected duration of participation and the time needed to complete a questionnaire will be 30-45 minutes per session/household.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason. However, after submitting a questionnaire it will not be possible to withdraw. This is because questionnaires will not have names of respondents and so it will be difficult to identify the questionnaire that belongs to you.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

Findings from this study will provide information for guiding social mobilization activities for the vaccination campaigns and will provide information for implementation of a comprehensive rabies prevention and control plan in Makhuduthamaga Local Municipality, which may positively impact the health of the population.

The information from this study will also be available to policy makers to use to design and implement rabies control strategies in rural settings of Limpopo province of South Africa.

ARE THEIR ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

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There are no foreseeable risks of harm or side effects to you by participating in this study. The only inconvenience to you will be your valuable time that you will sacrifice answering the questions in the questionnaire.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet at the University of South Africa, for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable.

Anonymous data collected may be used for other purposes, such as a research report, journal articles and/or conference proceedings. However names of participants will not be included in such publications. It will not be possible to link individuals in publications and people in the study area.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

Participating in this study is voluntary and participants are not entitled to any payment.

HAS THE STUDY RECEIVED ETHICS APPROVAL

This study has received written approval from the Research Ethics Review Committee of the College of Agriculture and Environmental Sciences, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

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If you would like to be informed of the final research findings, please contact Mrs Bertha Nchabeleng on +27 726750497 / +27 609953034 or Disolbm@gmail.com. The findings are accessible from February 2018.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact Mrs Bertha Nchabeleng on +27 726750497 / +27 609953034 or 37122037@mylife.unisa.ac.za

Should you have concerns about the way in which the research has been conducted, you may contact Prof James Oguttu, e-mail: joguttu@unisa.ac.za. Contact the research ethics chairperson of the CAES General Ethics Review Committee, Prof EL Kempen on 011-471-2241 or kempeel@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.
Thank you.

Mrs BM Nchabeleng
Department of Agriculture and Animal Health
Calabash Building, Office 322
Science campus, Florida
c/o Christiaan de Wet and Pioneer Avenue
Cell: 0609953034
E-mail: nchabbm@unisa.ac.za

CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the questionnaire.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname…… (please print)

Participant Signature……Date……

Researcher's Name & Surname……(please print)

Researcher's signature……Date……

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Appendix 8: Proof of language editing

John Dewar Tel: +27833210844
PhD, DAHM Email: johndewar65@gmail.com

Dear Dr Oosthuizen,

This letter is to confirm that I completed a language and content edit of a dissertation entitled: **Rabies in Makhuduthamaga local municipality, Limpopo province, South Africa: knowledge, attitude, and practises**

This dissertation describes a research study under your supervision and will be presented to the Department of Agriculture and Animal Health, College of Agriculture and Environmental Sciences, University of South Africa in fulfilment for the requirements for the degree Master of Science in Agriculture. The dissertation was prepared by Bertha Nchabeleng.

My edit included the following:

- Correcting spelling and grammar.
- Paginating document.
- Checking references for consistent presentation.

Text formatting included:

- Suggesting an example of abstract format.
- Suggesting clarity regarding similarities between study objectives 3 and 4.
- Suggesting more information on the KAP models and emphasis on statistical methods.
- Suggesting that conclusions align to study objectives.
- Suggesting that recommendations include details of successful rabies training programs.

Yours sincerely,

John Dewar
24th July 2023