SWANSEA UNIVERSITY

Faculty of Medicine, Health and Life Sciences

A dissertation presented for the degree of Master of Science

(Public Health and Health Promotion)

Module code SHGM57

"PREVALENCE OF RABIES AMONG BUTCHERS AND HUNTERS IN NORTHERN NIGERIA"

A SYSTEMATIC REVIEW

STUDENT NAME

EMMANUEL YEBO SHIAWOYA

Student Number

Word Count:

14990

Date of submission

28/01/2024

ABSTRACT

Rabies is a highly fatal infectious disease that is mostly transmitted by dogs which serve as the primary host of the virus via the virus rich saliva which gains entry mostly through dog bite in other susceptible warm-blooded hosts like humans. The zoonotic nature of this disease makes it of important public health significance across the world with low-income countries like Nigeria bearing most of the burdens of high mortality. To generate relevant evidence to ascertain the prevalence of rabies among hunters and butchers in Northern Nigeria, 11 medical databases were searched using a systematic approach wherein results were reported in a PRISMA diagram. All 5 studies which met the inclusion criteria used a cross sectional study design and thus were critically appraised using JBI checklist to assess the risk of bias. Northern States captured under these 5 studies include Taraba, Kaduna, Gombe and Kogi where relevant data from these studies were extracted and underlying themes like demographic characteristics, knowledge and attitude of dog owners, vaccine coverage of dogs, dog bite cases and rabies detection from dog samples were generated. Synthesis from the results showed that the risk of dog bite was higher in individuals who kept dogs for meat consumption and for slaughter (30.6%) thus making the practice of dog meat consumption a risk factor where hunters and butchers are an occupational group at high risk of infection. Most dog owners also did not have sufficient knowledge on the clinical signs of rabies and what steps to take in the event of a possible rabies exposure. Records over a 10-year period showed that among other Northern States, Taraba State had the lowest rate of vaccination coverage in dogs with 13.5%. The prevalence of rabies in Northern Nigeria has continued to increase from the earliest study in 2013 to the latest in 2020 with Gombe State having the highest rates of rabies positive samples of 60%. The use of cross-sectional study design by all included studies limited the ability to determine whether there was a direct causal association between the exposure (dog meat) and

the outcome (rabies) among the population (hunters and butchers) however, this occupation and the practice of dog meat consumption are risk factors in the prevalence of rabies not only in Northern Nigeria but across the country. The 'Zero by 30' goal provides a formidable intervention plan all individuals, stakeholders, health professionals across disciplines and countries can adopt to end dog mediated human rabies by 2030.

Declarations and Statements

Declaration

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed .███████████████   Date ....28/01/24..........

Statement 1

This work is the result of my own independent study/investigation, except where otherwise stated. Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.
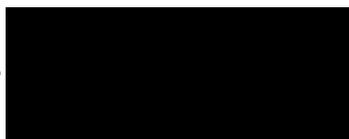
Signed ..███████████████   Date ....28/01/24............

Statement 2

I hereby give my consent for my work, if relevant and accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed ...███████████████   Date ....28/01/24.............

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEGEMENT

LIST OF ABBREVIATIONS

CDC	Centres for Disease Control and Prevention
DFAT	Direct Fluorescent Antibody Test
DRIT	Direct Rapid Immunohistochemistry Test
FAO	Food and Agriculture Organisation of The United Nations
GARC	Global Action Alliance for Rabies Control
JBI	Joanna Briggs Institute
MIT	Mouse Inoculation Test
MPI	Multidimensional Poverty Index
OIE	World Organisation for Animal Health
PEP	Post exposure Prophylaxis
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analysis
RABV	Rabies Virus Antibody Titre
RT-PCR	Reverse Transcriptase Polymerase Chain Reaction
TPB	Theory of Planned Behaviour
WHO	World Health Organisation
WPR	World Population Review

INTRODUCTION

Rabies, one of the deadliest zoonotic diseases ever known to mankind, has been shown to be associated with over 59,000 deaths in humans every year mostly in low-income countries (Gan et al., 2023). Though the infection is 100 % preventable by vaccination, it remains a major threat to man and animals especially canids such as dogs and cats (Gan et al., 2023). Rabies virus belongs to the Rhabdoviridae family of viruses and the Lyssavirus genus under which the virus is classified. It has a bullet-like form and is a negative-sense single-stranded RNA virus that is enclosed (Rupperecht et al., 2017). The nucleoprotein of the virus facilitates genome encapsidation, which is necessary for viral replication and transcription, whereas the glycoprotein plays a crucial role in viral entrance and host cell recognition (Mebatsion et al., 1999). Rabies is spread majorly through the bite or scratch of an infected animal with virus-laden saliva entering the host's tissues where mammals such as dogs, cats and wild animals like bats, raccoons, and foxes serve as reservoir hosts for the rabies virus (Singh et al., 2017). Zhang et al. (2018) and Zhou et al. (2016) have reported cases of the transmission of rabies through organ transplants from infected donors although this is rare. Studies from within the last decade have demonstrated dog meat butchery, dog meat trade and dog meat consumption as risk factors in the transmission of rabies to man via exposure to infected tissues (Ahmed et al., 2015; Ekanem et al., 2014).

According to the World Health Organisation (WHO; 2021) over 99% of human cases of rabies are caused by contact with infected dogs with most of the victims being children and this virus has been shown to be present in over 150 countries in the world. Interestingly, another source of infection has been demonstrated through contact with the brain, saliva or nervous tissue of a rabid dog either via butchering, or hunting (Thi-Nguyen et al., 2021) which puts individuals in occupations such as dog meat butchering and hunting at risk of becoming infected with

rabies as most research in the past had focused on children, dog owners, veterinary and animal health workers as those who are at a higher risk of coming in contact with a rabid dog and also getting infected with the virus. Nevertheless, there are regional variations in the epidemiology of rabies, which is mostly determined by elements including the existence of reservoir hosts, animal vaccination programs, socioeconomic elements, and accessibility to medical facilities and vaccines. (Singh et al., 2017). As a result of difficulties associated with implementing rabies control and delivering post exposure prophylaxis (PEP) on time, developing nations especially those in Africa and Asia, carry an excessive burden of up to 95% cases of human deaths due to rabies (WHO, 2021). Rabies is endemic in Nigeria causing over 55,000 deaths annually in the country where dogs have been incriminated to be responsible for over 96% of cases (WHO, 2005). In addition to the difficulties associated with rabies control as stated in the previous paragraph, evidence has shown that human activities that involve dogs or the use of dogs such as hunting, dog meat butchering or processing, dog trade, dog festivals and even dog meat consumption are now risk factors contributing to the endemicity of rabies in Nigeria. Adedeji et al. (2010) have reported points of slaughter for dogs in states like Kaduna, Kebbi and Ondo which are sold to individuals or restaurants as meat while Ekanem et al. 2014 identified similar slaughter points for dog meat in Calabar (Cross river state). According to the Centres for Disease Control and Prevention (CDC; 2021) rabies is nearly always fatal and once clinical signs appear, prompt and proper PEP administration is crucial to stop the spread of the virus within the infected individual. Rabies infection in humans initially manifests with non-specific symptoms such as fever, headache and weakness which may last a couple of days after which neurologic signs begin to develop such as incoordination, anxiety and hallucination (CDC, 2021). Subsequently as the disease progresses further, the infected individual may experience delirium, abnormal behaviour, difficulty in eating, insomnia and the classical

symptom of the fear of water which is why the disease is also called "Hydrophobia" (CDC, 2021).

The incubation period of rabies infection in humans is not fixed as it is dependent on certain factors such as the distance between the exposure site in the body and the brain, the type of rabies virus involved, and any immunity that may already exist in the individual (Rupprecht et al., 2010). Evidence from clinical studies however show that the incubation period in humans ranges from days to months, with an average of one to three months (Apanga et al., 2016). However, with progressive knowledge from research in recent times there seems to be another source of infection: innocuous, hardly detectable and thus even more fearful or dreaded than the known source of infection (dog bite). Some of these new sources of infection being discovered are infection through contact with the brain, saliva or nervous tissue of a rabid dog either via butchering, or hunting (Thi-Nguyen et al., 2021) which are occupation groups not previously known to be people at risk of becoming infected with rabies as most research in the past had focused on veterinary and other animal health workers, dog owners, children as those who are at a higher risk of coming in contact with a rabid dog and also getting infected with the virus.

THEORITICAL FRAMEWORK

Socio-ecological Model of Health

Keneth McLeroy in 1988 put forward an ecological theory on health promotion called the Socio-ecological model of health which can provide a comprehensive framework towards understanding the various factors that contribute towards exploring the prevalence of rabies amongst hunters and butchers in Northern Nigeria (McLeroy et al., 1988). This theory comprises of five concentric levels of factors that can influence health which will be examined

briefly starting from individual to public policy level (McLeroy et al., 1988). The individual level considers how personal characteristics like people's knowledge and beliefs about rabies, influences their behaviour towards taking precaution or seeking treatment for potential exposure to rabies (Rine, 2017). Next is the interpersonal level which demonstrates how social and cultural factors (social norms) influence people's decision to engage in behaviours that potentially increases the risk of exposure to rabies such as wrong handling of dogs and other animals without protective clothing (Rine, 2017). Following interpersonal level is the organisational level and the model explains how availability and access to amenities like healthcare centres in communities can play a huge role in influencing the epidemiological distribution of rabies among hunters and butchers in Northern Nigeria (Redding et al., 2019).

The fourth level describes how community relationships between organisations influence health through links, networks, and partnerships (Redding et al., 2019). It gives insight into how community networks formed by occupational groups (e.g. Hunters Association of Nigeria) across different areas in Northern Nigeria can influence the health of those within that population seeing the variables they share (Redding et al., 2019).

Lastly, the socio-ecological model considers public policies, laws or regulations at local, state, and national levels which are wider societal factors that can determine the prevalence of rabies on a wider scale (Costa et al., 2018). These factors may include the availability of effective public health policies and interventions put forward by the government to either protect animal welfare, place restrictions on dog meat consumers, enforce transport of dogs and other wild animals across borders and mandatory anti rabies vaccination policies on dog owners (Costa et al., 2018). Summarily, McLeroy's theory provides a framework that implies that the prevalence of rabies among hunters and butchers in Northern Nigeria goes beyond the individual behaviours and practices of hunters and butchers.

Social Determinants of Health – Dahlgren and Whitehead

Göran Dahlgren and Margaret Whitehead in 1991 proposed a model called the social determinants of health which is another theoretical framework that can attempt to explain certain aspects of the prevalence of rabies among hunters and butchers in Northern Nigeria. Dahlgren and Whitehead's social determinants of health model suggests that health outcomes are influenced by overarching factors which create unequal distribution of health opportunities and risks within a population (Dahlgren & Whitehead, 2021). These factors which are arranged in a rainbow fashion include individual lifestyle factors (age, gender, genetics), social and community networks, living and working conditions (education, housing, healthcare, occupation) and general socioeconomic, cultural, and environmental conditions which are often referred to as the wider determinants of health (Dahlgren & Whitehead, 2021).

At the individual and lifestyle level, the model considers how factors like age, gender and genetics can pose a risk to people's rabies exposure (Dahlgren & Whitehead, 2021). Secondly, the model provides supporting evidence to show how social support systems and community networks around people influence their health. With healthier and stronger social and community networks amongst dog owners come better health outcomes among people while weak and deprived social communities and networks are likely to produce poorer or undesired health outcomes like rabies infection, poor food consumption practices (Costa et al., 2018).

At the third level, the model demonstrates how living and working conditions determine the health of a population such as that of hunters in Northern Nigeria who use dogs both as security and for companionship while hunting for wild meat. This working condition exposes both the hunters and the dogs to rabies virus present in reservoir hosts like foxes and raccoons in the wild (Mshelbwala et al., 2021). Additionally, the dog meat butchers stand the occupational risk of infection with rabies because of poor knowledge or educational level whenever they expose

cuts on their hands during dog meat processing as some of these dogs might be infected with rabies virus (Mshelbwala et al., 2021).

Lastly, the wider determinants of health as described by this model involve general socioeconomic, cultural, and environmental factors (Dahlgren & Whitehead, 2021). Due to the poverty level in a low-income country like Nigeria, most individuals consider hunting or dog meat butchering as an occupation to survive and earn a living considering the high rate of unemployment in the country (Mshelbwala et al., 2021). From a cultural standpoint, dog meat is considered as a special delicacy because of its perceived medicinal powers by certain cultures in Northern Nigerian states like Gombe, Kaduna, Bauchi, Plateau and Taraba (Mshelbwala et al., 2021). This cultural practice facilitated the epidemiological spread of dog mediated rabies virus in that region thereby increasing the risk of infection of rabies to those within these population especially those in close contact with dogs such as hunters and dog meat processors (butchers) (Mshelbwala et al., 2021). In summary, it will suffice to mention that although both McLeroy and Dahlgren and Whitehead's models look similar, they are quite different at the wider levels considering that while McLeroy's model involves public policy and other related issues that affect health outcomes, Dahlgren and Whitehead's model, deals with general socioeconomic, cultural and environmental factors that affect health. However, it has been demonstrated how both models provide the theoretical framework to the prevalence of rabies among hunters and butchers in Northen Nigeria.

RESEARCH JUSTIFICATION

Evidence has shown that the prevalence of rabies among butchers and hunters in Northern Nigeria has not been comprehensively studied and thus this leaves many gaps in knowledge (Odeh et al., 2013). Studies by Oluwayelu et al. (2015) also show that most dogs used for hunting are not vaccinated against rabies and by implication this puts hunters at risk of

contracting the virus in the event where their dogs are infected with rabies thereby constituting an occupational risk to those in this profession.

Evidence according to a scoping review by Mshelbwala et al. (2021) on a total of 30 studies carried out between 2000 – 2019 in Nigeria also showed that more cases of dog mediated human rabies deaths were recorded in Ekiti 7.1% (6/84) – 27.3% (12/44) and Imo 4% (17/436) – 6.4% (7/110) both of which are south-western and southeastern states respectively leaving a wide gap in knowledge and time as to what the situation is in Northern Nigeria post 2019 till date. Therefore, the information which the proposed systematic review will provide, will aid in identifying knowledge gaps, high risk regions, regional disparities which can culminate in providing valuable insights into the burden and distribution of rabies among the target population of butchers and hunters in Northern Nigeria. The results from this review can potentially help to inform policymakers, public health authorities, and stakeholders in developing effective preventive strategies against rabies infection among the population and shape evidence-based practice of Medicine in Northern Nigeria.

AIMS & OBJECTIVE

The primary aim of this systematic review is to assess the prevalence of rabies among butchers and hunters in Northern Nigeria and its associated factors.

The objective of this review includes:

- ✔ synthesising the findings from included studies to determine the overall prevalence of rabies among butchers and hunters in Northern Nigeria.
- ✔ Examining the regional variations and patterns in the prevalence of rabies in Northern Nigeria.
- ✔ Exploring the risk factors associated with rabies infection, such as dog vaccination coverage, dog population density, and community awareness.

METHODOLOGY

The method used for this systematic review was reported in line with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Page et al. (2021). The study protocol was documented and registered under the Prospero guidelines to avoid duplication of this systematic review in the future (Appendix 2).

Study Selection Criteria

The inclusion and exclusion criteria used was according to the Joanna Briggs Institute (Moola et al., 2020) recommendations for systematic reviews of prevalence and incidence which comprises studies that have reported the prevalence of rabies among dog butchers and hunters in Northern Nigeria including cross-sectional, cohort, and case-control studies.

The exclusion criteria used were studies conducted outside of Nigeria and in other languages asides English, studies not reporting primary data, studies with a focus on rabies in other occupational groups and animal species, and studies without clear prevalence estimates. Both inclusion and exclusion criteria were applied as standard protocol which needs to be followed when conducting research methods like this (Garg, 2016). Setting an inclusion criterion is necessary to identify studies relevant to the topic or population group as well as to improve the internal and external validity of the evidence while an exclusion criterion helps to eliminate studies which may not be related or relevant to topic or population (Garg, 2016).

