Scoping review of risk assessment studies in animal health and trade in Africa

By

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DECLARATION

I, Karen Onai SAMOISY, do hereby declare that this dissertation entitled “Scoping review of risk assessment studies in animal health and trade in Africa”, which I hereby submit for the partial fulfilment of the degree of Master of Science in Tropical Animal Health at the University of Pretoria, is my work and has not previously been submitted in part or full by me for a degree at this or any other tertiary institution. All sources cited or quoted in this research paper are indicated and acknowledged with a comprehensive list of references.

Karen Onai SAMOISY 25 October 2022

ETHICS STATEMENT

I, Karen Onai SAMOISY, the author of this dissertation, have obtained for the research described in this work the applicable research ethics approval. I declare that I have observed the ethical standards required in terms of the University of Pretoria's Code of ethics for researchers and the policy guidelines for responsible research. The ethics approval reference number is REC114-21 (Annexe B).

DEDICATION

To my Husband Jean Marc, my three children Anne-Sophie, Denzel, and Ethan

To my mother, Betty, my brothers Denton, and Ralph

And my late father Samuel

Thank you for believing in me

ACKNOWLEDGEMENTS

I would like to thank the Almighty God for giving me the willpower to accomplish this mini dissertation.

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To my mother and my two brothers, your best wishes and prayers were instrumental in the successful completion of this project.

ABSTRACT

Background: Risk assessments are crucial foundations for effective animal health control and surveillance. They demonstrate the safety of a country's livestock commodities for trade, thereby improving trust between trade partners.

Methods: A scoping review was conducted across three major multidisciplinary databases as well as grey literature to identify and classify relevant peer-reviewed and unpublished risk assessment studies on animal health and trade conducted in Africa. The Arksey and O'Malley (2005) framework for scoping reviews was used to identify, select, and synthesize evidence of the different risk assessments conducted in animal health and trade in Africa. Both the World Organization for Animal Health (WOAH) risk assessment framework and the Population, Concept, Context (PCC) nomenclature were used to assist in screening and assessing articles for eligibility. The scoping review was conducted based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension guidelines for scoping reviews (PRISMA-ScR) and the review process was mapped in a PRISMA flowchart.

Results and Discussion: A total of 25 articles were included in the final analysis. There were 15 quantitative risk assessments and 10 qualitative risk assessments. Most of these risk assessments were conducted in Eastern and Southern Africa. The risk assessments were published from 12 different countries of which the most frequent were from Ethiopia (25%) followed by South Africa (21%). The most frequently assessed diseases were foot-and-mouth disease and avian influenza. Although, the findings show that there has been an increase in the number of studies conducted on risk assessments in animal health and trade over the past 30 years, the quantity of studies published is still low considering that only 25 risk assessment studies have been documented during this period.

Conclusion: To enable a comprehensive risk estimation, more risk assessments employing the WOAH risk assessment framework should be openly published to inform policy on livestock health and trade and to add to the body of work available to risk analysts.

Keywords: Risk assessment, scoping review, animal health, commodities, trade, Africa

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LIST OF ACRONYMS

OIE	Office International des Epizooties (now known as World Organization for Animal Health)
WOAH	World Organization for Animal Health (Founded as *Office International des Epizooties (OIE))*
TADs	Transboundary Animal Diseases
PVS	Performance of Veterinary Services
PCC	Population Concept Context
IRA	Import Risk Analysis
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PRISMA-SCR	PRISMA Extension for Scoping Reviews
JBI Manual	Joanna Briggs Institute Manual
WOS	Web of Science

CHAPTER 1: INTRODUCTION

1.1. Research context and rationale

Scoping reviews are a relatively new method of evidence synthesis and are ideal to establish and appraise the size and extent of available literature on a specific topic (Munn *et al*.,2018; Sucharew,2019; Grant & Booth,2009). Scoping reviews are also useful in determining whether systematic reviews should be conducted (Cachione,2016). Arksey and O'Malley (2005) were the first to provide a methodology for scoping reviews. Other authors and institutions such as Levac *et al* (2010) and the Joanna Briggs Institute have continued to expand on this methodology thus improving the approach for conducting scoping reviews. The Arskey and O'Malley methodology which was used in this study consists of five compulsory steps and one optional step (Westphaln *et al.*,2021). The five compulsory steps include the formulation of a research question based on the Population, Concept, Context (PCC) framework, the identification of relevant literature, the selection of studies, extracting and charting of data and lastly summarizing and reporting the results (Westphaln *et al.*,2021). The optional step is the consultation stage which may be performed at the start of the scoping review or the end (Arksey & O'Malley, 2005).

The rationale for conducting this scoping review is based on the recognition that animal health and trade in Africa are confronted by precarious situations that necessitate risk assessments.

First and foremost, more transboundary animal diseases occur in Southern and Eastern Africa than anywhere else in the world (Thomson *et al.*, 2013). Most of the diseases previously listed under the old classification method as OIE List 'A' Notifiable Diseases (Annexe A) are indigenous to Africa and hinder most African countries from having access to lucrative international markets (Penrith & Thomson, 2004). Transboundary animal diseases (TADs) are therefore a threat to Africa. They are highly transmissible and have the potential to disrupt the food supply and may have devastating socioeconomic and public health effects (Clemmons *et al*., 2021).

Globalisation has resulted in the interlinking of different countries' economies and industries thereby increasing the likelihood of disease spread among animal

populations (Beltran-Alcrudo *et al.,* 2019). This is especially so in Africa where there are large populations of both wildlife and livestock.

High-risk activities such as illegal livestock movement and trade are common in Africa (Little *et al*., 2015). Cross-border animal trade, for example, is a lucrative business, especially in East Africa and is a major concern due to the risk of spreading animal diseases (Grace & Little, 2020).

Risk assessments in animal health and trade in Africa are therefore essential as they provide an organized and scientifically based argument to evaluate the risk of the introduction of transboundary animal diseases (Beltran-Alcrudo *et al*., 2019). Risk assessments also provide vital information on the occurrence of disease events in animal populations (Matika,2021). They also help to facilitate animal disease prioritization and are thus important in formulating animal health policies. Risk assessments are also important in demonstrating loopholes in a country's biosecurity system including inadequately implemented import regulations and quarantine protocols (Otte *et al.,* 2004).

The need and circumstance under which risk assessments are conducted vary with each country and disease process but the overall goal is to re-enforce biosecurity and demonstrate that a country's commodities are safe for trade (Adamchick *et al*., 2021a). Risk assessments in animal health and trade have become a requisite due to the introduction of commodity-based trade and due to the growing lucrative foreign markets for livestock and livestock products in Africa.

The quantity and classification of research conducted in Africa on risk assessments in animal health and trade need to be evaluated to ascertain what kind of information is available, which animal diseases have been assessed, in which species has the study been conducted and which type of risk assessments have been conducted. Knowledge derived from this study could help governments identify risk assessment gaps and be able to develop policies that could help mitigate such gaps in knowledge. Well-conducted risk assessments could help governments identify and control potential hazards before they cause disease outbreaks, thus contributing to reducing the economic and social impacts of livestock diseases.

Before conducting this study, a preceding search for available scoping reviews and systematic reviews on risk assessments in animal health and trade in Africa was conducted as recommended by the Joanna Briggs Manual for Evidence Synthesis (Aromataris & Munn, 2020). The search was conducted between November - December 2021. The databases searched were the same as the databases used in this study i.e., Scopus, Web of Science and PubMed. Although a systematic review on the prevalence and prioritization of animal diseases in Africa (Mpouam *et al.*, 2021) and another on risk assessment of foot-and-mouth disease (Souley Kouato *et al.*, 2018) have been conducted, neither of them provide comprehensive evidence in the field of risk assessments in animal health and trade. Another study on the use of risk analysis methodologies by veterinary services in Africa was conducted by Bastiaensen *et al.* (2017). However, the study was neither a scoping review nor a systematic review but, a questionnaire-based survey relying mostly on Performance of Veterinary Services (PVS) reports provided by governments and veterinary services. In contrast to the above-mentioned studies, the current study offers a new perspective by adopting a scoping review to synthesize evidence from peer-reviewed papers and grey literature on the extent to which the subject of risk assessment in animal health and trade has been covered in Africa.

Based on the above given scenarios and arguments, as well as the rationale for conducting scoping reviews (Munn *et al.*, 2018), this research was thus conducted to discern the scope of available literature and methodically map the research done on risk assessments in animal health and trade, and to flag any existing knowledge gaps.

1.2. Aim of the study

The aim of the study was to evaluate the research that has been conducted in Africa on risk assessment in animal health and animal trade and to characterize these risk assessments.

1.3. Research topic and questions

The research conducted was a scoping review of risk assessment in animal health and trade in Africa. The central research question which was formulated using the Population, Concept and Context (PPC) nomenclature was:

What is the focus of (risk assessment) in (animal) (health and trade in Africa)?

Concept Population Context

The hypothesis was that risk assessment in animal health in Africa is under-researched, and if it is undertaken it is mainly qualitative and not quantitative. To answer the research question, different types of risk assessment methodologies were assessed for each disease and each process through a scoping review.

1.4. Research objectives

- Identify and classify risk assessments undertaken in animal health and trade in Africa.
- Evaluate whether the subject is sufficiently addressed in the literature by quantifying the risk assessment studies conducted/published.
- Provide a descriptive summary of findings in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews (PRISMA-ScR) guidelines template and PRISMA-ScR flow chart.
- Identify and make recommendations for future research on risk assessments in animal health and trade in Africa.

1.5. Research protocol

The protocol was conditionally approved by the Research Ethics Committee of the Faculty of Veterinary Science, the University of Pretoria on the 8th of November 2021 (Annexe B). The priori review protocol is available at the University of Pretoria repository.

CHAPTER 2: MATERIALS AND METHODS

2.1. Introduction

The Arksey & O'Malley (2005) methodology was used in this study. The consultation stage was not conducted.

Transparency in the reporting of the scoping review was ensured by using guidelines known as the PRISMA extension for Scoping Reviews (PRISMA-Scr) (Tricco *et al*., 2018). A fillable, Microsoft Word PRISMA-ScR checklist document is attached in Appendix 1**.** This document was used throughout the review process to ensure adherence to the recommended PRISMA guidelines for conducting scoping reviews as well as a final checklist at the end of the review process.

A narrative description of the review process was given in the form of a PRISMA flowchart.

2.2. Eligibility criteria

The criteria for inclusion or exclusion of articles in this research were clearly defined by a team of three reviewers; Karen Onai Samoisy (KOS), John Duncan Grewar (JDG) and Melvyn Quan (MQ) so that only evidence relevant to the review question and objectives stated in section 1.3 and 1.4 above, were included. The PCC framework was used as a basis to frame the inclusion and exclusion criteria.

Population: All terrestrial animals were included, including both domestic animals and wildlife. Aquatic animals were excluded.

Concept: The concept was risk assessment in animal health and trade as defined by the WOAH risk assessment framework.

Context: The scoping review was limited to risk assessment studies conducted in animal health and trade in Africa only.

Although the publication year range was set between 1920 to 2021, none of the databases had publications before 1960. No language restriction was imposed during

the searches, however, during the full-text assessment, articles that were not in English were disregarded.

Only risk assessment studies were considered. Studies on risk factor analysis, risk factor identification, risk mapping, risk overview and hazard identification were excluded. It was agreed to include the following publications: import and export risk analysis with regards to cross-border trade, and risk assessment of animal diseases in Africa and transboundary animal diseases (TADs). Zoonotic diseases were included only if data from both human and animal subjects were used, or if the animal was the main subject of study. Risk assessments of zoonotic diseases where data was collected exclusively in humans were excluded i.e., the focus was more on animal health than on veterinary public health. Risk assessments of antimicrobial use in food animals, as well as risk assessments about public health risks due to contaminated foodstuffs, were also excluded.

The WOAH risk assessment framework (Figure 2.1) was used in this study to determine the eligibility of the studies. Any study which clearly outlined or conducted any of the 3 risk assessment steps (release assessment, exposure assessment and consequence assessment) was included.

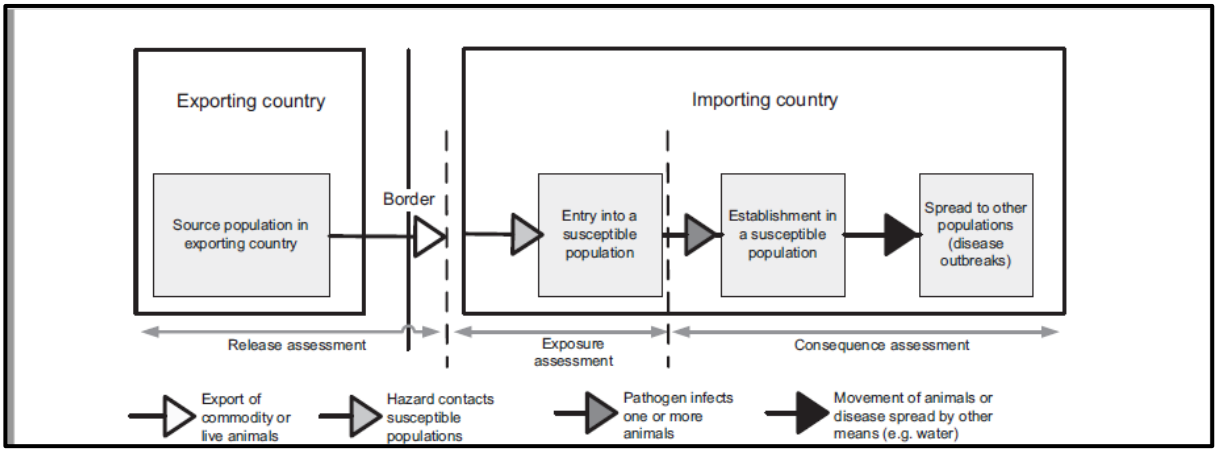


Figure 2.1. Import risk assessment and pathways of spread adapted from Peeler et al. (2015).

The inclusion and exclusion criteria used in this study are summarized in Table 2.1.

Table 2.1. Inclusion and exclusion criteria for the scoping review.

Inclusion • The study was a risk assessment. • The study applied the WOAH risk assessment framework. • The study was conducted in Africa. • The study was in English. • The study was conducted on animal diseases and/or issues about animal health or animal trade including export and import issues. • The study was conducted on domestic animals or wildlife or both. **Exclusion** • The article was a conference abstract. • The full-text article could not be retrieved. • The study was not a risk assessment but a risk factor analysis or risk mapping or risk communication or risk overview. • The study contained key search terms not relevant to this study. • The study did not apply the WOAH risk assessment framework. • The study identified the hazard in Africa, but risk assessment was conducted outside of Africa. • The study was conducted on aquatic animals. • The study was of a public health issue about food contamination. • The study was not in English. • The study was conducted in humans, not in animals.