Search Strategy

A systematic literature search was conducted in eleven databases namely: Medline (Ovid / EBSCOhost interface), Scopus, CINAHL, Green file, Embase, APA Psych Info, APA Psych Articles, Proquest Biological Database, PubMed, ASSIA and Biomed Central using literature

that captures the first reported case of rabies in humans in Northern Nigeria from inception to January 2023. Search tools like: Truncation, Phrase searching, and Boolean operators (AND, OR) were used to search keywords. The search terms used included keywords or phrases like: "Rabies", "dog-mediated human rabies", "prevalence of rabies", and "Northern Nigeria". The search was done with and without the native names by which some hunters, butchers and the disease rabies is known or called in Hausa language because it is the language spoken in the northern part of Nigeria to capture as many papers as possible. Medical Subject Headings (MeSH terms) were used where applicable in combination with the free text search terms above for databases like Medline and PubMed (which allow for the use of MeSH terms) to ensure a thorough search is done without missing out on any relevant literature (DeMars & Perruso, 2022). Citation searching was done to identify additional studies. A series of test searching was first carried out at first to have a broad overview of the search results as this helps with familiarization of the search process (DeMars & Perruso, 2022). Table 1 below shows an example of the compilation of the keywords and phrases used.

Table 1

Key Words, Phrase and Subject Headings Search Table

Population	Exposure	Outcome
butcher* OR hunter* OR "dog butcher*" OR "dog meat butcher*" OR "dog hunter*" OR "dog handler*" OR mafarauchi OR marauchi OR "dog meat processor*" OR "dog exterminator*" OR	"dog meat*" or "nama kare" or ekuke or "canine meat*" or "dog flesh" or "canine flesh" or "dog cadaver*" or "canine cadaver*" or "dog carcass*" or "canine carcass*"	"Mad dog disease" OR "crazedog" OR "mad dog" OR rabi* OR "canine madness" OR "rabi* virus*" OR rabiform OR rhabdovir* OR "ciwon haukan kare" OR

"dog meat merchant*" OR "dog meat seller*" OR "dog slaughter*" OR "dog meat trader*" OR "dog meat dresser*" OR "dog meat flesher*" OR "dog meat carver*"		lyssa* OR hydrophobi* OR "dog fury"
Population (without native name)	**Exposure (without native name)**	**Outcome (without native name)**
butcher* OR hunter* OR "dog butcher*" OR "dog meat butcher*" OR "dog hunter*" OR "dog handler*" OR "dog meat processor*" OR "dog exterminator*" OR "dog meat merchant*" OR "dog meat seller*" OR "dog slaughter*" OR "dog meat trader*" OR "dog meat dresser*" OR "dog meat flesher*" OR "dog meat carver*"	"dog meat*" or "canine meat*" or "dog flesh" or "canine flesh" or "dog cadaver*" or "canine cadaver*" or "dog carcass*" or "canine carcass*"	"Mad dog disease" OR "crazedog" OR "mad dog" OR rabi* OR "canine madness" OR "rabi* virus*" OR rabiform OR rhabdovir* OR lyssa* OR hydrophobi* OR "dog fury"

The search strategy described above was used for each database making sure to observe the dynamics of the operation of each database after which references from the literature gathered were exported into Zotero, a recommended referencing management software that helps in building intext citations and reference lists. The software was also used to ensure the process of evidence retrieval is transparent and replicable (Lorenzetti & Ghali, 2013).

The PRISMA flow chart reporting searches done during the systematic review is shown in the results section (Figure 1).

Study Risk of Bias Assessment

The quality of the studies considered was assessed using the Joanna Briggs Institute critical appraisal tool recommended for cross sectional studies which has a total of 8 questions in the checklist ("JBI Manual for Evidence Synthesis," 2020). There are 4 possible outcomes to any of the questions in the checklist and they include: "yes", "no", "unclear", and "not applicable" depending on the content of the studies. The scoring system using the JBI tool is subjective which allows the reviewer to assign a scoring system. However, to ensure proper checks and balances are done, the risk of bias assessment was also carried out along with another independent reviewer after which a scoring system was agreed. The scoring system assigns a score of 1 to all "yes" answers and 0 for "no", "unclear" and "not applicable".

Articles with a total score of 0 - 2, 3 - 5, and 6 - 8 were judged to have high (poor quality), moderate (fair quality) and low (good quality) risk of bias respectively.

Data Extraction

Data extraction was represented in a tabular form including data such as the author and year of publication, reason for study, study design, study location, data collection methods (sample and sample size), exposure variable, outcome measurement and the results of key findings ("JBI Manual for Evidence Synthesis," 2020).

Data Synthesis

Narrative synthesis, one of the methods of synthesizing evidence from multiple studies which primarily adopts the use of words and text to summarise and explain findings, was used.

Thomas and Harden (2008) provide evidence on the use of narrative synthesis to draw out themes as they emerge which can show the outcomes and effects of various studies.

Pannucci and Wilkins (2010) recommend that conducting a comprehensive and transparent reporting of information on all aspects of a study allows the reviewer(s) to assess the potential usefulness of its findings and risk of bias. A thematic approach is therefore used in reporting these findings under different headings wherein results are synthesised. Due to the varying forms of evidence present in the included studies, a narrative synthesis was considered instead of a meta-analysis due to its strength in incorporating diverse forms of evidence within a systematic review without generalising results despite the differences in the primary research in each study which is a common weakness of meta-analysis (Garg et al., 2008). However, to mitigate the weaknesses of a narrative synthesis since there is currently no consensus on the elements that must be contained in a narrative synthesis, the Synthesis without meta-analysis (SWiM) guideline developed by Campbell et al. (2020) which provides a transparent approach to the synthesis process was followed thereby ensuring risk of bias was avoided when reporting the synthesis.
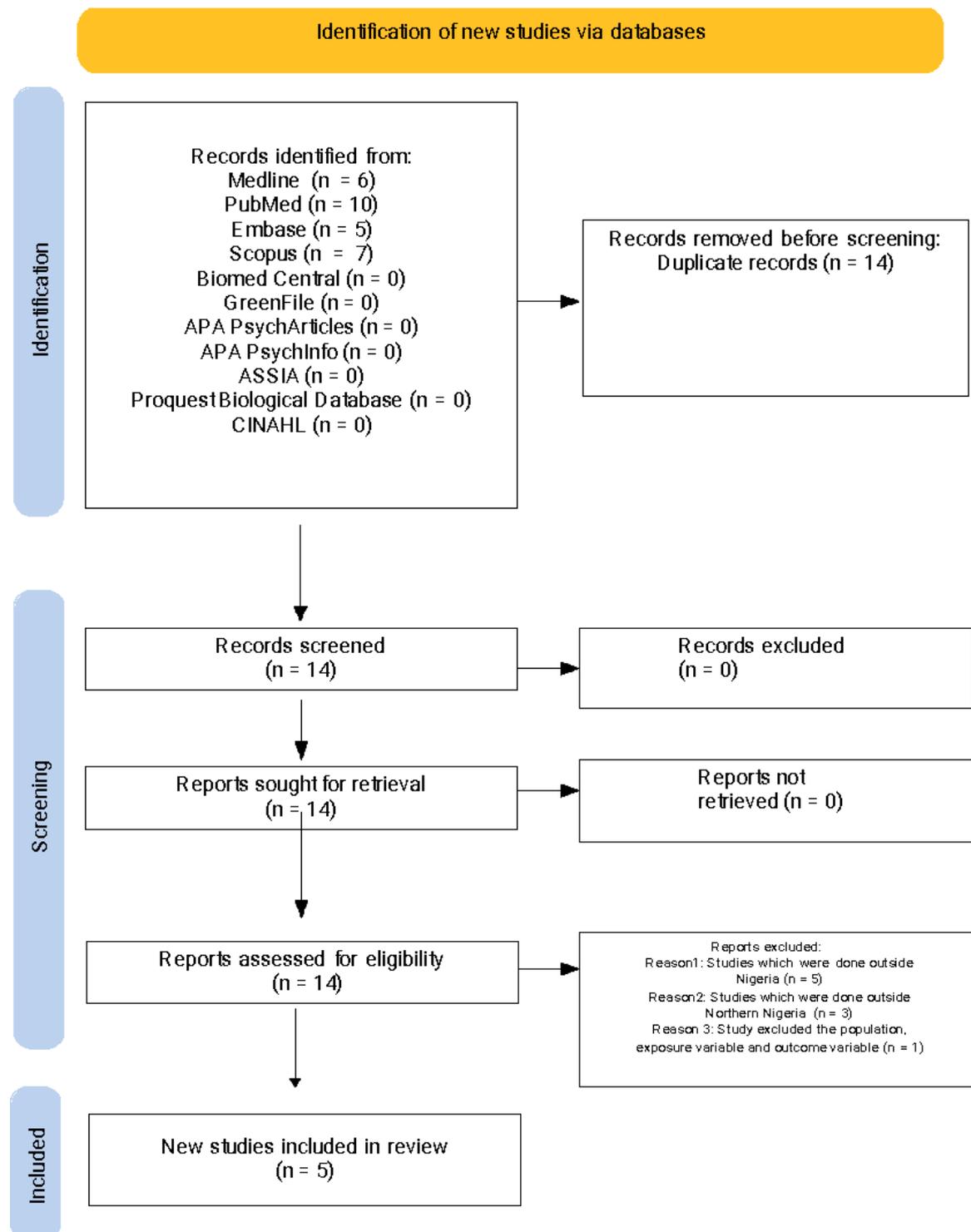
RESULTS

Study Selection

5 (35%) of the 14 studies retrieved from 11 databases after removal of duplicates met the inclusion criteria. However, there were 9 studies remaining which did not meet the inclusion criteria and were thus excluded. The reasons for exclusion applied to studies done outside Nigeria (n= 5), studies done outside Northern Nigeria (n= 3) and studies which failed to capture the population, exposure and outcome variables (n=1). See figure 1 PRISMA diagram below for full details.

Figure 1

PRISMA Diagram

Identification of new studies via databases

Identification

Records identified from:
Medline (n = 6)
PubMed (n = 10)
Embase (n = 5)
Scopus (n = 7)
Biomed Central (n = 0)
GreenFile (n = 0)
APA PsychArticles (n = 0)
APA PsychInfo (n = 0)
ASSIA (n = 0)
Proquest Biological Database (n = 0)
CINAHL (n = 0)

Records removed before screening:
Duplicate records (n = 14)

Screening

Records screened
(n = 14)

Records excluded
(n = 0)

Reports sought for retrieval
(n = 14)

Reports not
retrieved (n = 0)

Reports assessed for eligibility
(n = 14)

Reports excluded:
Reason1: Studies which were done outside
Nigeria (n = 5)
Reason2: Studies which were done outside
Northern Nigeria (n = 3)
Reason 3: Study excluded the population,
exposure variable and outcome variable (n = 1)

Included

New studies included in review
(n = 5)

Study Characteristics

All included studies (n = 5) used cross sectional study design in undertaking their research process. Ehimiyein et al., 2010 conducted a study in Kaduna State sampling 30 dog brain samples at random from dog markets to detect rabies antigen using Direct Fluorescent Antibody Test (DFAT); Direct Rapid Immunohistochemistry Test (DRIT); Mouse Inoculation Test (MIT); and a Reverse Transcriptase- Polymerase Chain Reaction Test (RT-PCR). Odeh et al., 2013 carried out a study in Zaria and Kafanchan in Kaduna State sampling 160 butchers and dog meat consumers (100 from Zaria and 60 from Kafanchan) using the method of structured questionnaires for sample collection. Ameh et al., 2014 conducted a study in Taraba State sampling 200 dog owners and 188 brain samples of dogs slaughtered to identify rabies virus antigen while using the sample collection method of structured questionnaires for the dog owners and random purchase of dog heads from meat processors at different slaughter points. Suleiman et al., 2020 collected 50 dog brain samples of dogs slaughtered for meat in Biliri and Kaltungo Local Government Areas of Gombe State using DFAT and RT-PCR to detect rabies virus antigen. Okeme et al., 2020 conducted two separate cross-sectional studies in Lokoja Kogi State; first a retrospective study of records of human dog bite cases and the extent of vaccine coverage of offending dogs over an 11-year period from 2003 – 2013 and secondly, sampling of 208 brain tissues of dogs collected from 5 points where dogs are frequently slaughtered for consumption. The study characteristics and other relevant findings from each of the 5 included studies are summarised in a data extraction table below (Table 2) for proper organisation and clarity of data.

Table 2

Data Extraction Table

Author and Year	Study Aim	Study design	Study Location	Data Collection Methods (Sample, Sample Size)	Exposure variable	Outcome Measurement	Findings / Results
Ameh et al. 2014	to assess the risk of exposure to rabies by assessing the rabies related knowledge, attitudes and practices of dog owners, checking for evidence of rabies infection in slaughtered dogs and assessing	Descriptive Cross Sectional Study	Wukari, Taraba State Nigeria	Dog owners , Dog meat Processors (200 respondents)	1. Rabies related knowledge, attitudes and practices of dog owners 2. Evidence of rabies infection in slaughtered 3. Rabies vaccination coverage in dogs	Rabies Infection	Association with dogs Konwledge of Rabies Attitudes towards Rabies Practices towards Rabies Detection of Rabies Antigen Vaccine Coverage

	rabies vaccination coverage in dogs in Wukari, Taraba State						

Odeh et al. 2014	to assess the risk of exposure to rabies by assessing the rabies related knowledge, attitudes and practices of those involved in dog meat related activities in Zaria and Kafanchan, Kaduna state and checking for evidence of rabies infection in the slaughtered dogs	Descriptive Cross Sectional Study	Zaria and Kafanchan Kaduna State	Dog meat Processors and Dog meat consumers (160 respondents)	Dog meat / Dog meat consumption	Rabies Infection	Demographic Characteristics of Respondents Knowledge of Rabies Attitudes towards Rabies Practice towards Rabies Relationship between Attitude and Practice and Knowledge Detection of Rabies Antigen

Suleiman et al. 2020	To provide insight into any possible sequence variability and phylogenetic relatedness of the rabies virus derived from the slaughtered dogs in the two Local Government Areas of Gombe state, Nigeria.	Cross-sectional study	Billiri and Kaltungo LGAs in Gombe State	50 brain sapmles from dog markets in Billiri and Kaltungo	Dog meat	Rabies Virus (its genotypic characteristic)	Rabies virus antigen was detected in 3 out of the 50 samples screened (6.0%)

Okeme et al. 2020	to provide a comprehensive One Health evaluation of the public health risk of rabies transmission in the city of Lokoja, Nigeria by profiling dog bites in humans and offending dogs and investigating the presence of rabies antigen in the brain of dogs slaughtered for human consumption in the city.	Observational Cross Sectional Studies	Kogi State, Nigeria	All clinical records of dog bite cases and vaccination records of dogs from the state veterinary clinic and one private veterinary clinic from January 2003 to December 2013	Dog bite and dog meat consumption	Canine rabies	Results show a statistically significant association between sex of victims and their age, with a greater proportion of bites in males <10 years of age compared to other age groups $(P < .001)$.
Ehimieyin et al. 2010	To determine the potential role of dog markets in the epidemiology of rabies in Kaduna State	Cross-sectional study	Kaduna State, Nigeria	30 dog brain samples from slaughtered dogs	Dog markets, Dog meat	Rabies	Fifteen (50%) samples tested positive for rabies virus antigens

Quality Evaluation

A risk of bias assessment was done to check the quality of all 5 studies included using the Joanna Briggs Institute checklist for critically appraising cross sectional studies. The scores obtained for these 5 studies varied from 5 to 7 with a median of 6.

The study by Ameh et al., 2014 had a score of 7 and based on the scoring system was evaluated to be of good quality or low risk of bias. The studies by Odeh et al., 2013, Ehimiyein et al., 2010 and Suleiman et al., 2020 all had a score of 6 and were thus evaluated as papers of good quality while the study by Okeme et al., 2020 had a score of 5 and was evaluated as paper of fair quality or moderate risk of bias. Most of the papers therefore had a low risk of bias (4/5; 80%) while only one paper had a moderate risk of bias (1/5; 20%) thereby making all 5 papers fit for the systematic review. The completed checklist for each study is found in appendix 1. The results of the critical appraisal results are summarised in a colour shaded format in the table below.

Table 3

Critical Appraisal Summary

JBI Checklist Criteria	Ameh et al. 2014	Odeh et al. 2013	Suleiman et al. 2020	Okeme et al. 2020	Ehimiyein et al. 2010
1. Were the criteria for inclusion in the sample clearly defined?	🟩	🟩	🟩	🟩	🟩
2. Were the study subjects and the setting described in detail?	🟩	🟩	🟩	🟩	🟩

3. Was the exposure measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes
4. Were objective, standard criteria used for measurement of the condition?	Yes	Yes	Yes	No	Yes
5. Were confounding factors identified?	Yes	No	Unclear	Unclear	Unclear
6. Were strategies to deal with confounding factors stated?	Unclear	No	Unclear	Unclear	Unclear
7. Were the outcomes measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes
8. Was appropriate statistical analysis used?	Yes	Yes	Yes	Yes	Yes
Overall Risk of bias	Low risk	Low risk	Low risk	Moderate risk	Low risk

Note. Colour code: Green – Yes, Red – No, Yellow - Unclear

Strength of evidence

With 80% of the evidence having a good quality (low risk) and only 10% being of fair quality (moderate risk), the overall strength of the evidence is judged to be strong and not weak.

Demographic characteristics

Based on the age of respondents 2 out of the 5 included studies (40%) reported that participants aged between 20 – 30 years had one form of association with dogs either as a dog owner or one who had been bitten by a dog. Based on gender, 2 out of the 5 included studies (40%) reported that most of the participants were males. Based on the level of education of respondents, 2 out of the 5 included studies (40%) reported that most of the participants had above secondary school education. Based on marital status, 2 out of 5 included studies (40%) reported that most of the participants were married.

Association of respondents with dogs and dog meat consumption

Ameh et al. (2014) reported that most of the respondents 190 (95%) owned dogs for the purpose of protection only while Odeh et al. (2013) reported that most of the respondents 111 (69.4%) owned dogs for the purpose of handling and consumption and protection. 3 out of the 5 included studies (40%) reported an association between ownership of dogs with the risk of having a dog bite. Ameh et al. (2014) reported that 43 (21.5%) of the respondents who owned dogs had been bitten by their dogs at least once while Odeh et al. (2013) reported that 30 (27.0%) of respondents who kept dogs for handling and consumption had been bitten by their dogs while 49 (30.6%) who kept dogs for slaughter had been bitten by their dogs. Okeme et al. (2020) reported a total of 95 dog bite cases in humans from 2003 to 2013 in Lokoja with most of the victims being male children less than 10 years old with the leg also as the body part mostly bitten by these dogs. The total number of dog bite cases reported in the 3 studies are summarised in the bar chart below (Figure 2).

Figure 2

Summary of Reported Dog Bite Cases
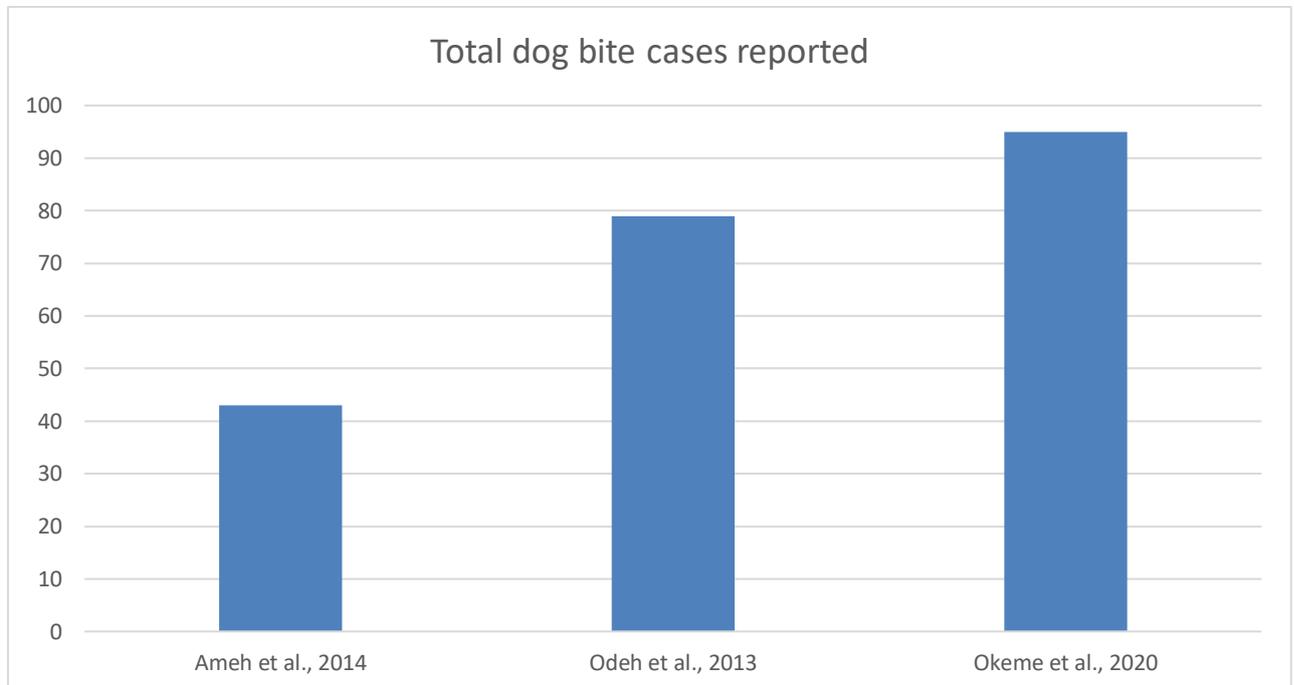
Knowledge of respondents on rabies

Only 2 out of the 5 included studies reported the knowledge of respondents (individual dog owners, dog handlers, hunters and butchers) on rabies. The studies by Ameh et al. (2014) reported that Most of the respondents 171 (85.5%) agreed that rabies does not kill only animals but also humans. The studies by Odeh et al. (2013) reported that most of the respondents 123(76.9%) knew that dogs were the common source of rabies in Nigeria. Despite the awareness on the zoonotic threat of rabies however there were still some gaps in the knowledge of the respondents about rabies

The studies by Ameh et al. (2014) showed that most of respondents 172 (86%) were ignorant about rabies immunisation. The studies by Odeh et al. (2013) further revealed that 110(68.8%) of respondents did not have sufficient knowledge of the clinical signs of rabies in dogs.

2 out of the 5 included studies reported the association between the occupation of respondents and their knowledge on rabies. Results from the studies by Ameh et al. (2014) showed a statistically significant association between respondents' occupation and knowledge in which civil servants were 4.8 times more likely to have a better knowledge of rabies (OR=4.84, 95% CI on OR 1.09-21.44) than other occupation groups. Results from the studies by Odeh et al. (2013) however showed that the proportion of farmers with sufficient knowledge on rabies was greater than any other occupation group with the (OR= 2.292, 95% CI)

Attitude of respondents towards rabies

To measure the attitude of respondents towards rabies which could either be a positive or negative attitude, an attitude score of out of 9 items was used by 2 out of the 5 included studies. The respondents in the study by Ameh et al. (2014) had a mean attitude score of 6.45 out of 9 items which indicates a moderately positive attitude towards rabies while the respondents in the study by Odeh et al. (2013) had a mean attitude score of 6.38 out of 9 items which infers that the respondents also had a moderately positive attitude towards rabies. The studies by Ameh et al. (2014) and Odeh et al. (2013) further revealed an association between categorized attitude scores of respondents with variables like age, occupation and educational qualification. The studies by Odeh et al. (2013) showed that compared to respondents under the age of 19, older respondents were more likely to adopt positive attitudes. More positive attitudes towards rabies were also exhibited by those unemployed and the likelihood of having a positive attitude towards rabies increased with educational qualification.

Practice towards rabies

Only 2 out of the 5 included studies reported the practices of respondents towards rabies. Studies by Ameh et al. (2014) and Odeh et al. (2013) both showed how most of the respondents in their research 151 (75.5%) and 133 (83.1%) respectively advised that dog handlers should have rabies immunization. Ameh et al. (2014) reported a statistical significance between occupation and categorized practice scores of respondents in which civil servants and those who were self-employed had higher practice scores (χ^2=9.983, p=0.019). Odeh et al. (2013) unlike in the previous study showed that there was no statistical significance between associations of age and the level of education with categorized practice scores of which most respondents (>90%) had acceptable practice scores with mean of 8.34 out of 12 items.

Vaccine coverage of dogs

2 out of the 5 included studies (40%) reported the vaccination coverage of dogs in their respective study locations and other variables associated with this vaccination. Ameh et al. (2014) reported that between January 2003 and December 2012, a total of 8,370 dogs were presented to the veterinary hospital in Taraba State out of which 1,128 (13.50%) received anti rabies vaccine. Okeme et al. (2020) reported that between 2003 and 2013, a total of 4281 dogs were presented to the veterinary clinics in Lokoja Kogi State out of which 1339 (31%) received anti rabies vaccine. Both studies by Ameh et al. (2014) and Okeme et al. (2020) showed a correlation in the association between vaccine coverage of dogs with variables such as age of the dog, sex and breed. According to Ameh et al. (2014) based on age, sex and breed most of the dogs vaccinated in Taraba State were puppies 664 (58.9%) between 3 - 12 months, males 589 (52.2%) and of Nigerian indigenous breed 921 (81.6%) respectively. Also, according to Okeme et al. 2020 based on age, sex and breed, most of the dogs vaccinated in Lokoja Kogi State were puppies 683 (51%) between 3 – 12 months, males 768 (57.4%) and of Nigerian

indigenous breed 585 (44%) respectively. The vaccine coverage is summarised in the bar chart below.

Figure 3

Bar Chart Showing Vaccine Coverage.
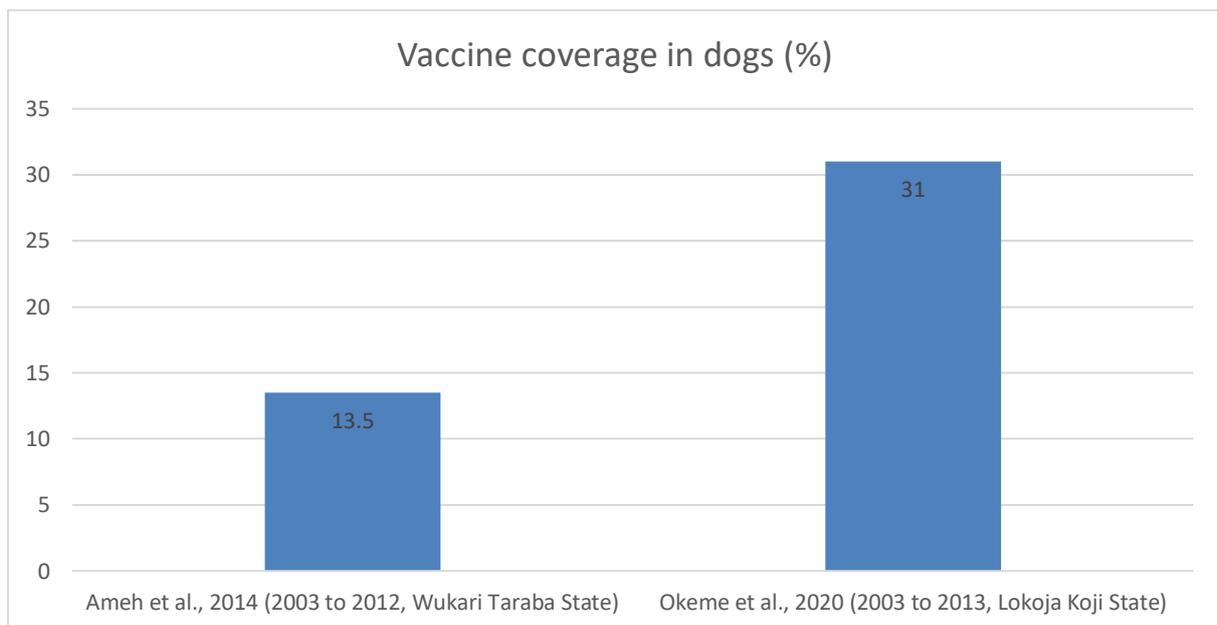
Detection of rabies virus

All 5 included studies (100%) tested for the presence of rabies antigen in all the brain samples of dogs collected at different slaughter points across the various study locations. Ameh et al. (2014) reported 15 (7.98%), Odeh et al. (2013) 6 (3.9%) Suleiman et al. (2020) 3 (60%), Okeme et al. (2020) 11 (5.28%) and Ehimiyein et al. (2010) 15 (50%) positive dog brain samples respectively. All the 5 included studies (100%) also used DFAT in the detection rabies antigen in the brain samples (Ameh et al., 2014; Odeh et al., 2013; Suleiman et al., 2020; Okeme et al.,

2020 and Ehimiyein et al., 2010). These results are summarised in the line graph below for clarity.

Figure 4

Rabies Detection Line Graph

Percentage of dog brain samples infected with rabies virus (%)
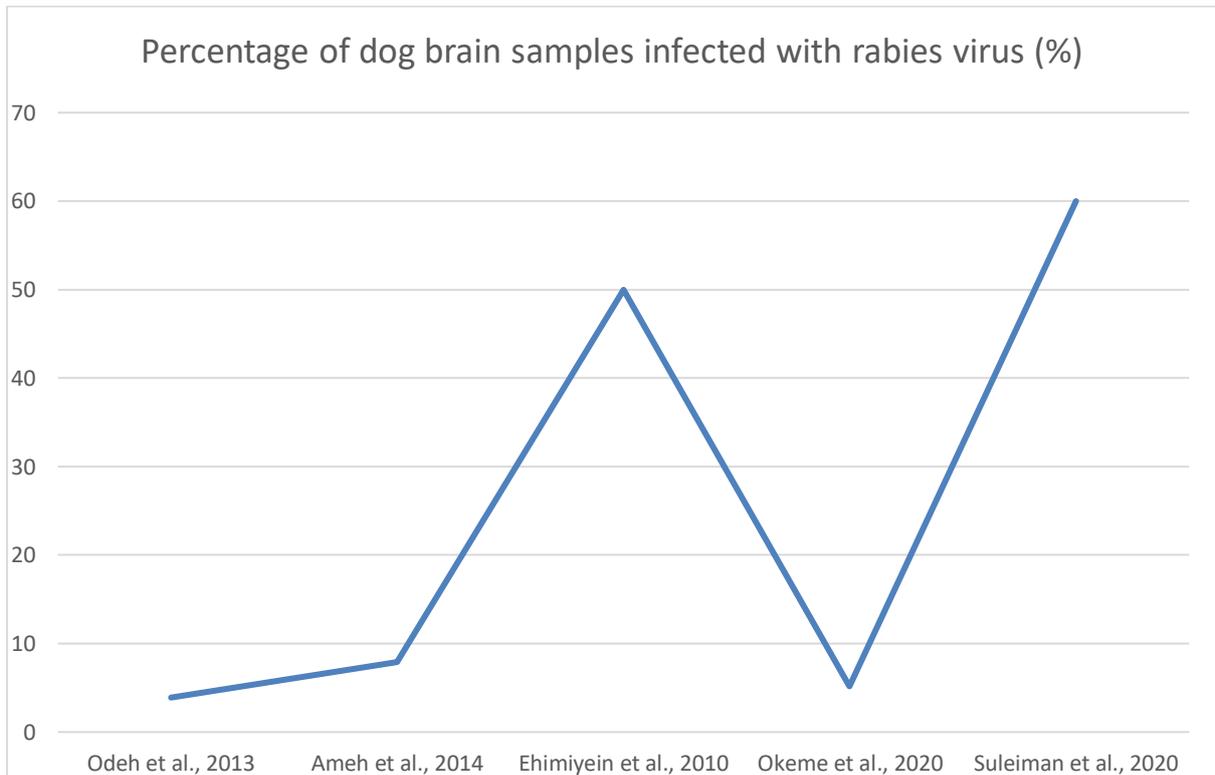
Data analysis

3 out of the 5 included studies (60%) Ameh et al. (2014); Odeh et al. 2013 and Okeme et al. 2020 all inputted numerical data such as age and categorical data such as gender, occupation, educational level, vaccination status, history of dog bite, site of bite, knowledge scores on rabies and attitude scores on rabies using Statistical Package for Social Sciences (SPSS) to analyse data obtained while the associations between demographic variables and categorized scores were measured using χ^2 test of association and odds ratio while confidence intervals (95%) were calculated for odds ratios. Values of $p<0.05$ were considered significant in the χ^2 analysis.