2.3. Evidence sources

Three multidisciplinary databases; PubMed, Scopus, and Web of Science (WOS), were used to extract peer-reviewed research studies conducted in risk assessments in animal health and trade in Africa. "*Snowballing"* or reverse reference searching from included reports and some selected articles was used to identify additional studies which were not found in the three databases. Evidence was also identified via grey literature and the search engines Google and Google scholar were used to perform this task.

The identification of sources was done in three stages. Firstly, studies from the three databases were identified, screened, and selected. The selected studies were then used for snowballing. Lastly, a grey literature search was conducted.

2.4. Search terms and search strategy

The following search terms were used across the three databases:

("Risk assessment" OR "risk analysis") AND (animal OR livestock) AND (health OR trade) AND (Africa or African).

Searching for grey literature was done using the research topic "*Risk assessment or risk analysis in animal health and animal trade in Africa.*"

Details of the search strategy are provided in Appendix 2.

2.5. Citation management

All citations were exported into the reference management software Endnote Version 20.2.1. An Endnote library entitled "*Scoping Review of Risk Assessments in Africa*" was created. References from the three databases were exported and managed in this library. A copy of this Endnote library is available at the University of Pretoria repository.

The management and coding of citations for the scoping review were done in Endnote using suggested guidelines (Peters, 2017). The references were saved in a group set entitled "*Evidence Sources*". Each reference was saved in different groups according to database source e.g., *PubMed*, *Scopus, and WOS*.

Duplicates from the three databases were removed automatically using the "*Find Duplicates*" tool in the toolbar of the Endnote application. These references were designated as "*Trash*" in the Endnote library. During further screening, more duplicates were discovered, and these were removed manually. These references were designated as "*Duplicates/Manually removed*" in the Endnote library, to distinguish them from those removed automatically.

Other groups and group sets were created, and this enabled the classification of the references as the screening process progressed. For example, all articles excluded were placed in one group set. The group set was further divided into different groups according to the reason for exclusion.

Management of citations obtained via other sources was done exclusively in Microsoft Excel. The file entitled "*Other Sources*" is available amongst the additional files related to this scoping review.

2.6. Screening process

2.6.1. Title and abstract relevance screening

Title and abstract screening were done simultaneously. If both the title and abstract of a publication alluded to a risk assessment by containing keywords relevant to the context of the scoping review, the publication was retained. All keywords and expressions related to and including risk assessment such as "*risk*", "*risk assessment" "risk pathways*", "*hazard identification*"," *risk analysis*", "*risk factors*", "*risk modelling" and "epidemiological modelling*" were considered during this stage. This was the longest phase of the review as it entailed perusing each of the abstracts for relevance. The process was conducted by one reviewer (KOS) under the guidance of the other two reviewers (JDG, MQ). The process lasted from March 2022 to May 2022.

2.6.2. Full-text screening

The following methods were used to obtain full texts; via the Endnote application using the "*Find full-text*" function, via Google scholar or by direct request to the authors through ResearchGate or emails. The assistance of an information specialist was sought for articles not available at the University of Pretoria library or on Google scholar. Findings of full-text screening were summarized in Microsoft Excel in the file "*Full-text screening and eligibility screening*". Retained articles were coded in black and the reason for inclusion was documented. Articles that were discarded were coded in red and the reason for exclusion was indicated. Some articles were coded in blue. These articles were discarded at a later stage but were retained as they contained relevant information for discussion and were also used for snowballing. This step was conducted by two reviewers (KOS and JDG). Conflicts or disagreements concerning the inclusion or exclusion of an article were resolved via Zoom meetings or through email exchanges as well as using the "*edit*" function in EndNote. An endnote library entitled "*Selected Articles JDG reviewed (2)*" illustrating this process is available at the University of Pretoria repository for reference.

2.6.3. Reverse reference search (snowballing)

This process was conducted in July 2022. All the articles retained after full text screening and those coded in blue during full-text screening were then used for snowballing. This process involved perusing through the reference section of each article for any titles relevant to the scoping review.

2.6.4. Full-text screening for grey literature

All the articles retrieved from grey literature were subjected to full text screening. The process of identifying and screening evidence from grey literature was conducted in August 2022.

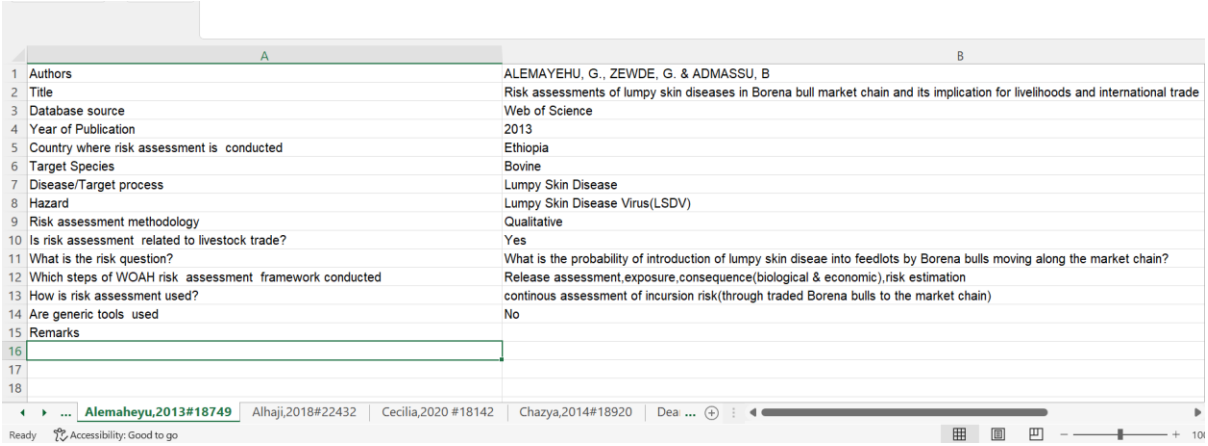
2.7. Data items and data charting process

The key findings relating to the scoping review questions were compiled by answering a set of questions which constituted part of the data items. For each of the articles in the final analysis, the following data were extracted in an Excel spreadsheet:

- Authors
- Title
- Database source
- Year of publication
- Country/region where risk assessment was conducted.
- Target species
- Disease/Target process
- Risk assessment methodology
- Is the hazard identified? (Hazard listed)
- Is risk assessment related to livestock trade? (Yes/No)
- Is the risk question framed? What is the risk question?
- Are the risk pathways clearly outlined? Which of the 4 steps of the WOAH risk assessment are conducted?
- How is risk assessment used? (Three options; horizon scanning, continuous assessment of incursion risk or response to a disease event)

- Are generic tools used? (Yes/No)
- Remarks

Below is a screenshot of the extract of the data extraction sheet in Microsoft Excel (Figure 2.2). The rest of the document entitled "*Data Extraction KOS*" is available at the University of Pretoria repository. A copy of the data extraction form is attached in Appendix 3.