Result Summary

Overall based on the strength of the included studies 80% of which are of good quality (low risk of bias) the evidence are strong and not weak. These studies showed that the reason for respondents owning or associating with dogs was primarily for protection and secondarily for consumption in the case of those who bred dogs for meat (Ameh et al., 2014 & Odeh et al., 2013). The association of these individuals with their dogs emerged as the chief reason why they had once been bitten by their dog(s) or were at risk of being bitten. According to Odeh et al. (2013) the risk of dog bite (30.6%) was higher among respondents who kept dogs for slaughter and consumption (butchers). Across the 2 studies that assessed the knowledge of respondents on rabies and its risk to their health most respondents acknowledged the highly fatal nature of rabies infection in humans however, they did not have sufficient knowledge of the clinical signs of rabies in dogs nor how to avoid the risk of infection (Ameh et al., 2014 & Odeh et al., 2013). Studies by Ameh et al. (2014) and Odeh et al. (2013), reported a moderately positive attitude towards rabies by the respondents based on mean scores of 6.45 and 6.38 respectively. Most respondents from the studies by Ameh et al., (2014) and Odeh et al., (2013) agreed that dog handlers should have rabies immunisation. Studies by Okeme et al. (2020) and Ameh et al. (2014) based on records from veterinary clinics in Taraba and Kogi states between 2003 – 2013 shows that only a total of 2467 (19.5%) dogs out 12,651 dogs presented at these clinics within this 10-year period received anti rabies vaccination at one time or the other in both states. This therefore implies a sustained pattern of low vaccination coverage among dogs in these states. Finally, the diagnostic method for rabies consistent across all 5 included studies was DFAT (Ameh et al., 2014; Odeh et al., 2013; Suleiman et al., 2020; Okeme et al., 2020; Ehimiyein et al., 2010). The studies by Suleiman et al. (2020) conducted in Billiri and Kaltungo local government areas of Gombe state had the highest rabies positive test result (60%) across the brain samples collected for each study.

DISCUSSION

One of the 5 key action principles for health promotion set by the Ottawa Charter in 1986, which helps to explain some reasons behind certain findings from the result section is building healthy public policy (WHO, 1986). Other areas of discourse captured under this section include theoretical and methodological critique of the included literature.

Build Healthy Public Policy

Vaccine coverage in dogs, one of the themes reported by Ameh et al. (2014) and Okeme et al. (2020) between 2003 to 2013 was 13.5% in Taraba State and 31% in Kogi State respectively. This shows a low vaccination coverage in these states over a 10-year period which is a contributing factor to the prevalence of rabies in Nigeria. Other studies outside Northern Nigeria have also recorded low vaccination coverage in dogs such as evidence by Oluwayelu et al. (2015) where only 5.7% vaccination coverage was recorded in 230 dogs whose vaccination status were assessed using their Rabies Virus (RABV) Antibody Titres across the Southwestern states of Ogun and Oyo. Considering the low levels of vaccine coverage of dogs in Northern Nigeria as seen from the evidence, it will be safe to assert that hunters and butchers a population group known to be constantly in close contact with these dogs most of which are unvaccinated are highly at risk of rabies infection either from bites and scratches during handling (hunters) or through cuts and wounds during meat processing (butchers) (Adesola et al., 2023). The evidence thus reveals a wide gap in the number of unvaccinated dogs in Nigeria as well as the need for the government to adopt the principle of health promotion above to urgently implement a healthy vaccination policy in the country for dogs and their owners especially hunters who own large packs of dogs. According to previous research, dog meat markets in Nigeria also contribute significantly to the burden of rabies, and dogs slaughtered

in these markets have been found to be seropositive for rabies virus (Eze et al., 2020). This implies that policies will need to be implemented to reduce or restrict dog slaughter in these markets.

According to World Population Review (WPR), Nigeria is currently the highest consumer of dog meat in Africa because of the indiscriminate activity of hunters and butchers who engage in dog meat trade (*Dog Consumption Legality 2024*, n.d.). Dog meat trade is mostly carried out by hunters and butchers who breed these dogs and sell most of them to ready dog meat markets (Adesola et al., 2023). Implementing government policies that regulate the dog meat trade and enforce mandatory vaccination programs can also contribute to reducing the prevalence of rabies among dogs in Northern Nigeria (Adesola et al., 2023). Overall, the evidence has shown that there is a low vaccination coverage not just in Northern Nigeria but in Nigeria as a whole and this low coverage is a risk factor contributing to the prevalence of rabies in the country which puts hunters and butchers at risk of rabies infection making it imperative for the implementation of effective vaccination policies by the government.

THEORETICAL CRITIQUE

Socioecological Model of Health

Haven highlighted in the introductory chapter on how the prevalence of rabies among hunters and butchers in Northern Nigeria is a significant public health concern Gan et al. (2023), the socioecological model of health under this theoretical critique will be used to provide valuable insights into understanding the underlying factors that contribute to this issue based on evidence from the result section and other relevant literature. The socioecological model of health has a conceptual framework that demonstrates the complex interplay between individual and environmental factors and the role they play in determining health outcomes among populations such as hunters and butchers in Northern Nigeria. Looking at the role of culture

and social factors as outlined in the model suggests that individuals in Northern Nigeria whose cultural norms and societal values permits the use of dogs for hunting and the slaughter of dog meat for food may not only stand the risk of exposure to rabies but may also contribute to the prevalence and epidemiological spread of rabies within the regions where these cultures and social believes are upheld. These cultural factors express themselves through belief systems, attitudes and practices some of which were seen to be measured or assessed in some of the included studies where some respondents identified as traditional hunters, dog handlers and dog butchers (Ameh et al., 2014 & Odeh et al., 2013). Unfortunately, the risk associated with holding onto such kinds of beliefs and practices predisposes these people groups towards contracting rabies either through sustained bites from rabid dogs or infection of wounds during the processing of dog meat (brain or nervous tissues) infected with rabies virus. (Daigle et al., 2023).

At the level of public policy, the socioecological model demonstrates the role policies play in determining health outcomes in populations. Unlike countries like Argentina, Mexico, Columbia, Macau, United States of America where dog meat consumption is illegal, Nigeria as a country currently does not have any policy that prohibits individuals from consuming dog meat neither is there a policy that makes anti rabies vaccination compulsory for dog owners, hunters or butchers and their animals (Abubakar et al., 2023). With these kinds of policies absent, individuals will continue to carry out these risky dog eating and handling practices unhindered thereby maintaining or promoting the transmission of the virus both within animal populations and between animal and human populations (Abubakar et al., 2023). Therefore, this theory helps to explain why dog meat slaughter and consumption is a risk factor to the prevalence of rabies in Northern Nigeria because of the lack of dog welfare policies and anti-rabies vaccination policies both for humans and animals.

At the organisational level, this model describes the role of health care institutions in providing medical interventions and awareness campaigns on rabies detection and prevention (Friant et al., 2015). For instance, due to economic burdens faced by some of these rural areas in Northern Nigeria where most of the activities of hunters and butchers take place, healthcare services are limited and hardly accessible coupled with poor road infrastructure to get to these centres (Friant et al., 2015). Thus, reporting cases of suspected rabies in dogs or humans for accurate and timely diagnosis is greatly hampered which leaves most cases undiagnosed, misdiagnosed or under reported which by implication increases the risk of exposure of the target population and increases the prevalence of the disease (Abubakar et al., 2023). The level of enlightenment and public awareness which public health institutions can deliver to individuals especially dog owners and those associated with dogs is a significant determinant to the prevalence of rabies among hunters and butchers in Northern Nigeria as evidence from some of the included studies shows the gross level of ignorance about rabies by hunters, butcher and even some dog owners (Ameh et al., 2014 & Odeh et al., 2013). According to the socioeconomic model, economic factors also play a significant role in determining health outcomes in a population. Economic factors like poverty and limited employment opportunities can potentially cause individuals to engage in dog meat trade as an alternative source of livelihood leading to increased chances of exposure to the virus as they engage in these kinds of trades and practices (Ijoma et al., 2022). In 2022, the Federal Government of Nigeria launched the results of the Multidimensional Poverty Index (MPI) survey which revealed that 63% of Nigerians (133 million) live in abject poverty with 65% of these poor persons (86 million) living in Northern Nigeria (*About | National Bureau of Statistics*, n.d.). These statistics provide evidence to show how poverty as a socioeconomic risk factor can exacerbate the prevalence of rabies among hunters and butchers in Northern Nigeria. Furthermore, the socioeconomic model also helps to explain the role of the environment in the prevalence of rabies among hunters and butchers in Northern

Nigeria (Nguyen et al., 2021). Environmental factors such as the presence of rabies-infected animals in the wild like foxes, racoons and bats which serves as reservoir host of the rabies virus can still shed the virus innocently unto other animals such as hunting dogs whenever they interact in the wild (Ijoma et al., 2022). The lack of proper sanitation in butchering facilities can also contribute to the transmission and spread of rabies among butchers who fail to use protective clothing while processing meat (Ijoma et al., 2022). At the level of the individual, interpersonal and community networks, the socioecological model allows for a comprehensive understanding of the prevalence of rabies among hunters and butchers in Northern Nigeria. The individual-level factors that may contribute to the prevalence of rabies among hunters and butchers as seen from the included studies include knowledge and awareness of rabies, personal attitudes towards animals, and preventive behaviours such as vaccination and proper animal handling (Ameh et al., 2014 & Odeh et al., 2013).

However, while the socioecological model of health provides a robust framework for understanding the multiple determinants of health outcomes, it is essential to critically analyse the theory when applying it to specific contexts, such as the prevalence of rabies among hunters and butchers in Northern Nigeria. One potential critique of the socioecological model in understanding the prevalence of rabies among hunters and butchers in Northern Nigeria is that it may not fully capture the complex and dynamic nature of religious, cultural and social factors that influence hunting and butchering practices in the region (Bardosh, 2018). The socioecological model may also overlook the influence of global factors like terrorism and its impact on food security in Northern Nigeria such as with the 'Boko Haram' insurgency that has plagued the region since 2009 (Lekan, 2021). Studies by Lekan (2021) shows how the activity of insurgents through cattle rustling has displaced livestock farmers from their farms thereby causing an inflation in the price of beef which is the common source of animal protein in Northern Nigeria. This has led to the consideration of cheaper alternative sources of animal

protein such as dog meat hence promoting dog meat trade in the region which by implication has facilitated the prevalence of rabies (Lekan, 2021). By implication insurgency somewhat acts like a confounding variable since it does not directly have a causal effect on the prevalence of rabies among hunters and butchers in Northern Nigeria. This is because the above evidence by Lekan (2021) suggests a reason why there is high association of hunters and butchers with dogs and dog meat in Northern Nigeria as reported in the synthesis of the studies by Ameh et al. (2014) and Odeh et al. (2013). The confounding variable of insurgency thus encourages the use of dogs for protection by these hunters against the insecurity caused by insurgents in the region to safeguard their homes and properties which then increases their risk of exposure to rabies infection. Additionally, while the socioecological model considers economic factors as determinants of health outcomes, it may not sufficiently emphasise the role of geopolitical factors like rural- urban migration due to political instability in the prevalence of rabies among hunters and butchers in Northern Nigeria. Olaniyan and Yahaya (2016) provide evidence which shows that Northern Nigeria has suffered from geopolitical crisis in recent years which has led to different forms of insecurity (kidnapping, banditry, cattle rustling), internal displacement of rural dwellers (e.g. hunters) from their native settlements to urban areas, refugee camps or even neighbouring countries like Niger and Chad. Under these harsh circumstances certain people groups like dog owners, hunters and butchers and their families are be forced to migrate wherever they go with these animals thereby facilitating the distribution of this virus across different regions and territories especially with the fact that there are no effective border control measures nor proper rabies surveillance systems in place to track the arrival of new animals into a territory (Olaniyan & Yahaya, 2016). Therefore, to comprehend wider aspects of the prevalence of rabies where the socioecological model cannot explain sufficiently, such as economic inequalities, politics and terrorism, it will be imperative to conduct a culturally

sensitive and context-specific research that goes beyond the individual-level factors typically considered in the socioecological model.

Applying the Socioecological Framework to Rabies Prevention

When applying the socioecological framework in designing public health interventions such as rabies prevention, the interventions should aim to improve knowledge and awareness of rabies, promote positive attitudes towards animals, and encourage preventive behaviours such as vaccination and proper animal handling (Ijoma et al., 2022). These interventions should also be tailored towards meeting the specific needs and circumstances of hunters and butchers in Northern Nigeria, considering their cultural beliefs, social norms, economic and geographical challenges (Ijoma et al., 2022).

At the individual level, educational campaigns can be implemented to provide accurate information about rabies transmission, symptoms, and prevention strategies as there is a huge knowledge gap amongst some of the respondents. For instance, studies by Odeh et al. (2014), showed that 71.2% of the respondents (butchers and dog handlers) did not know that rabies was zoonotic and highly fatal while Ameh et al. (2014) also showed that 73% of the respondents (butchers and dog handlers) did not know that butchers were at risk of rabies infection. At the interpersonal level, community leaders, healthcare providers (nurses, doctors, caregivers) and veterinarians can play a key role in promoting rabies prevention practices by engaging in dialogue with hunters and butchers through their respective associations or groups to address any misconceptions or concerns they may have about rabies prevention (Lie et al., 2021).

At the community level, efforts can be made to improve access to healthcare services and veterinary services such as diagnostic laboratories which are able to diagnose rabies virus using DFAT the gold standard test as evidence shows that none of the states where these studies were

carried out had a DFAT enabled laboratory except for the studies conducted by Ehimiyein et al. (2010) and Odeh et al. (2014) in Kafanchan Kaduna State which used the Ahmadu Bello University Veterinary Teaching Hospital present in the same state. By implication states which lack rabies detection laboratories will suffer the risk of misdiagnoses or under reporting. Therefore, using the socioecological model to achieve rabies prevention in Northern Nigeria may require establishing more state equipped laboratories or mobile clinics which can carry out on field diagnosis with rabies rapid diagnostic kits (Nguyne et al., 2021).

Cultural and Behavioural Factors Influencing Rabies Risk in Northern Nigeria

Cultural and behavioural factors can significantly influence the risk of rabies among hunters and butchers in Northern Nigeria. The socioecological model of health recognises the importance of these factors and suggests that interventions should consider cultural beliefs, attitudes, and practices to effectively address the prevalence of rabies in this context. For instance, the studies by Suleiman et al. (2020) conducted in Billiri and Kaltungo in Gombe state is home to a popular tribe called "Tangale" which have been known for consuming dog meat since over a century because of their belief that dog meat confers certain spiritual powers for protection (Garba et al., 2013). In 2021 a year after the Study by Suleiman et al. (2020) recorded 60% infection rate in brain samples of dogs slaughtered for meat, a daily newspaper in Nigeria called Nigerian News Leader published a report on "Shag bai" festival a 3-day carnival hosted by the Tangale people in Billiri from the 26th – 28th December 2021 where hundreds of dogs were butchered and prepared into various meat delicacies to mark the celebration and revival of an almost extinct annual cultural tradition among the people (Nigeria, 2021). Other well-known newspaper agencies like Independent Newspaper and African Prime News also reported the event which drew the attention and criticism of animal welfare groups, veterinarians as well as vegetarians within and outside the country (Reporter, 2022).

Although newspaper and media reports fall at the bottom of the hierarchy of evidence, they still help to capture events in history providing information which can be further investigated (Babic-Rosario et al., 2019). The implication of these kinds of cultural practices if left to continue will lead to higher levels of incidence and prevalence of rabies infection in dogs and humans especially in dog butchers who process the meat of possibly infected dog brain tissues. Zootherapy is another cultural factor that may contribute to the prevalence of rabies among hunters and butchers in northern Nigeria as it involves the use of animals or animal products for traditional healing (Gurumyen et al., 2020). In the study by Okeme et al. (2020) conducted in Lokoja, Kogi State, 208 brain samples of dogs were collected from different slaughter markets for the research. However, most of the dogs brought to the dog markets in Lokoja were supplied from other neighbouring states with Plateau State contributing the greatest number of live dogs supplied 96 (46.1%) followed by Nassarawa State 83 (39.9%) and Kogi State 29 (13.9%). Although the exact communities where these dogs were sourced were not reported by the researcher, Evidence by Gurumyen et al. (2020) in a study conducted in Plateau State to examine the use of dog meat for zootherapy shows that communities in 'Kanke' one of the local government areas of Plateau State which is also in Northern Nigeria, practice the use of dog meat as a means of traditional healing for individuals with various bodily ailments. This supporting evidence by Gurumyen et al. (2020) provides a supporting basis for why most dogs butchered in Kogi State for meat were sourced from Plateau State (46.1%) as reported by Okeme et al. (2020). The use of dog meat in healing ailments however has no scientific basis and only remains a superstitious belief that certain people hold thus by implication individuals in communities like Kanke who engage in the use of dog meat either for consumption or traditional are highly at risk of contracting rabies virus from infected dogs or are largely responsible for facilitating the spread of the virus through poor practices like cruel animal handling or aggregation of dogs from different areas at slaughter points without proper

screening or surveillance (Nguyen et al., 2021). Furthermore, the lack of proper knowledge and awareness by these people on the implications of their cultural or traditional practices may lead to a disregard for anti-rabies interventions such as vaccination or proper handling of potentially infected animals (Daigle et al., 2023). In closing, implementing a socioecological approach in rabies vaccination programs for hunters and butchers in Northern Nigeria can have several implications. Therefore, it is important to recognise that individual-level factors such as knowledge and beliefs about rabies play a crucial role in determining preventive behaviours (Daigle et al., 2023). Education and awareness programs should be developed to address misconceptions and provide accurate information about rabies transmission, prevention, and treatment (Nguyen et al., 2021). Interventions should carefully consider the cultural beliefs and practices of different cultures like the Tangale and Kanke tribes and different individuals at risk like hunters and butchers in Northern Nigeria by engaging with community leaders and religious authorities to promote accurate information about rabies and its prevention (Daigle et al., 2023). Summarily, based on the findings from the results across all 5 included studies, risk factors associated with the prevalence of rabies among hunters and butchers in Northern Nigeria as explained by the socioecological model of health are summarised in the conceptual diagram below.

Figure 5

Socioecological Framework Showing Risk Factors of Rabies in Northern Nigeria

Public Policies, ban on dog meat consumption

Community & Culture e.g. 'Shag bai' dog festival, Tangale tribe

Institutional: rabies education in schools

Interpersonal, families, friends

Individual, knowledge, attitudes and behaviours on rabies
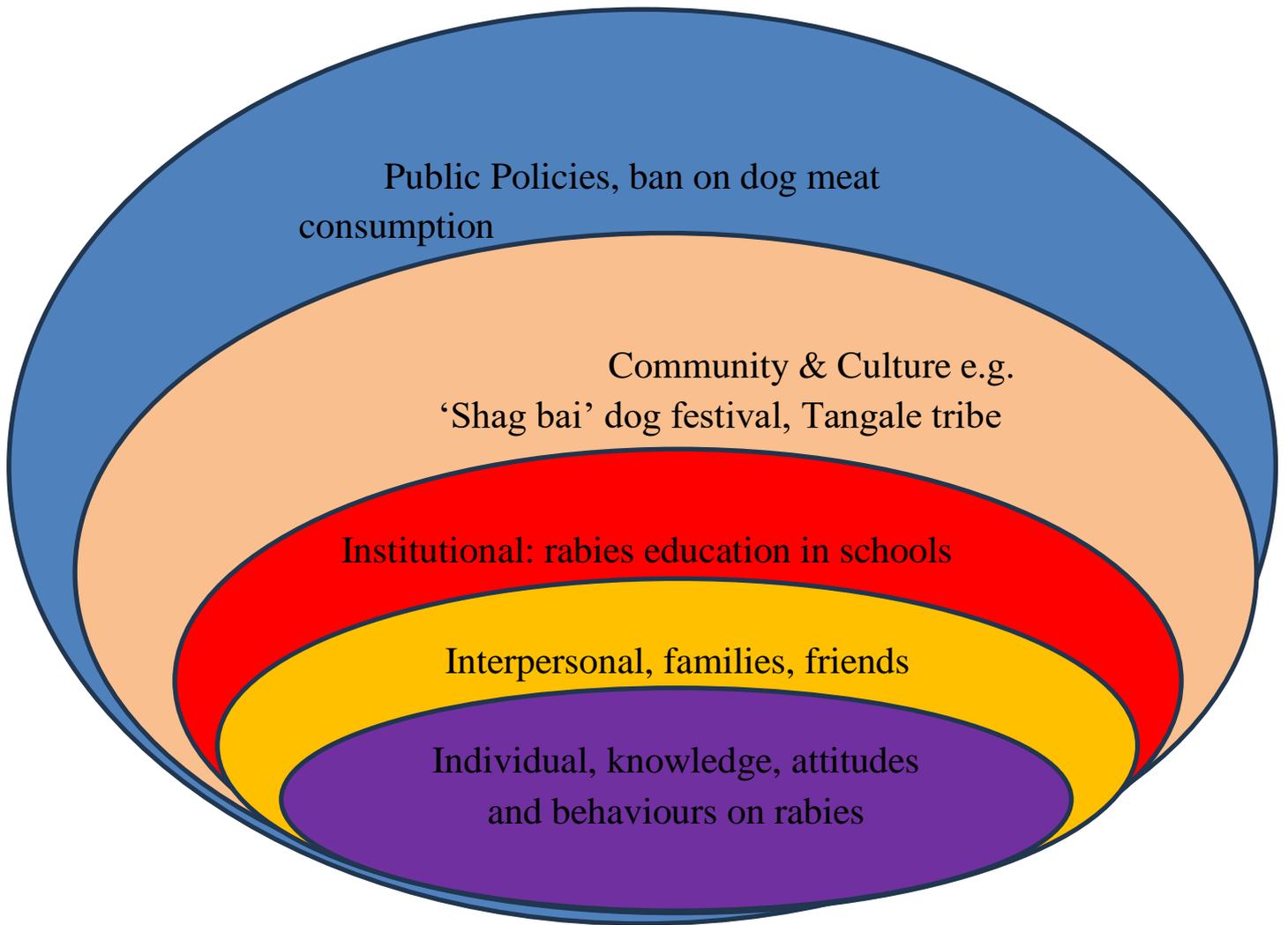
Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is another important model that provides a relevant framework towards understanding the prevalence of rabies among hunters and butchers in Northern Nigeria. TPB which is a social cognitive theory was developed by Icek Ajzen and is a well-known tool because of its applicability in the fields of social psychology and health behaviour mostly used to predict human behaviour (Ajzen, 1991). According to TPB, human behaviour is influenced by the individual's intention to engage in that behaviour, which is, in turn, influenced by three main factors: attitudes, subjective norms, and perceived behavioural control (Ajzen, 1991). The objective of this section is to critique the potential role of the TPB in understanding the prevalence of rabies among hunters and butchers in Northern Nigeria based on findings from the included studies. Before examining the various components of the TPB it is important to recall that the common behaviour (exposure variable) that makes hunters and butchers (population) in Northern Nigeria at risk of rabies infection (outcome variable) is dog meat consumption or dog association. The first component of the TPB is behavioural intentions, which refers to an unseen or unspoken level of willingness or innate desire which motivates an individual to act out or express a behaviour (Ajzen, 1991). In the context of rabies and its prevalence among hunters and butchers in Northern Nigeria based on the findings from the included studies, the TPB suggests that the behavioural intention of hunters and butchers ranges from a desire for food satisfaction from dog meat, desire to earn a living of the sale of either live dogs or slaughtered dog meat, the desire to feel protected when hunting with a dog. In Wukari, Taraba State, 86 out of 200 of the respondents (43%) in the study by Ameh et al. (2014) are self-employed based on occupational status where the desire to earn a living is the behavioural intention of engaging in dog meat trade or slaughter. In another study by Odeh et al. (2014) carried out in Zaria and Kafanchan in Kaduna State, out of a total of 160 respondents,

111(69.4%) were involved in dog handling and dog meat consumption which was the behavioural intention for associating with dogs while 49 (30.6%) were involved in in dog sale and dog slaughter which was the behavioural intention for associating with dogs. These intentions are among the driving forces behind why they express the behaviours of associating with dogs either for consumption or for protection which by implication exposes them to the risk of infection with rabies. While the TPB provides a useful framework for understanding behavioural intentions, it is important to note that cultural and socioeconomic factors may influence the intentions of these sets of people (Morowatisharifabad et al., 2014). In the light of the above consideration, TPB as a theoretical framework has limitation in the context of rabies prevalence among hunters and butchers in Northern Nigeria because it is unable to vividly explain how cultural and socioeconomic factors influence the behavioural intentions of hunters and butchers who associate with or consume dog meat unlike the socioecological model of health (Morowatisharifabad et al., 2014).

The next three components of TPB which includes personal attitudes, subjective norms and perceived behavioural control will be considered consecutively. Personal attitudes within the TPB framework describes the summation of an individual's knowledge, attitude which contributes to the thought process of an individual about a behaviour (Ajzen, 1991). Only 2 out of 5 studies assessed the personal attitudes of respondents towards dogs, dog meat and rabies. In the study by Ameh et al. (2014), 113 out of 200 respondents (56.5%) reported that their personal attitude towards an unknown or stray dog was to stay away or maintain a distance. Although this may seem like a positive attitude, it does not in however eliminate the risk of these individuals from exposure to rabies as rabies virus infection in dogs has a dumb form where the dog though infected may not exhibit clinical signs of infection thus making giving the owner or handler of such a dog no reason to take precaution or stay away from the dog unlike the furious form of rabies where the dog exhibits clear neurologic signs of psychosis

(Ghosh et al., 2009). The studies by Odeh et al. (2014) reported the mean score of personal attitudes of respondents in their study towards rabies to be 6.38 out of 9 interpreted as moderately positive attitudes.

Subject norms under TPB considers the idea people hold about what others think about a certain behaviour (Ajzen, 1991). In the context of the prevalence of rabies among hunters and butchers, some of the included studies have shown how certain cultures and communities view dogs, and the consumption of dog meat as a generally acceptable practice (Tangale and Kanku tribes) hence individuals would prefer to still behave in this manner with no reason for change since other members of their communities find the practice acceptable (Gurumyen et al., 2020).

Perceived behavioural control, which is the last component of TPB, describes how internal and external factors influence how people perceive the extent of control they have over a certain behaviour (Ajzen, 1991). The current absence of policies and laws to penalise individuals who engage in mishandle dogs in unruly or cruel forms especially by butchers will rather fuel continuation of behaviours like this which increase the rabies transmission both among dogs and between dogs and humans (Adesola et al., 2023). While the Theory of Planned Behaviour helps to dissect the underlying reasons on the prevalence of rabies among hunters and butchers in Northern Nigeria, it is important to consider contextual factors and the role of individual agency in predicting human behaviours. TPB as a framework is limited with regards to as it does not help to explain the role of contextual factors such as availability of resources, access to healthcare facilities, and how these factors affect help to predict the behaviour of hunters and butchers towards association with dogs or dog meat as well as the risk involved with this association (Lembo, 2012).

Critiquing the framework further highlights a gap within the framework that fails to consider ecological and environmental dynamics within this population and how it can influence the behaviour of these people. These factors can significantly impact individuals' abilities to

engage in rabies prevention behaviours, such as seeking medical care for potential exposure. For instance, Ameh et al. (2014) describes Wukari the location for their study as a rocky and highly mountainous area with 2 major rivers Donga and Benue passing through the town. By implication individuals who live in communities that are hardly motorable will find it difficult to access health care services in situations where there is the need to report a rabies case or access rabies post exposure prophylaxis in the case of individuals who sustain dog bites.

Another key limitation of the TPB in explaining the prevalence of rabies among butchers and hunters is that the framework does not have a component that captures the complexity of psychological factors which influence rabies prevention behaviours amongst hunters and butchers in Northern Nigeria. For example, the theory does not account for potential psychological barriers or fears that these individuals may face when it comes to actively engaging in rabies prevention programs like vaccination campaigns. Some of these psychological barriers include lack of trust in the vaccine and the fear of adverse effects from anti-rabies vaccine both on them as individuals and on their dogs (Beyene et al., 2018).

Supporting this case is the study by Odeh et al. (2013) which reported that 24 out of 200 respondents (comprising of hunters' dog butchers and other dog owners) did not see the need for hunters, butchers and dog owners to receive anti-rabies vaccination although most of the respondents (136) thought it was necessary. These 24 respondents who do not see the need for receiving anti-rabies vaccine based on their lack of understanding on the vaccine's importance can hinder the potential success of a rabies awareness or anti-rabies vaccination campaign especially when the goal of the vaccination program is to achieve herd immunity (Beyene et al., 2018 & Odeh et al., 2013).

METHODOLOGICAL CRITIQUE

Introduction to Cross-Sectional Study Design Critique

Cross-sectional study is a type of study design commonly used to measure the exposures and outcomes observed among the participants in the study at a single point in time (Setia, 2016). Researchers often employ this design when conducting studies to determine the prevalence of a disease condition within a specific population at the same time (Setia, 2016). All 5 included studies Ameh et al. (2014); Odeh et al. (2013); Suleiman et al. (2020); Okeme et al. (2020) and Ehimiyein et al. (2010) utilised cross-sectional study design in conducting their research. However, it is important to acknowledge the strengths, limitations and methodological concerns associated with the use of cross-sectional study design in these studies.

Strengths

According to Wang and Cheng (2020), one key strength with cross sectional studies is that they can be used to estimate measures of association between multiple exposures and outcome variables like prevalence and odds ratio as seen in all the included papers. These measures of association are relevant in answering the research question for this systematic review which is to determine the prevalence of rabies among hunters and butchers in Northern Nigeria. To demonstrate the accuracy of how well all 5 included studies Ameh et al. (2014); Odeh et al. (2013); Suleiman et al. (2020); Okeme et al. (2020) and Ehimiyein et al. (2010) estimated prevalence between various exposure and outcome variables in their studies, it is important to highlight the definition of prevalence. Prevalence in medical epidemiology refers to the proportion of individuals with a disease condition or with a certain characteristic at a specific time (point prevalence) or during a certain period (period prevalence) (Spronk et al., 2019).