	A	B
1	Authors	ALEMAYEHU, G., ZEWDE, G. & ADMASSU, B
2	Title	Risk assessments of lumpy skin diseases in Borena bull market chain and its implication for livelihoods and international trade
3	Database source	Web of Science
4	Year of Publication	2013
5	Country where risk assessment is conducted	Ethiopia
6	Target Species	Bovine
7	Disease/Target process	Lumpy Skin Disease
8	Hazard	Lumpy Skin Disease Virus(LSDV)
9	Risk assessment methodology	Qualitative
10	Is risk assessment related to livestock trade?	Yes
11	What is the risk question?	What is the probability of introduction of lumpy skin diseae into feedlots by Borena bulls moving along the market chain?
12	Which steps of WOAH risk assessment framework conducted	Release assessment,exposure,consequence(biological & economic),risk estimation
13	How is risk assessment used?	continous assessment of incursion risk(through traded Borena bulls to the market chain)
14	Are generic tools used	No
15	Remarks	
16		
17		
18		

Figure 2.2. Extract of data extraction sheet.

2.7.1. Critical appraisal of individual sources of evidence

This process was not conducted due to time constraints.

2.7.2. Synthesis of results

The results of the findings were summarized into tables and graphs using Microsoft Excel Office 365. The geographical distribution of the studies was done using the application QGIS version 3.16.0. The results were presented as they apply to the review questions and objectives of the scoping review as recommended by the JBI manual (Peters *et al.*, 2020).

CHAPTER 3: RESULTS

The initial search from the three databases yielded 11 069 references of which 620 were removed automatically as duplicates whilst 141 duplicates were removed manually. A total of 10 308 articles from the three databases were screened by title and abstract. Of these references, only 85 were retained as eligible for full-text screening. Full texts of 84 of these articles were obtained, either from the University of Pretoria Library, from Google scholar or directly from the authors. Only one reference from the database search could not be retrieved (article by Njoka *et al., 2015*) because it was an abstract for a conference proceeding.

The 85 articles were then assessed for eligibility using the inclusion and exclusion criteria described in Table 2.1 above.

Sixty-four (64) of these articles were excluded and the reasons thereof are given in Table 3.1 below. The full details of excluded articles with reason are available in Appendix 4.

Table 3.1. The number of excluded articles from databases and reasons thereof.

Reason number	Reason for exclusion	Number of publications
1	The study was not a risk assessment but a risk factor analysis or risk mapping or risk overview or risk communication	33
2	The article contained keywords related to the search in the abstract and title but was found to be irrelevant to the study on perusing the full text	16
3	The study was a risk assessment but does not apply to the WOAH risk assessment framework	1
4	The study identified hazards in Africa, but risk assessment was conducted outside of Africa	4
5	The study pertained to a public health issue related to food contamination	3
6	The full text of the article was not in English	1
7	Conference abstract	1
8	The study was conducted in humans and not in animals	5

Identification of studies via other methods was also conducted. A grey literature search yielded nine (9) articles and snowballing yielded eight (8) articles, making a total of

seventeen (17) articles. Five (5) of these articles could not be retrieved. Twelve (12) articles were shortlisted for eligibility assessment. Eight (8) were excluded and the reasons for exclusion are mentioned hereunder in Table 3.2.

Table 3.2. The number of excluded articles from other sources and reasons thereof.

Reason number	Reason for exclusion	Number of publications
1	The study was not a risk assessment but a risk factor analysis, risk mapping, risk overview or risk communication	4
2	The article contained keywords related to the search in the abstract and title but was found to be irrelevant to the study on perusing the full text	2
3	The study pertained to a public health issue related to food contamination	1
4	Conference abstract	1

The full details of articles excluded from other sources are available in Appendix 4 (articles from other sources are marked with a star (*) at the beginning of the reference). Eventually, only four (4) articles were retained from other sources.

Figure 3.1 below summarizes the identification and screening of the different evidence available for the scoping review.

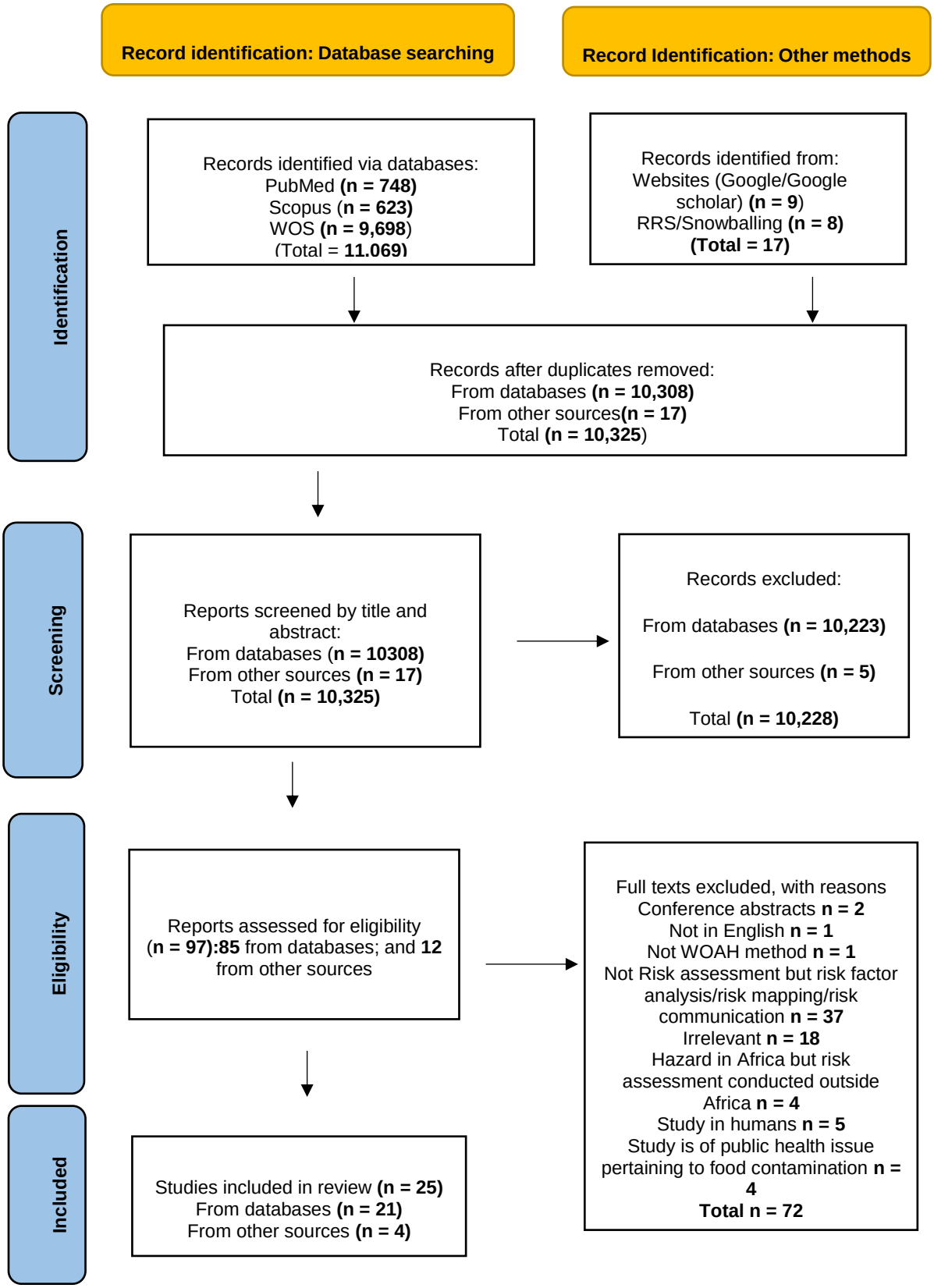


Figure 3.1. Preferred Reporting Items for Systematic review and Meta-Analyses (Prisma) flow diagram (adapted from Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al., 2021).

Risk assessment studies were then classified according to methodology (Figure 3.2) and year of publication (Table 3.3). The highest number of articles were published in 2021 followed by 2014, 2015 and 2007 in this order.

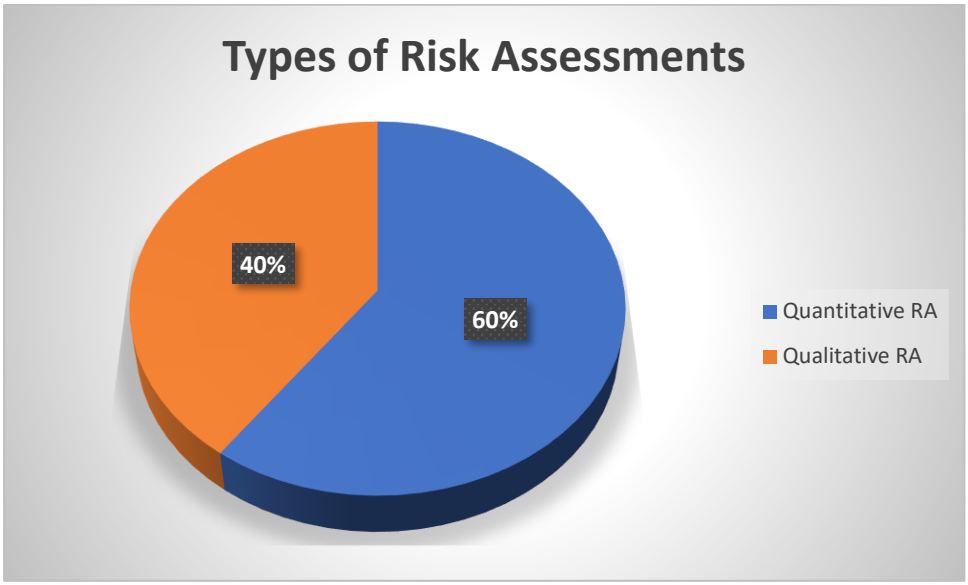


Figure 3.2. Types of risk assessments conducted in Africa in animal health and trade.

Table 3.3. Classification of risk assessments according to the year of publication.

Year	Publication count	(%)
2000	1	4
2007	3	12
2009	1	4
2013	2	8
2014	4	16
2015	3	12
2016	1	4
2018	2	8
2019	1	4
2020	2	8
2021	5	20
TOTAL	**25**	**100**

The trend at which publications were released was then analysed every ten years for the past 30 years (Table 3.4 and Figure 3.3).

Table 3.4: Number of risk assessments conducted in the last 30 years in Africa (1991-2021.).

Period	Number of studies	(%)
1991-2000	1	4
2001-2010	4	16
2011-2021	20	80

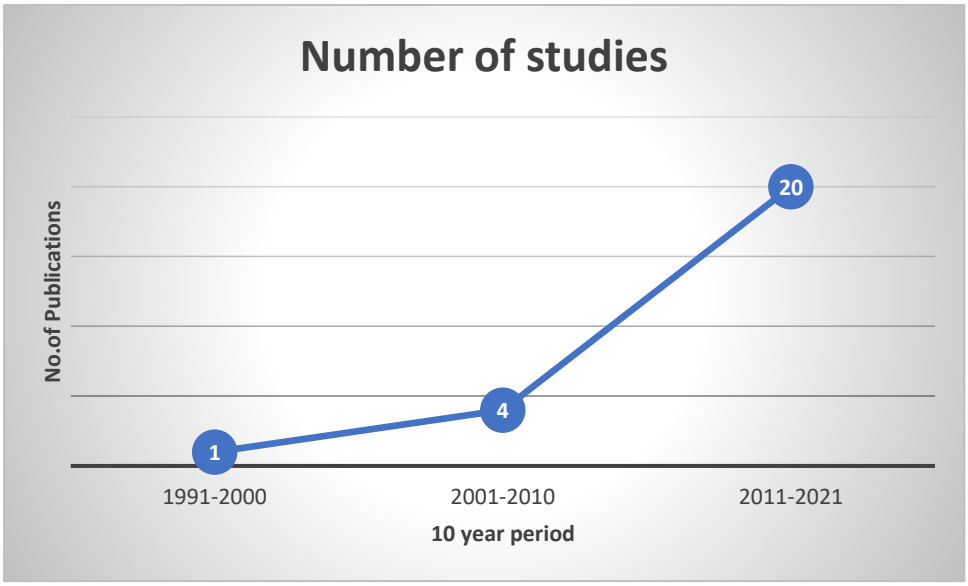


Figure 3.3. Graph showing the trend of publications for the past 30 years.

The trend shows an exponential rise in the number of studies conducted on risk assessment in Africa over the past 30 years. Most of these studies (80%) were conducted between 2011 and 2021.

The risk assessments were further assessed for their application of the WOAH risk assessment framework (Table 3.5).

Table 3.5. Evaluation of the use of the WOAH framework, ✓-step conducted; ✗-step not conducted.

SN	Publication	Risk question(s)	Release assessment	Exposure assessment	Consequence assessment	Risk estimation
1	Adamchick, 2021 #17392	✓	✓	✓	✗	✗
2	Adamchick,2021 #18083	✓	✓	✓	✗	✗
3	Alemaheyu, 2013 #18749	✓	✓	✓	✓	✓
4	Alhaji, 2018 #22432	✓	✓	✓	✓	✗
5	Aloto, 2020	✓	✓	✗	✗	✗
6	Cecilia, 2020 #18142	✓	✓	✗	✗	✗
7	Chazya, 2014 #18920	✓	✓	✓	✓	✓
8	Chazya, 2015	✓	✓	✓	✗	✓
9	Elsobky, 2021 #23 226	✓	✗	✓	✓	✓
10	Dean, 2013 #18874	✓	✓	✓	✗	✗
11	Goutard, 2007 #17518	✓	✓	✓	✗	✗
12	Grewar, 2021 #18783	✓	✓	✗	✗	✗
13	Jori, 2009 #18711	✗	✓	✓	✓	✓
14	Knight-Jones, 2014 #17336	✓	✓	✗	✗	✗
15	Latif, 2019 #17490	✓	✓	✓	✓	✗
16	Magalhaes, 2007 #19965	✓	✓	✗	✗	✗
17	Makungu, 2014 #18730	✓	✓	✗	✗	✗
18	Napp, 2018 #18753	✗	✓	✓	✗	✗
19	Olive, 2007 #18 844	✓	✓	✓	✓	✓
20	Sergeant, 2015	✓	✓	✓	✓	✓
21	Sergeant, 2016 #18814	✓	✓	✗	✗	✗
22	Squarzoni-Diaw, 2021 #18869	✓	✓	✓	✗	✗
23	Sutmoller, 2000 #17684	✓	✓	✗	✗	✗
24	Thomson, 2014	✗	✓	✓	✓	✓
25	Woube, 2015 #19019	✓	✓	✗	✗	✗

Only six (6) risk assessment studies fulfilled all four steps of the WOAH framework (release assessment, exposure assessment, consequence assessment and risk estimation). Nine (9) of the risk assessments were conducted up to the consequence assessment. Twenty-four (24) risk assessments conducted at least release assessment and 15 conducted both release and exposure assessments. One risk

assessment did not conduct a release assessment i.e., the article by Elsobky *et al.* (2021).

b) The risk assessments were also quantified in terms of disease or process as illustrated in Table 3.6 below. The highest number of risk assessments were conducted for foot and mouth disease and avian influenza; each representing 20% of the total publication count.