Based on the above definition, prevalence can be calculated as:

Prevalence (%) =   total number of individuals with a disease

_____   X 100

total population at risk of the disease

Prevalence (%) =   number of individuals in a sample with a characteristic

_____   X 100

total number of individuals in the sample

Based on prevalence in the context of the strength of the included studies, Ameh et al., 2014 measured the association between the purpose of owning a dog and the risk of having a dog bite which is a very relevant information that can aid in answering the research question. While 95 % of the respondents in Wukari, Taraba State owned dogs because of protection, 21.5% of those who owned dogs for the sake of protection (mostly hunters), reported they had been bitten at least once by their dogs (Ameh et al., 2014). Some of these dog bites sustained by the individuals may have been unprovoked bites which is the kind of bite commonly associated with rabid dogs. Although the type of bite is not mentioned in the study, it is important to note that most rabies infections from dog bites in humans are due to unprovoked bites because dogs do not have the habit of biting their owners without any initial provocation which may arise due to wrong handling most times (*CDC - Exposure: Types of Exposure - Rabies*, n.d.). In addition, the low vaccine coverage of dogs in Wukari, Taraba (13.5%) as reported by Ameh et al. (2014) also infers that most of the dogs responsible for those bites may be unvaccinated which is further puts the victims of these bites mostly hunters and other dog owners at risk of rabies infection. Odeh et al. (2013) also uses prevalence to measure the association between

the purpose of owning a dog and the risk of exposure to dog bite among respondents in Zaria and Kafanchan Kaduna State. 27% of the respondents who kept dogs for the purpose of hunting and for consumption reported they had been bitten by their dogs while 30.6% of respondents who kept dogs for the purpose of slaughter (butchers) reported they had been bitten by their dogs. Although the type of bite still was not mentioned in this study, as in the dog bite cases in Wukari by Ameh et al. (2014), these bites could also have been unprovoked bites which by implication means that these people groups are at risk of rabies infection if bitten by an unvaccinated rabid dog. Furthermore, on strengths of the study design, most cross-sectional studies are done through questionnaires as is the case with most of the included studies in this systematic review thus the cost of reaching a large sample population is relatively inexpensive (Wang & Cheng, 2020). Also, the participants are neither directly exposed or treated and as such there are minimal ethical constraints (Wang & Cheng, 2020).

Limitations

One significant limitation of a cross-sectional study design is the inability to establish a temporal association between exposure and outcome. Based on Bradford Hill's criteria for causation which are a group of nine principles or viewpoints used in epidemiology and public health research to determine causal relationships, exposure precedes outcome (Fedak et al., 2015). Therefore, because cross-sectional studies are conducted at a single point in time, they do not allow for the determination of the sequence of events (Wang & Cheng, 2020). Thus, without a temporal sequence, it becomes difficult to establish whether the exposure (in this case, dog meat consumption, dog association or dog bite) precedes the outcome (rabies infection) or vice versa (Fedak et al., 2015). This is the case with all 5 included studies which measured associations between exposure and outcome variables at a certain period.

Another chief limitation of cross-sectional study design is the potential for selection bias. The respondents in the studies by Ameh et al. (2014); Odeh et al. (2013); Suleiman et al. (2020); Okeme et al. (2020) and Ehimiyein et al. (2010) were selected based on certain inclusion criteria such as occupation set by the researchers according to the respective aims and objectives of their study. The process of selection could introduce bias as individuals who choose to become hunters or butchers may have different characteristics or behaviours that could affect their risk of rabies infection compared to the general population. Another limitation of cross-sectional study is the inability to account for and address potential confounding factors that may influence the relationship between the exposure and outcome (Friant et al., 2015). Under the theoretical critique of the socioecological model of health certain confounding factors which were not captured in any of the 5 included studies were identified such as rural-urban migration, availability and accessibility of health services, tough topography of some regions and the effect of insurgency all of which influence the association between the exposure (dog meat consumption, dog association or dog bite) and the outcome (rabies infection) on the target population (hunters and butchers). Furthermore, the limitation of cross-sectional studies is limited Causal Inference. Since cross-sectional study designs only provide information on the prevalence or frequency of a condition or disease in a specific population at a given moment, this limits the study's ability to make causal inferences about the relationship between the exposure and outcome (Ross & Zaidi, 2019). For example, across all 5 included studies by Ameh et al. (2014); Odeh et al. (2013); Suleiman et al. (2020); Okeme et al. (2020) and Ehimiyein et al. (2010), the cross-sectional design used does not allow for determination of whether being a hunter or butcher directly causes an increased risk of rabies infection or if there are other factors at play. Moreover, cross sectional studies have a limited generalisability since they can only provide a snapshot of the prevalence of a condition or disease at a specific point in time and within a specific population (Ross & Zaidi, 2019). The

challenge is that it limits the generalisability of the findings to other time periods or populations (Ross & Zaidi, 2019). For example, it would have been more beneficial to know the prevalence of dog bite cases reported Ameh et al., (2014) and Odeh et al., (2013) in Taraba and Kaduna State respectively over a longer period instead of a point in time to observe the epidemiological patterns established over time. Finally, the reliance on self-reported data by all 5 included studies Ameh et al. (2014); Odeh et al. (2013); Suleiman et al. (2020); Okeme et al. (2020) and Ehimiyein et al. (2010) introduces the potential for recall bias by the respondents. The respondents may also underreport or overreport certain information regarding their exposure to rabies, dog bites, dog meat or vaccination history leading to inaccurate prevalence estimates. Overall, while cross-sectional studies can provide useful information on the prevalence and associations of various exposures and outcomes, they have limitations when it comes to establishing causality, temporality, generalisability and providing detailed information on the proportion of hunters, butchers and individuals who precisely have rabies infection because of dog bites, their close association or activity with dogs or their dog meat consumption behaviours.

Ameh et al. (2014) study methods and limitations

Ameh et al. (2014) used a cross-sectional study design to assess the knowledge, attitude and practice of dog owners to canine rabies in Wukari, Taraba State. While the study provides valuable information on the association between the purpose of owning a dog and the risk of having a dog bite amongst other relevant details already discussed under the theoretical critique, there are methodological limitations that need to be considered. One chief limitation is the possibility of having type 1 (false positive) or type 2 error (false negative) due to the sample size used. Ameh et al. (2014) in their study used a sample size of 200 people out of a given estimated population of 241,546 people in Wukari metropolis. Using Qualtrics, which is one of the recommended software tools for calculating sample size shows that the ideal sample

size for this study should be 384 based on 95% confidence intervals 95% and 5% margin of error as stated in the study (Qualtrics, 2023). Therefore, using a sample size of 200 instead of 384 could have led to erroneous inference because of using a sample size that is not a true representation of the total population. Another limitation is the reliance on self-reported data. Respondents in the study by Ameh et al. (2014) were asked to recall their occupation and any previous exposure to rabies, which introduces the possibility of recall bias. Some respondents may not accurately remember or disclose their true occupation, exposure history to a dog bite or even exposure to dog meat by consumption, leading to biased prevalence estimates. Additionally, since cross-sectional study design does not allow for the establishment of causality or temporality, this means that the study could not determine whether hunters or butcher were directly the cause for the prevalence of rabies in the region. Furthermore, the study design does not provide information on the natural history of rabies among hunters and butchers (Ling et al., 2023).

Odeh et al. (2013) study methods and limitations

Odeh et al. (2013) conducted a cross-sectional study to assess the risk of possible exposure to rabies among processors and consumers of dog meat in Zaria and Kafanchan, Kaduna state, Nigeria. The study provides valuable insights that show dog meat processors (butchers) and everyday consumers are deficient in their knowledge of rabies and also dog meat processors (butchers) are still at risk of exposure to rabies. However, there are methodological limitations that need to be addressed. First, the study relied on convenience sampling for recruiting respondents who process and consume dog meat which may have introduced selection bias. This is because the selected individuals in the study may not be representative of all processors and consumers of dog meat in Zaria and Kafanchan, Kaduna State as those who did not participate may have been busy engaging in other activities even though they still fit into the

inclusion criteria (Odeh et al., 2013). Additionally, because the study design was cross-sectional, it means the data was collected at a single point in time and this limits the ability to establish a causal relationship between being a butcher or dog meat consumer and the prevalence of rabies (Odeh et al., 2013). Inadequate sample size is also a concern in this study by Odeh et al. (2013) as they did not provide justification for the sample size of 160 respondents selected considering there could be more butchers and dog meat consumers in the area. Using Qualtrics to calculate the ideal sample size for this study based on the estimated population of individuals given for Zaria (547,000) and Kafanchan (83,092) which sums up to 630,092 gives an ideal sample size of 384 (Qualtrics, 2023). Therefore, using a relatively smaller sample size of 160 instead of 384 by Odeh et al. (2014) may limit the statistical power of the study and lead to possible type 1 or type 2 error or imprecisions in the prevalence estimates. The reliance on self-reported data is another limitation of the study. Respondents were asked to recall details on their knowledge of rabies, history of dog bite, vaccine status or any previous exposure to rabies, which introduces the possibility of recall bias (Odeh et al., 2014). This is because respondents may not accurately remember or disclose all the information asked in the questionnaire, leading to biased prevalence estimates. Furthermore, the study does not provide information on important confounding factors that may influence the prevalence of rabies among butchers and dog meat consumers (Odeh et al., 2013).

Suleiman et al. (2020) study methods and limitations

Suleiman et al. (2020) conducted a cross-sectional study to check the molecular dynamics of rabies virus among slaughtered dogs in Billiri and Kaltungo, Gombe state. However, there are some methodological limitations of this study that need to be addressed. First, the study design relied on convenience sampling, which may have introduced selection bias. 50 brain samples of dogs slaughtered for meat were collected at different dog meat markets across Billiri and

Kaltungo out of which 3 samples tested positive for rabies virus (Suleiman et al., 2020). Since convenience sample was done instead of randomisation, other dog brain samples in other dog meat markets may have been missed resulting in a small sample size which may not be representative of the number of dog meat available in the entire dog meat market in Billiri and Kaltungo (Suleiman et al., 2020). By implication, this may limit the generalisability of the findings to the broader dog population in the area.

Okeme et al. (2020) study methods and limitations

Okeme et al. (2020) conducted a cross-sectional study to profile the public health risk of canine rabies transmission in Kogi state. The collection and analysis of vaccination records of dogs which had received anti-rabies vaccination at the veterinary clinic in the state during a 10-year period (2003 to 2013) at the same time provides a snapshot of the vaccine coverage (30%) in Kogi State and the population of both dogs and humans at risk of rabies infection in the area. However, there is a limitation of possible reporting bias by those responsible for inputting these records. This limitation can lead to the faulty inferences being drawn from this study (Chan et al., 2017).

Ehimiyein et al. 2010 study methods and limitations

Ehimiyein et al. (2010) conducted a cross-sectional study to determine the role of dog markets in the epidemiology of rabies in Kaduna state, northern Nigeria. The study confirmed rabies positive samples from among some dog markets which provided insights in the fact that some local dog markets in Kaduna may contribute to the transmission of rabies in that area (Ehimiyein et al., 2010). One limitation with this study is that it does not account for how it arrived at the sample size of 30 dog brain samples used for the study and this might have led to the use of an inadequate sample size which can introduce type 1 or type 2 error into the

research which might give either a false positive or false negative result based on the outcome of the laboratory diagnosis of rabies virus in the samples (Banerjee et al., 2009).

Overall Strengths and Limitations of the Review

Haven examined some of the strengths and limitations of the 5 included studies used in this review, this section briefly highlights the strengths and limitations of this systematic review process itself. One key strength of this systematic review is the fact that it followed the Cochrane Handbook for Systematic Reviews of Interventions which is a recommended protocol for systematic reviews (Higgins et al., 2023). Secondly, this review is replicable and reproducible because it has followed the above protocol. Thirdly, to reduce the risk of bias in the evidence, a check and balance system called critical appraisal of evidence was done using the JBI tool on all 5 included papers to ensure the papers used were fit for this review ("JBI Manual for Evidence Synthesis," 2020). Finally, the review was transparent as it was done with another independent reviewer to reduce the risk of bias due to human errors during the research process.

However, while this review has its strengths, it also has its limitations. Certain papers relevant to this study may have gone unretrieved because of insufficient keyword search inputted into the database while searching. The comprehensive list of the 9 papers excluded was not given although the reason for their exclusion was captured in the PRISMA diagram. Including the list of these studies may have given another reviewer a better understanding of the nature of evidence available around this topic. No grey literature was consulted for relevant pieces of evidence which may have denied this review of more studies in addition to the 5 which met the inclusion criteria. Having more papers would have given a broader scope on other studies carried out in other parts of Northern Nigeria regarding the prevalence of rabies among hunters and butchers.

RECOMMENDATIONS

This section provides certain evidence-based recommendations in line with the key principles of health promotion which can help to determine better health outcomes among the target population, other individuals, communities and even the country at large. First, Increasing educational programs and public enlightenment campaigns targeted at everyday people who own dogs, occupational groups like hunters and butchers and the public due to the lack of proper awareness and right knowledge on the right practices concerning animal health, welfare and the potential risk of rabies transmission (Sikana et al., 2021) Secondly, providing access to affordable and accessible anti-rabies post exposure prophylaxis for victims of dog bite case in health care centres together with affordable and accessible veterinary services, including anti-rabies vaccination for dogs, in rural and urban areas with large dog populations. (Thomas et al., 2013)

Thirdly, building and implementing government policies to regulate or ban the dog meat trade or dog meat consumption (Chen et al., 2023). Although this might be difficult considering the age-long nature of this practice and culture it is however doable as recently in January 2024, South Korea officially banned the sale and slaughter of dog meat which was in response to the increasing threat of rabies to that population (Lee, 2024). There is also the need to enforce mandatory vaccination programs for dogs by their dog owners (Chen et al., 2023). Seeing that there are a lot of gaps in the epidemiological dynamics of rabies in Northern Nigeria, there is the need to increase targeted surveillance in forest and woodland areas where hunting activities take place to detect canine rabies cases (Atuman et al., 2014).

Finally, Public health authorities in Nigeria needs to leverage on global anti-rabies intervention strategies as the fight against rabies will require concerted efforts which is why the 'Zero by 30' global strategic action plan to end dog mediated rabies by 2030 was set up in 2015 through

the collaboration of the WHO, the World Organisation for Animal Health (OIE), the Food and Agriculture Organisation of the United Nations (FAO) and the Global Alliance for Rabies Control (GARC) (Tidman et al., 2022). This plan encourages collaboration between veterinary services, public health agencies, and local communities to develop comprehensive rabies control programs (Tidman et al., 2022). These interventions however must be tailored to the specific needs and context of northern Nigeria, taking into consideration factors such as cultural practices, socioeconomic conditions, and access to healthcare services (Tidman et al., 2022).

CONCLUSION

The aim of this research was to assess the prevalence of rabies among hunters and butchers in Northern Nigeria and its associated risk factors. By virtue of the systematic review approach used to answer the research question, certain striking findings emerged upon which conclusions on the subject matter are made. This research has shown that hunters and butchers are a population group highly at risk of rabies infection because of their insufficient knowledge about the virus and their moderate attitude towards it. Unhealthy behaviours and practices like dog meat consumption, dog meat processing and handling of dogs without having an up-to-date anti-rabies vaccination record both for themselves and for their dogs, lack of safety measures like wearing protective clothing, hand washing with soap before or after associating or handling dogs especially of unknown history or source, all contribute to the risk of exposure to rabies by these individuals. Cultural practices like the 'shag-bai' dog festival of the Tangale people in Billiri and Kaltungo Gombe State as well as the practice of zootherapy by the Kanke people of Plateau State where dogs of unknown medical history and source are aggregated for slaughter where the meat is consumed or used for traditional healing practices also serve as risk factors to rabies infection not only to hunters and butchers in these communities but also

to other innocent individuals who unknowingly engage in such practices. This is seriously a thing of concern because the rabies detection line graph plotted from the synthesis of results on the diagnosis of dog brain samples shows that there is a prevalence of rabies among dogs in Northern Nigeria as the graph shows an increase in the number of rabies positive samples from the earliest samples analysed by Odeh et al. (2013) to Suleiman et al. (2020). Supporting the above result is another finding drawn from this study which reveals a low vaccination coverage among dogs in Northern Nigeria with Taraba State having the lowest rate of 13.5% among the other states studied under this review which explains why there is a prevalence in the number of positive rabies samples upon diagnosis. Haven summarised the key findings, it is safe to establish upon the set evidence that rabies is prevalent in dogs especially in Northern Nigeria with hunters and butchers highly at risk of infection. However, because of the inability to establish temporal association a key limitation with cross sectional studies which was the study design used by the authors of the 5 included studies, it was difficult to determine if the exposure to dogs or dog meat by the population (hunters and butchers) is what directly causes rabies infection (outcome) among the population. This drives home an important lesson that association does not always lead to causation which means that although the population of hunters and butchers in Northern Nigeria are highly at risk of rabies an infection which is prevalent in the region, it does not guarantee they will all be infected with rabies because of their association or practices with dogs and dog meat. To this end it will suffice to use the above findings from this research to enforce the 5 key principles of health promotion especially among multi-diverse cultures such as in places like Northern Nigeria. Building and implementing effective vaccination policies for dogs and their owners together with enforcing animal welfare policies that prohibits unhealthy practices like dog meat trade and consumption, can greatly reduce the spread of rabies in the region. Nigeria as a country and Africa as a continent can learn from other regions of the world that have eradicated rabies virus by aligning

with 'Zero by 30' the global strategic plan which contains a robust framework equipped with evidence-based action plans to end dog mediated human rabies by 2030 a vision which is still achievable.

REFERENCES

About | National Bureau of Statistics. (n.d.).
https://nigerianstat.gov.ng/news/78#:~:text=63%25%20of%20persons%20living%20
within,million)%20live%20in%20the%20South.

Abubakar, A. T., Al-Mustapha, A. I., Oyewo, M., Ibrahim, A., Abdulrahim, I., Yakub, J. M.,
Elelu, N., Nguku, P., Balogun, M. S., Awosanya, E. J., Kia, G., Kwaga, J. K. P.,
Okoli, I., Bolajoko, M. B., Alimi, Y., Mbilo, C., & Dacheux, L. (2023). Prospects for
dog rabies elimination in Nigeria by 2030. *Zoonoses and Public Health*.
https://doi.org/10.1111/zph.13084

Adedeji, A. O., Eyarefe, O. D., Babalola, E. T., Amusan, T. A., Amande, J. T., & Okonko, I.
O. (2010). Why is there still rabies in Nigeria? - A review of the current and future
trends in the epidemiology, prevention, treatment, control and elimination. *Electronic
Journal of Environmental, Agricultural and Food Chemistry*, *9*(8), 1283–1307.
https://www.cabdirect.org/abstracts/20103373305.html

Adesola, R O., Akinniyi, H T., & Lucero-Prisno, D E. (2023, February 1). An evaluation of the
impact of anti-rabies programs in Nigeria.
https://scite.ai/reports/10.1097/ms9.0000000000000250

Ahmed, K., Phommachanh, P., Vorachith, P., Matsumoto, T., Lamaningao, P., Mori, D., Takaki, M.,
Douangngeun, B., Khambounheuang, B., & Nishizono, A. (2015). Molecular epidemiology
of rabies Viruses circulating in two rabies endemic provinces of Laos, 2011–2012: Regional
diversity in Southeast Asia. *PLOS Neglected Tropical Diseases*, *9*(3), e0003645.
https://doi.org/10.1371/journal.pntd.0003645

Ajzen, I. (1991, December 1). The theory of planned behavior. Organizational Behavior and Human
Decision Processes, 50(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-t

Ameh, V. O., Dzikwi, A. A., & Umoh, J. U. (2014). Assessment of knowledge, attitude and practice of dog owners to canine rabies in Wukari Metropolis, Taraba State Nigeria. *Global Journal of Health Science*, *6*(5). https://doi.org/10.5539/gjhs.v6n5p226

Apanga, P. A., Awoonor-Williams, J. K., Acheampong, M., & Adam, M. A. (2016). A presumptive case of human rabies: a rare survived case in rural Ghana. *Frontiers in Public Health*, *4*. https://doi.org/10.3389/fpubh.2016.00256

Atuman, Y. J., Adawa, Y. A., Solomon, A. E., Mshelbwala, P. P., & Ogunkoya, A. (2014). Potential Risks for Rabies Spill-Over from Apparently Healthy Dogs to Wildlife in Bauchi State, Nigeria. *Journal of Veterinary Advances*, *4*(4), 493. https://doi.org/10.5455/jva.20140418115203

Babic-Rosario, A., Sotgiu, F., & De Valck, K. (2019). Conceptualizing the electronic word-of-mouth process: What we know and need to know about eWOM creation, exposure, and evaluation. *Journal of the Academy of Marketing Science*, *48*(3), 422–448. https://doi.org/10.1007/s11747-019-00706-1

Banerjee, A., Chitnis, U. B., Jadhav, S., Bhawalkar, J. S., & Chaudhury, S. (2009). Hypothesis testing, type I and type II errors. *Industrial Psychiatry Journal*, *18*(2), 127. https://doi.org/10.4103/0972-6748.62274

Bardosh, K. (2018, July 19). Towards a science of global health delivery: A socio-anthropological framework to improve the effectiveness of neglected tropical disease interventions. PLOS Neglected Tropical Diseases, 12(7), e0006537-e0006537. https://doi.org/10.1371/journal.pntd.0006537

Beyene, A. S., Mindaye, B., Leta, S., Cernicchiaro, N., & Revie, C. W. (2018). Understanding factors influencing dog owners' intention to vaccinate against rabies evaluated using health belief model constructs. *Frontiers in Veterinary Science*, *5*. https://doi.org/10.3389/fvets.2018.00159

Campbell, M., McKenzie, J. E., Sowden, A., Katikireddi, S. V., Brennan, S., Ellis, S., Hartmann-Boyce, J., Ryan, R., Shepperd, S., Thomas, J., Welch, V., & Thomson, H. (2020). Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. *The BMJ*, l6890. https://doi.org/10.1136/bmj.l6890

CDC - exposure: Types of exposure - rabies. (n.d.). https://www.cdc.gov/rabies/exposure/type.html#:~:text=Was%20the%20bite%20from%20a,that%20the%20animal%20is%20rabid.

Centers for Disease Control and Prevention. What are the signs and symptoms of rabies? Updated December 23, 2021. Accessed July 8, 2022, https://www.cdc.gov/rabies/symptoms/index.html

Chan, A., Pello, A., Kitchen, J., Axentiev, A., Virtanen, J. I., Liu, A., & Hemminki, E. (2017). Association of trial registration with reporting of primary outcomes in protocols and publications. *JAMA*, *318*(17), 1709. https://doi.org/10.1001/jama.2017.13001

Chen, R., Zeng, Y., Deng, Z. Y., Liu, H., Chen, M., & Liang, Y. (2023). Optimizing dog rabies vaccination services to the public: a Discrete choice experiment in Guangdong, China. *Animals*, *13*(11), 1767. https://doi.org/10.3390/ani13111767

Costa, G B., Gilbert, A T., Monroe, B., Blanton, J D., Ngam, S N., Recuenco, S., & Wallace, R M. (2018, June 21). The influence of poverty and rabies knowledge on healthcare seeking behaviors and dog ownership, Cameroon. PLOS ONE, 13(6), e0197330-e0197330. https://doi.org/10.1371/journal.pone.0197330

Daigle, L., Ravel, A., Rondenay, Y., Simon, A., Mokoush, K N., & Aenishaenslin, C. (2023, February 20). Knowledge, attitudes, and practices regarding dogs and dog bites in Indigenous northern communities: A mixed methods study. https://scite.ai/reports/10.3389/fvets.2023.1080152

Daigle, L., Ravel, A., Rondenay, Y., Simon, A., Mokoush, K N., & Aenishaenslin, C. (2023, February 20). Knowledge, attitudes, and practices regarding dogs and dog bites in Indigenous northern communities: A mixed methods study. https://scite.ai/reports/10.3389/fvets.2023.1080152

DeMars, M., & Perruso, C. (2022). MeSH and text-word search strategies: precision, recall, and their implications for library instruction. *Journal of the Medical Library Association*, *110*(1). https://doi.org/10.5195/jmla.2022.1283

Dodet, B. (2009). The fight against rabies in Africa: From recognition to action. *Vaccine*, *27*(37), 5027–5032. https://doi.org/10.1016/j.vaccine.2009.06.030

Dog Consumption Legality 2024. (n.d.). https://worldpopulationreview.com/state-rankings/dog-consumption-legality

Ehimiyein, A. M., Niezgoda, M., Orciari, L. A., Kuzmin, I. I., Osinubi, M., Ehimiyein, I. O., Adawa, D. a. Y., Sudi, A., Ogunkoya, A., & Rupprecht, C. E. (2010). Rabies cases in dog markets in Kaduna state, northern Nigeria. *International Journal of Infectious Diseases*, *14*, e476. https://doi.org/10.1016/j.ijid.2010.02.675

Ekanem, E. E., Eyong, K., Philip-Ephraim, E. E., Eyong, M., Adams, E., & Aa, A. (2014). Stray dog trade fuelled by dog meat consumption as a risk factor for rabies infection in Calabar, southern Nigeria. *African Health Sciences*, *13*(4), 1170. https://doi.org/10.4314/ahs.v13i4.44

Eze, U U., Coetzer, A., Scott, T P., Anene, B M., Ezeokonkwo, R., Nwosuh, C., Nel, L H., & Sabeta, C. (2020, February 28). Economic and feasibility comparison of the dRIT and DFA for decentralized rabies diagnosis in resource-limited settings: The use of Nigerian dog meat markets as a case study. https://scite.ai/reports/10.1371/journal.pntd.0008088

Fisher, C. R., Streicker, D. G., & Schnell, M. J. (2018). The spread and evolution of rabies virus: Conquering new frontiers. *Nature reviews. Microbiology*, *16*(4), 241. https://doi.org/10.1038/nrmicro.2018.11

Friant, S., Paige, S B., & Goldberg, T L. (2015, May 22). Drivers of Bushmeat Hunting and
Perceptions of Zoonoses in Nigerian Hunting Communities. PLOS Neglected Tropical
Diseases, 9(5), e0003792-e0003792. https://doi.org/10.1371/journal.pntd.0003792

Friant, S., Paige, S B., & Goldberg, T L. (2015, May 22). Drivers of Bushmeat Hunting and
Perceptions of Zoonoses in Nigerian Hunting Communities. PLOS Neglected Tropical
Diseases, 9(5), e0003792-e0003792. https://doi.org/10.1371/journal.pntd.0003792

Gan, H., Hou, X., Wang, Y., Xu, G., Huang, Z., Zhang, T., Lin, R., Xue, M., Hu, H., Liu, M., Cheng,
Z. J., Sun, B., & Zhu, Z. (2023). Global burden of rabies in 204 countries and territories, from
1990 to 2019: results from the Global Burden of Disease Study 2019. *International Journal
of Infectious Diseases*, *126*, 136–144. https://doi.org/10.1016/j.ijid.2022.10.046

Garba, A., Dzikwi, A. A., Okewole, P. A., Chitunya, W. B., Tirmidhi, A. B., Kazeem, H. M., &
Umoh, J. U. (2013). EVALUATION OF DOG SLAUGHTER AND CONSUMPTION
PRACTICES RELATED TO THE CONTROL OF RABIES IN NIGERIA. *Journal of
Experimental Biology and Agricultural Sciences*, *1*(ISSN No. 2320 – 8694).
https://irepos.unijos.edu.ng/jspui/handle/123456789/2779

Garg, A. X., Hackam, D. G., & Tonelli, M. (2008). Systematic review and meta-analysis. *Clinical
Journal of the American Society of Nephrology*, *3*(1), 253–260.
https://doi.org/10.2215/cjn.01430307

Garg, R. (2016). Methodology for research I. *Indian Journal of Anaesthesia*, *60*(9), 640.
https://doi.org/10.4103/0019-5049.190619

Glanz, K R M D B A S K. (2023, January 1). An Ecological Perspective on Health Promotion
Programs. https://journals.sagepub.com/doi/10.1177/109019818801500401

Gurumyen, B. D., Àkànle, Ọ., Yikwabs, Y., & Nomishan, T. S. (2020). ZOOTHERAPY: THE USE
OF DOG MEAT FOR TRADITIONAL AFRICAN MEDICINE IN KANKE LOCAL
GOVERNMENT AREA, PLATEAU STATE, NIGERIA. *HAL (Le Centre Pour La
Communication Scientifique Directe)*. https://doi.org/10.33281/jths20129.2020.2.1

Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). *Cochrane Handbook for Systematic Reviews of Interventions* version 6.4 (updated August 2023). Cochrane, 2023. Available from www.training.cochrane.org/handbook.

JBI Manual for Evidence Synthesis. (2020). In JBI eBooks. https://doi.org/10.46658/jbimes-20-01

Lee, B. J. M. J. K. a. H. (2024, January 9). South Korea passes law banning dog meat trade. *BBC News*. https://www.bbc.co.uk/news/world-asia-67920167

Lekan, D. a. A. (2021). Terrorism, Insurgency and Food Security - How Insecurity and Conflict has Affected Food Security in Northern Nigeria. *Social Science Research Network*. https://doi.org/10.2139/ssrn.3997952

Li, D., Liu, Q., Fan, C., Jiang, Q., Wang, T., Yin, X., Lu, Z., & Cao, S. (2021, December 1). Knowledge, attitudes, and practices regarding rabies and its prevention and control among bite victims by suspected rabid animals in China. https://scite.ai/reports/10.1016/j.onehlt.2021.100264

Ling, M Y J., Halim, A F N A., Ahmad, D., Ramly, N., Hassan, M R., Rahim, S S S A., Jeffree, M S., Omar, A., & Hidrus, A. (2023, May 1). Rabies in Southeast Asia: a systematic review of its incidence, risk factors and mortality. https://scite.ai/reports/10.1136/bmjopen-2022-066587

Lo, C. K. L., Mertz, D., & Loeb, M. (2014). Newcastle-Ottawa Scale: comparing reviewers' to authors' assessments. *BMC Medical Research Methodology*, *14*(1). https://doi.org/10.1186/1471-2288-14-45

Lorenzetti, D., & Ghali, W. A. (2013). Reference management software for systematic reviews and meta-analyses: an exploration of usage and usability. *BMC Medical Research Methodology*, *13*(1). https://doi.org/10.1186/1471-2288-13-141

McLeroy, K R., Bibeau, D L., Steckler, A., & Glanz, K. (1988, December 1). An Ecological Perspective on Health Promotion Programs., 15(4), 351-377. https://doi.org/10.1177/109019818801500401

Mebatsion, T., Weiland, F., & Conzelmann, K. (1999). Matrix Protein of Rabies Virus Is Responsible for the Assembly and Budding of Bullet-Shaped Particles and Interacts with the Transmembrane Spike Glycoprotein G. *Journal of Virology*, *73*(1), 242–250. https://doi.org/10.1128/jvi.73.1.242-250.1999

Moola, S., Munn, Z., Tufanaru, C., Aromataris, E., Sears, K., Sfetc, R., Currie, M. J., Lisy, K., Qureshi, R., Mattis, P., & Mu, P. F. (2020). Chapter 7: Systematic reviews of etiology and risk. In *JBI eBooks*. https://doi.org/10.46658/jbimes-20-08

Morowatisharifabad, M A., Karimi, M., & Jannati, M. (2014, January 1). Utility of the health belief model to assess predictors of rabies preventive measures.. PubMed. https://doi.org/10.4103/2277-9531.134770

Mshelbwala, P. P., Weese, J. S., Sanni-Adeniyi, O., Chakma, S., Okeme, S. S., Mamun, A. A., Rupprecht, C. E., & Magalhaes, R. J. S. (2021). Rabies epidemiology, prevention and control in Nigeria: Scoping progress towards elimination. *PLOS Neglected Tropical Diseases*, *15*(8), e0009617. https://doi.org/10.1371/journal.pntd.0009617