Table 3.6. The number of publications reporting on risk assessment of each disease/process.

Disease/Process	Publication count	%
Foot and mouth disease	5	20
Avian influenza	5	20
Rift Valley fever	3	12
Transboundary animal diseases in general	3	12
African horse sickness	2	8
Lumpy skin disease	1	4
Peste des petit ruminants	2	8
Canine leishmaniasis	1	4
Bovine theileriosis	1	4
Contagious bovine pleuropneumonia	1	4
Health certification methods/trade	1	4

The risk assessments were further classified according to the country where the assessment was conducted (Table 3.7). The 25 risk assessments were conducted in 12 different countries of which two of the risk assessments were conducted simultaneously in Kenya and Uganda (Adamchick *et al.,* 2021a; Adamchick *et al.*, 2021b). One of the risk assessments was conducted in Togo but the findings were beneficial to all the neighbouring countries of Togo (Dean *et al.*, 2013).

Table 3.7. Classification of risk assessments by country.

SN	Country	Publication count	%
1	Egypt	2	8
2	Ethiopia	6	24
3	Kenya /Uganda	2	8
4	Namibia	1	4
5	Nigeria	1	4
6	Senegal	1	4
7	Somalia	1	4
8	South Africa	5	20
9	Togo (West Africa)	1	4
10	Tunisia	1	4
11	Zambia	3	12
12	Zimbabwe	1	4

The highest number of risk assessment studies in animal health was conducted in Ethiopia, and they constitute 24% of the total number of studies conducted. Four of the six documented risk assessment studies conducted in Ethiopia, were of avian influenza whereas the other two were of lumpy skin disease and contagious bovine pleuropneumonia (CBPP). The second highest number of risk assessment studies were conducted in South Africa, and they constitute 20% of the total number of studies conducted. Two of the five documented risk assessment studies conducted in South Africa were on African horse sickness.

The number of risk assessments was then classified by region (Table 3.8). Most of the risk assessments (76%) were conducted in Eastern and Southern Africa. No documented risk assessments were reported in Central Africa whereas 24% of the risk assessments were conducted in Western and Northern Africa.

Table 3.8. Classification of risk assessments by African region.

SN	Region	Countries where RA were conducted	Number of RA (%)
1	Northern Africa	Tunisia, Egypt	3 (12%)
2	Western Africa	Togo, Nigeria, and Senegal	3 (12%)
3	Central Africa	-	0 (0%)
4	Eastern Africa	Uganda & Kenya, Ethiopia, Somalia,	9 (36%)
5	Southern Africa	South Africa, Zambia, Namibia, Zimbabwe	10 (40%)

The risk assessments were further mapped spatially onto a map of Africa (Figure 3.4). The two risk assessments conducted in Kenya were concurrently conducted in Uganda, hence they are represented as four different risk assessments in this map. The map clearly shows that most of the risk assessment studies were concentrated in Southern and Eastern Africa.

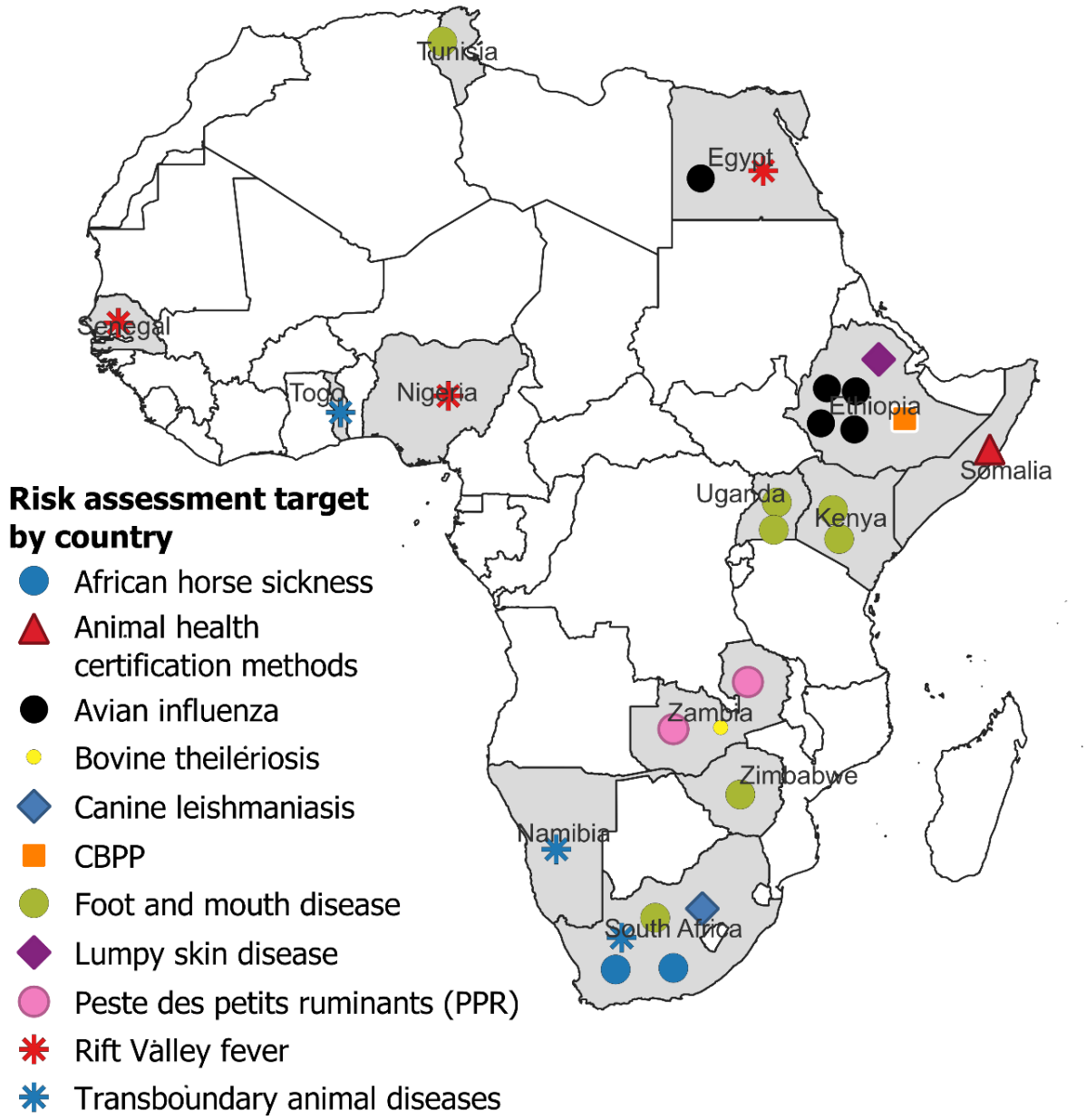


Figure 3.4. Classification of risk assessments by country and disease process.