Nigeria, R. (2021, December 3). *Gombe community to revive Bai 'dog meat' eating carnival*. Latest Nigeria News | Top Stories From Ripples Nigeria. https://www.ripplesnigeria.com/gombe-community-to-revive-bai-dog-meat-eating-carnival/

Odeh, L. E., Umoh, J. U., & Dzikwi, A. A. (2013). Assessment of Risk of Possible Exposure to Rabies among Processors and Consumers of Dog Meat in Zaria and Kafanchan, Kaduna State, Nigeria. *Global Journal of Health Science*, *6*(1). https://doi.org/10.5539/gjhs.v6n1p142

Okeme, S. S., Kia, G., Mshelbwala, P. P., Umoh, J. U., & Magalhães, R. J. S. (2020). Profiling the public health risk of canine rabies transmission in Kogi state, Nigeria. *One Health*, *10*, 100154. https://doi.org/10.1016/j.onehlt.2020.100154

Olaniyan, A., & Yahaya, A. (2016). Cows, bandits, and violent Conflicts: Understanding cattle rustling in northern Nigeria. *Africa Spectrum*, *51*(3), 93–105. https://doi.org/10.1177/000203971605100305

Oluwayelu, D O., Adebiyi, A I., & Ohore, O G. (2015, January 1). A survey of rabies virus antibodies in confined, hunting and roaming dogs in Ogun and Oyo States, Southwestern Nigeria. Asian Pacific Journal of Tropical Disease, 5(1), 17-21. https://doi.org/10.1016/s2222-1808(14)60620-4

Oluwayelu, D. O., Adebiyi, A. I., & Ohore, O. G. (2015). A survey of rabies virus antibodies in confined, hunting and roaming dogs in Ogun and Oyo States, Southwestern Nigeria. *Asian Pacific Journal of Tropical Disease*, *5*(1), 17–21. https://doi.org/10.1016/s2222-1808(14)60620-4

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T., Mulrow, C. D., Shamseer, L., Tetzlaff, J., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, n71. https://doi.org/10.1136/bmj.n71

Pannucci, C. J., & Wilkins, E. G. (2010). Identifying and avoiding bias in research. *Plastic and Reconstructive Surgery*, *126*(2), 619–625. https://doi.org/10.1097/prs.0b013e3181de24bc

Qualtrics. (2023, August 14). *Sample size calculator*. Qualtrics. https://www.qualtrics.com/blog/calculating-sample-size/

Redding, D W., Atkinson, P M., Cunningham, A A., Iacono, G L., Moses, L M., Wood, J., & Jones, K E. (2019, October 15). Impacts of environmental and socio-economic factors on emergence and epidemic potential of Ebola in Africa. Nature Communications, 10(1). https://doi.org/10.1038/s41467-019-12499-6

Reporter, O. (2022, January 8). *'We eat dogs and we are not ashamed of it.'* Tribune Online. https://tribuneonlineng.com/we-eat-dogs-and-we-are-not-ashamed-of-it/#:~:text=DESPITE%20opposition%20from%20a%20section,the%20dog%20meat%2Deating%20carnival.

Rine, R C. (2017, January 1). Knowledge, Attitude and Practice of Rabies in and Around Lafia Metropolis, Nigeria. Central African Journal of Public Health, 3(3), 27-27. https://doi.org/10.11648/j.cajph.20170303.11

Ross, P T., & Zaidi, N L B. (2019, July 25). Limited by our limitations. Perspectives on medical education, 8(4), 261-264. https://doi.org/10.1007/s40037-019-00530-x

Rupprecht, C. E., Briggs, D. J., Brown, C., Franka, R., Katz, S. L., Kerr, H. D., Lett, S. M., Levis, R., Meltzer, M. I., Schaffner, W., & Cieslak, P. R. (2010). Use of a reduced (4-Dose) vaccine schedule for postexposure prophylaxis to prevent human Rabies—Recommendations of the Advisory Committee on Immunization Practices. Annals of Emergency Medicine, 56(1), 64– 67. https://doi.org/10.1016/j.annemergmed.2010.05.020

Rupprecht, C. E., Kuzmin, I. V., & Meslin, F. X. (2017). Lyssaviruses and rabies: current conundrums, concerns, contradictions and controversies. *F1000Research*, *6*, 184. https://doi.org/10.12688/f1000research.10416.1

Setia, M. S. (2016). Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology*, *61*(3), 261. https://doi.org/10.4103/0019-5154.182410

Sikana, L., Lembo, T., Hampson, K., Lushasi, K., Mtenga, S., Sambo, M., Wight, D., Coutts, J., & Kreppel, K. (2021). Dog ownership practices and responsibilities for children's health in terms of rabies control and prevention in rural communities in Tanzania. *PLOS Neglected Tropical Diseases*, *15*(3), e0009220. https://doi.org/10.1371/journal.pntd.0009220

Spronk, I., Korevaar, J. C., Poos, R., Davids, R., Hilderink, H., Schellevis, F. G., Verheij, R., & Nielen, M. (2019). Calculating incidence rates and prevalence proportions: not as simple as it seems. *BMC Public Health*, *19*(1). https://doi.org/10.1186/s12889-019-6820-3

Suleiman, M. A., Kwaga, J. K. P., Okubanjo, O., Abarshi, M. M., & Kia, G. (2020). Molecular study of rabies virus in slaughtered dogs in Billiri and Kaltungo local government areas of Gombe state, Nigeria. *Acta Tropica*, *207*, 105461.

Thi Nguyen, A. K., Vu, A. H., Nguyen, T. T., Nguyen, D. V., Ngo, G. C., Pham, T. Q., Inoue, S., &
Nishizono, A. (2021). Risk Factors and Protective Immunity Against Rabies in Unvaccinated
Butchers Working at Dog Slaughterhouses in Northern Vietnam. *The American Journal of
Tropical Medicine and Hygiene*, *105*(3), 788-793. https://doi.org/10.4269/ajtmh.20-1172

Thomas, D., Delgado, A. H., Louison, B., Lefrançois, T., & Shaw, J. (2013). Examining dog owners'
beliefs regarding rabies vaccination during government-funded vaccine clinics in Grenada to
improve vaccine coverage rates. *Preventive Veterinary Medicine*, *110*(3–4), 563–569.
https://doi.org/10.1016/j.prevetmed.2013.02.009

Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in
systematic reviews. *BMC Medical Research Methodology*, *8*(1).
https://doi.org/10.1186/1471-2288-8-45

Tidman, R., Thumbi, S., Wallace, R. M., De Balogh, K., Iwar, V., Dieuzy-Labaye, I., Song, J.,
Shadomy, S. V., Yu, Q., Torres, G., Hutchison, J., Abela-Ridder, B., Bote, K., Beeching, S.,
Cronin, K., & Trees, A. J. (2022). United Against Rabies Forum: The One Health Concept at
work. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/fpubh.2022.854419

World Health Organisation. (1986). *Ottawa Charter for Health Promotion: First International
Conference on Health Promotion Ottawa, 21 November
1986.* https://www.healthpromotion.org.au/images/ottawa_charter_hp.pdf

Zhang, J., Lin, J., Tian, Y., Ma, L., Sun, W., Zhang, L., Zhu, Y., Qiu, W., & Zhang, L. (2018).
Transmission of rabies through solid organ transplantation: a notable problem in China. *BMC
Infectious Diseases*, *18*(1). https://doi.org/10.1186/s12879-018-3112-y

Zhou, H., Zhu, W., Zeng, J., He, J., Liu, K., Liu, Y., Zhou, S., Mu, D., Zhang, K., Yu, P., Z, L.,
Zhang, M., Chen, X., Guo, C., & Yu, H. (2016). Probable Rabies Virus Transmission through
Organ Transplantation, China, 2015. *Emerging Infectious Diseases*, *22*(8), 1348–1352.
https://doi.org/10.3201/eid2208.151993

JBI CRITICAL APPRAISAL CHECKLIST FOR ANALYTICAL CROSS SECTIONAL STUDIES

Reviewer: _____

Date_____

Author: Ameh_et al _____ Year__2014_____ Record Number___1_____

		Yes	No	Unclear	Not applicable
1.	Were the criteria for inclusion in the sample clearly defined?	☐	☐	☐	☐
2.	Were the study subjects and the setting described in detail?	☐	☐	☐	☐
3.	Was the exposure measured in a valid and reliable way?	☐	☐	☐	☐
4.	Were objective, standard criteria used for measurement of the condition?	☐	☐	☐	☐
5.	Were confounding factors identified?	☐	☐	☐	☐
6.	Were strategies to deal with confounding factors stated?	☐	☐	☐	☐
7.	Were the outcomes measured in a valid and reliable way?	☐	☐	☐	☐
8.	Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐   Exclude ☐   Seek further info ☐

Comments (Including reason for exclusion)

JBI CRITICAL APPRAISAL CHECKLIST FOR ANALYTICAL CROSS SECTIONAL STUDIES

Reviewer _____

Date_____

Author: Odeh et al_____Year__2013_____ Record Number____2_____

		Yes	No	Unclear	Not applicable
1.	Were the criteria for inclusion in the sample clearly defined?	☐	☐	☐	☐
2.	Were the study subjects and the setting described in detail?	☐	☐	☐	☐
3.	Was the exposure measured in a valid and reliable way?	☐	☐	☐	☐
4.	Were objective, standard criteria used for measurement of the condition?	☐	☐	☐	☐
5.	Were confounding factors identified?	☐	☐	☐	☐
6.	Were strategies to deal with confounding factors stated?	☐	☐	☐	☐
7.	Were the outcomes measured in a valid and reliable way?	☐	☐	☐	☐
8.	Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐   Exclude ☐   Seek further info ☐

Comments (Including reason for exclusion)

JBI CRITICAL APPRAISAL CHECKLIST FOR ANALYTICAL CROSS SECTIONAL STUDIES

Reviewer_____

Date_____

Author: Suleiman et al._____Year_2020_____ Record Number_____3__

	Yes	No	Unclear	Not applicable
1. Were the criteria for inclusion in the sample clearly defined?	☑	☐	☐	☐
2. Were the study subjects and the setting described in detail?	☑	☐	☐	☐
3. Was the exposure measured in a valid and reliable way?	☑	☐	☐	☐
4. Were objective, standard criteria used for measurement of the condition?	☑	☐	☐	☐
5. Were confounding factors identified?	☐	☐	☑	☐
6. Were strategies to deal with confounding factors stated?	☐	☐	☑	☐
7. Were the outcomes measured in a valid and reliable way?	☑	☐	☐	☐
8. Was appropriate statistical analysis used?	☑	☐	☐	☐

Overall appraisal: Include ☑   Exclude ☐   Seek further info ☐

Comments (Including reason for exclusion)

JBI CRITICAL APPRAISAL CHECKLIST FOR ANALYTICAL CROSS SECTIONAL STUDIES

Reviewer: _____

Date_____

Author: Okeme et al_____Year__2020_____ Record Number_____4_____

		Yes	No	Unclear	Not applicable
1.	Were the criteria for inclusion in the sample clearly defined?	☑	☐	☐	☐
2.	Were the study subjects and the setting described in detail?	☑	☐	☐	☐
3.	Was the exposure measured in a valid and reliable way?	☑	☐	☐	☐
4.	Were objective, standard criteria used for measurement of the condition?	☐	☑	☐	☐
5.	Were confounding factors identified?	☐	☐	☑	☐
6.	Were strategies to deal with confounding factors stated?	☐	☐	☑	☐
7.	Were the outcomes measured in a valid and reliable way?	☑	☐	☐	☐
8.	Was appropriate statistical analysis used?	☑	☐	☐	☐

Overall appraisal: Include ☑   Exclude ☐   Seek further info ☐

Comments (Including reason for exclusion)

JBI CRITICAL APPRAISAL CHECKLIST FOR ANALYTICAL CROSS SECTIONAL STUDIES

Reviewer _____

Date_____

Author_____Ehimiyien et al_____Year_2010____ Record Number___5__

		Yes	No	Unclear	Not applicable
1.	Were the criteria for inclusion in the sample clearly defined?	☐	☐	☐	☐
2.	Were the study subjects and the setting described in detail?	☐	☐	☐	☐
3.	Was the exposure measured in a valid and reliable way?	☐	☐	☐	☐
4.	Were objective, standard criteria used for measurement of the condition?	☐	☐	☐	☐
5.	Were confounding factors identified?	☐	☐	☐	☐
6.	Were strategies to deal with confounding factors stated?	☐	☐	☐	☐
7.	Were the outcomes measured in a valid and reliable way?	☐	☐	☐	☐
8.	Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐   Exclude ☐   Seek further info ☐

Appendix 2: Prospero Questionnaire

Literature review following a systematic approach –

Dissertation appendix (X)

Prospero - international database of prospectively registered systematic reviews in health and social care, welfare, public health, education, crime, justice, and International Development where there is a health related outcome.

Students undertaking a literature review following a systematic approach must complete this document and append it to your submission.

1. Review title

   Prevalence of Rabies Among Hunters and Butchers in Northern Nigeria

2. Original language

   English Language

3. Title

   Prevalence of Rabies Among Hunters and Butchers in Northern Nigeria

4. Anticipated or actual start date

   February 2023

5. Anticipated completion date

   January 2024

6. Named contact

   ███████

7. Named contact e-mail

   ████████████████

8. Organisational affiliation of the review

Swansea University

9. Review team members their organisational affiliations *(this will be the named student)*

EMMANUEL SHIAWOYA

10. Funding sources/ sponsors *(if any)*

None

11. Conflicts of interest

None

12. Collaborators

None

13. Review question

Is there a prevalence of rabies among butchers and hunters in Northern Nigeria? What

are the associated factors if present?

14. Searches

Medline (Ovid / EBSCOhost interface), Scopus, CINAHL, Green file, Embase, APA

Psych Info, APA Psych Articles, Proquest Biological Database, PubMed, ASSIA and

Biomed Central using literature

15. URL to search strategy.

ASSIA Combined Search results without native names.pdf
Emmanuel CORRECTED CINAHL Aug.pdf
Biomed Central Combined Search result with native names.pdf
Biomed Central Combined Search result without native names.pdf
Embase Combined search with native names.pdf
Emmanuel APA Psych Articles without Native names.pdf
Emmanuel APA Psych Info Search With native names.pdf
Emmanuel APA PsychInfo Search without native names.pdf
Emmanuel CORRECTED MEDLINE Aug.pdf

[Emmanuel CORRECTED MEDLINE without native names.pdf](#)

[Emmanuel CORRECTED SCOPUS.pdf](#)

[Emmanuel GreenFile Search with native names.pdf](#)

[Emmanuel GreenFile Search without native names.pdf](#)

[Medline Combine search result related to Rabies 5.pdf](#)

[Proquest Biological Science Database Combined Result with native name.pdf](#)

[Proquest Biological Science Database Combined Search without native names.pdf](#)

[PubMed Combined Results. without native names.pdf](#)

[PubMed Combined Results.pdf](#)

[Scopus Combine search P&O&S.pdf](#)

16. Condition or domain being studied.

    EBSCOhost

    ProQuest

    Elsevier

17. Participant(s)/ population.

    Butchers, Hunters,

18. Exposure(s)

    Dog meat

19. Types of study to be included.

    Cross sectional, Case control, Cohort studies

20. Context.

    Northern Nigeria

21. Main outcome(s).

    Rabies Infection

22. Additional outcome(s).

    None

23. Data extraction (selection and coding close).

    Microsoft Word Table

24. Risk of bias (quality) assessment.

    Joanna Briggs Institute Critical Appraisal Tool

25. Strategy for data analysis

    Narrative Synthesis

26. Analysis of subgroups or subsets

    Thematic analysis

27. Dissemination plan

Guidance on completing this can be accessed here ***N.B you are NOT completing the online***

Prospero registration document. You are answering the above questions.