CHAPTER 4: DISCUSSION, CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

4.1. Discussion

A total of 25 studies were included in the final analysis. Fifteen (60%) of these studies were quantitative risk assessments whilst ten (40%) were qualitative risk assessments. The highest number of risk assessments were published in the year 2021. The trend over the past 30 years shows a sharp rise in the number of risk assessments published.

Most of the studies were conducted in Southern and Eastern Africa representing 76% of the total number of studies in the scoping review. At least one of the four steps of the WOAH risk assessment framework was conducted in all 25 studies. However, all four steps were performed in only 6 studies. The most assessed diseases were foot and mouth disease and avian influenza each representing 20% of the total number of studies in the final analysis. The highest number of risk assessments (24%) were conducted in Ethiopia, followed by South Africa (20%).

Although the study shows a gradual increase in the number of studies conducted in Africa on risk assessments on animal diseases and trade over the past three decades, the quantity and quality of these assessments still need to improve. The growing increase in the number of studies is a clear indication that risk assessments are becoming more important due to increased trade in livestock commodities as well as an increased desire by African governments to access external lucrative markets (Adamchick *et al.*, 2021a). The increase in the number of risk assessments over the years may also be attributed to escalating numbers of emerging and re-emerging infectious diseases (Trivellone *et al.*, 2022).

Contrary to our initial hypothesis, this study showed that more quantitative studies are being performed in risk assessment than qualitative studies. This is an indication that data needs are being identified and data is being made available for analysis. This may also be attributed to the fact a high number of risk factor identification/analyses are being performed in Africa as evidenced by the number of articles that were

excluded because of this reason in this study. Risk factor analyses may provide useful information for use in risk assessments. Hence on a positive note, the risk factor analyses performed could be used as foundations for performing risk assessments in future.

In some cases, some authors conducted both qualitative and quantitative risk assessments of a disease (Chazya *et al.*, 2014; Chazya *et al*., 2015). In this case, the qualitative risk assessment was conducted first, followed by the quantitative risk assessment. The quantitative study was performed to quantify the risk identified in the qualitative study. Performing both qualitative and quantitative risk assessments of a particular disease process offers a more comprehensive understanding of the risk. This practice can be adopted for other risk assessments in Africa.

Even though the WOAH is the authority responsible for formulating import risk analysis techniques (Bastiansen *et al.*, 2017), the WOAH risk assessment framework is still being under-utilized in Africa. The quality of risk assessments may be gauged by the systematic use of the WOAH framework. Most studies performed only part of the framework and failed to take advantage of the full benefit of this framework which includes the complete evaluation of risks including biological and economic consequences. A gap was also noted, in the framing of the risk assessment question, for example, although the risk assessment question was framed in some studies, it was not in others. In such cases, the reader had to extrapolate the risk question from the given study objectives. For some of the studies where the risk assessment question was not well-framed, the risk pathways were however well-defined e.g., Jori *et al.*, 2009; Napp *et al.*, 2018 and Thomson & Venter, 2014.

Seven out of the 25 articles included in this study, clearly mentioned that the WOAH risk assessment guidelines were being adopted in the risk assessments (Jori *et al.*, 2009; Latif *et al.*, 2019; Aloto & Belete, 2020; Alemayehu, 2012; Chazya *et al.*, 2014; Thomson& Venter, 2012; Sergeant, 2015). The practice of stating clearly which risk assessment framework is being adopted in each study should be encouraged when conducting risk assessments.

The most performed step was the release/entry assessment. Most studies performed only this step probably due to time and financial constraints. This study has also shown that most countries performed either an entry assessment or both entry and exposure assessments. According to Peeler *et al.* (2015), all import risk analyses should include consequence assessment. However, most of the risk assessments (57%) did not perform this step. This, according to Peeler *et al.* (2015), is an incomplete import risk analysis (IRA). Some risk assessments purposefully omit consequence assessment because it is considered difficult to perform and requires the collection of more data (Peeler *et al*., 2015). It is also considered costly to perform. Nevertheless, consequence assessments provide vital information for decision-making. It is therefore encouraged that consequence assessments be performed even if it entails performing simulation modelling to assess the consequences of the risk. Six (6) of the nine consequence assessments conducted were both economic and biological assessments and three were biological assessments only. One study did not perform a release assessment as the risk was already present at the time of the study (Elsobky *et al.*, 2021). In this study, both exposure and consequence assessments were conducted to assess the effectiveness of certain measures put in place to mitigate the risk.

It is interesting to note that all the qualitative risk assessments performed at least three of the WOAH risk assessment steps apart from the study by Squarzoni Diaw *et al.* (2021) which performed only two (release and exposure assessments).

Most of the risk assessments conducted were performed for trade reasons (either before trade or as a continuous assessment of incursion risk because of trade). Only five of the risk assessments were not directly trade-related (Sutmoller *et al.*, 2000; Cecilia *et al.*, 2020; Jori *et al.*, 2007; Alhaji *et al*, 2018, Elsobky *et al.*, 2021). Two articles highlight the probable risk associated with cross-border trade (Dean *et al.*, 2013; Knight-Jones *et al.*, 2014).

The concept of regional disease risk assessment is explored by Dean *et al*. (2013). This principle was used in West Africa. Although the study was conducted in Togo, the findings of the research were beneficial to all countries bordering the Savannah Region i.e., Burkina Faso, Togo, Ghana, Benin, and Nigeria. Such a concept may be

adopted in other African regions thereby synchronizing risk assessments, synergizing efforts and reducing costs. Regional disease risk assessments could benefit countries that experience the simultaneous occurrence of disease phenomena such as the simultaneous occurrence of foot and mouth disease along the Zambezi River affecting Zambia, Zimbabwe, Botswana, and Namibia (Sinkala *et al.*, 2014). Findings in one country may offer insights into the likelihood of risk introduction into another country. The two risk assessments which were conducted concurrently in Uganda and Kenya also illustrate the advantage of at least two different countries teaming up to conduct risk assessments. This may be useful in resource-scarce countries where veterinary capacity is limited.

Eighteen out of the 25 studies were import risk analyses. Two out of the 25 studies were export risk analyses (Woube *et al.*, 2015; Sergeant *et al.*, 2016) whereas the remaining five were not trade-related. Export risk analysis may be used to prove a country's credibility as a trading partner. Hence countries should use this tool more often to prove that their commodities are safe for trade, hence boosting their credibility to foreign markets.

Seven risk assessments were conducted for vector-borne diseases namely bovine theileriosis, rift valley fever, canine leishmaniasis and African horse Sickness. Over the past two decades, Rift valley fever has been reported in new areas in Africa. One such region is the Sahel region (Nielsen *et al*., 2020). This may explain the distribution of the three risk assessments performed for Rift Valley Fever in North and West Africa. The study conducted in Zambia was the only quantitative risk assessment model related to a tick-borne disease in cattle in Africa (Makungu & Mwacalimba, 2014). Due to global warming, many vectors are shifting from their usual habitats, thereby increasing the threats posed by vector-borne diseases (Clemmons *et al.*, 2021). As such more risk assessments of vector-borne diseases should be conducted. The two mentioned risk assessment studies for African horse sickness were performed in South Africa. One was an import risk analysis (Grewar *et al*., 2021); whilst the other was an export risk analysis (Sergeant *et al*., 2016). This finding suggests that South African risk analysts are striving to protect the equine industry from the incursion of African horse sickness through import risk analysis, and at the same time endeavoring

to prove the safety of their equines for export to foreign markets through export risk analysis.

The most important TADS for Africa are listed by the WOAH. However, this study shows that some TADs are under-assessed. Risk assessments of the following important TADs on the WOAH notifiable disease list have not been documented in Africa, African swine fever, classical swine fever, Newcastle, and bluetongue. Besides foot and mouth disease, risk assessments for other pig TADs such as African swine fever, for example, are not well-documented.

Foot and mouth disease and avian influenza are the most assessed diseases as indicated by the findings. The high prevalence of foot and mouth disease in Africa limits access to foreign lucrative markets (Adamchick *et al.,* 2021b) and its distribution is widespread in Africa, which increases its incursion risk (de Vos *et al.*, 2022). The zoonotic nature of avian influenza obliges that risk assessments of the disease be performed due to the likely devastating effects on human health. These are probably the reasons why these two diseases are the most assessed in Africa.

The concept of participatory risk assessment was explored by some authors (Adamchick *et al.,* 2021b, Squarzoni-Diaw *et al.*, 2019 and Alhaji *et al.*, 2018). Participatory risk assessments have been conducted in food safety studies and seldom in the study of TADs incursions in animal trade (Adamchick *et al*., 2021). This method enables more data availability and sharing and improves the quality of risk assessments. A good example is the study where the participation of local veterinarians was solicited to help map risk pathways and quantify variables (Adamchick *et al.*, 20021b). The challenge with this method, however, is that additional information needs to be collected and transformed into quantitative data (Adamchick *et al*., 2021b). Nonetheless, it is an important method worth considering and can be adopted in different other African settings to help facilitate risk assessments.

More risk assessments have been conducted in southern and eastern Africa. This further supports the theory by Thomson *et al*. (2013) that more transboundary animal diseases occur in eastern and southern Africa than anywhere else in the world. The highest number of risk assessments were conducted in Ethiopia. Four of them were

for avian influenza and all were performed around 2007 to 2008. The high number of risk assessments conducted for avian influenza in Ethiopia around this time may be attributed to the fact that Ethiopia experienced an avian influenza scare at about the same time (Thomas *et al*., 2009) and the risk of incursion of the disease was considered elevated due to the porous nature of borders and the presence of migratory birds (Kelemwork *et al*., 2010). The second highest number of risk assessments were conducted in South Africa. As mentioned earlier two of the five risk assessments documented in South Africa were on African horse sickness. The focus on risk assessments in these two countries may reflect the need to protect the equine and avian industries respectively and at the same time provide evidence to support trade.

Lastly, it is worthwhile to compare the current study to the precursor studies which were mentioned earlier in the introduction. The study by Bastiaensen *et al*. (2017) focused mainly on risk analysis in general, including surveillance and disease monitoring. The study was mainly questionnaire-based and relied on information derived from the analysis of chosen PVS reports. The study noted poor documentation of risk assessments, which the current study attempted to investigate through a scoping review. The current study, focused mainly on risk assessments which are crucial for animal trade (Miller *et al.*, 2017). The information used was derived from peer-reviewed publications and grey literature and hence was more comprehensive. Another study which provides valuable insights into the current study was conducted by Souley Kuato *et al.* (2018). Although the study focused on risk assessments of foot and mouth disease in Africa, most of the IRAs used were from foot-and-mouth disease-free countries in Europe and USA and were therefore not relevant to this current study.

4.2. Limitations

- Although this scoping review has provided the vital groundwork for future research, it is unfortunate, however, that most articles which could have been potential risk assessments were disqualified because they were risk factor analyses as illustrated by the number of excluded articles due to this reason in Table 3.1 and Table 3.2.

- The databases were searched with a limited set of keywords; thus, some relevant studies could have been omitted.
- The study did not yield many articles on risk assessment in the trade of animals *per se*, however, most of the risk assessments were trade related. The risk of illegal trans-border trade of animals was not well highlighted in the different risk assessments conducted.
- Due to the unavailability of some full texts from reverse reference searching, some relevant publications may have been omitted.
- Language restriction may have prejudiced the inclusion of relevant evidence in this scoping review. However, some authors believe that excluding an article based on language represents no review bias (Morrisson *et al*., 2012).
- Import and quarantine protocols, government-sponsored risk assessments as well as government -conducted risk assessments could have been useful for this study, but they were not available online.

4.3. Conclusions

The current study was not restricted to the analysis of risk assessment of a single disease process but included the analysis of risk assessments of different diseases and processes affecting animal health and trade in Africa.

The main objectives of the study were to identify and classify risk assessments conducted in animal health and trade and to evaluate if the subject is sufficiently addressed in the literature. The findings corroborate the initial hypothesis that the subject is insufficiently addressed in the literature as evidenced by the number of articles included in the final analysis. However, contrary to the initial hypothesis more quantitative studies are performed in Africa compared to qualitative studies.

There is still more work to be done on risk assessment in animal health and trade in Africa. The following gaps in knowledge have been identified:

- Risk assessments on trade in livestock *per se*, are not well documented.
- Risk assessments of TADs of pigs are poorly documented.
- There is no documentation on the use of generic risk assessment tools in Africa.

- Risk models of TADS are insufficiently used in Africa.

Given these findings and the recommendations below, it is hoped that more risk assessments will be conducted and documented in Africa. This will add to the body of available literature and offer groundwork for risk analysts. An improvement in the quantity and quality of risk assessments will provide vital information on how to reduce the social and economic impacts of livestock diseases in Africa.

4.4. Recommendations for future research

- More qualitative risk assessments should be conducted to support quantitative risk assessments as well as to offer evidence to support policy decisions on livestock health and trade. The use of both qualitative and quantitative methods on a single risk assessment should be considered. The benefit of such a practice has been highlighted above.
- More risk assessments on the trade of animals should be conducted to provide relevant information on the transborder movement of pathogens.
- More risk assessments on the TADs of pigs need to be performed as these diseases have the potential to paralyze the pig industry in Africa. The actual situation on the ground solicits for more risk assessments to be conducted. There is an increase in African swine fever outbreaks, especially in Southern Africa where in the past, the disease was limited to the sylvatic cycle but now has invaded the domestic cycle and poses more risk to trade (Penrith and Kivaria,2022). There is also an increase in the number of African countries reporting the disease, thus making it a very important TAD worth more of the attention of the scientific community. Recently, TADs of swine such as African swine fever, classical swine fever and foot and mouth disease have shown the capacity to infiltrate across country borders, but the precise epidemiological information on how they spread is still missing (Betran-Alcrudo *et al*, 2019). Hence, the need to conduct more risk assessments of TADs of pigs in Africa.
- More risk assessment studies should make use of generic risk assessment tools. They have been used with success in Europe to hierarchize diseases and to perform rapid risk assessments (de Vos *et al.*, 2019; de Vos *et al.*, 2022).

- The participatory risk assessment method should be used more often as it amplifies the impact of risk assessments. Other benefits of this method have been highlighted above.
- African countries should continue to prioritize risk assessments of TADs because they provide valuable information on the source, extent, and likelihood of the spread of these diseases (de Vos, 2022).
- The WOAH risk assessment framework in its integrality should be used more often to inform policy on livestock trade.
- Risk models for the various TADs should be used more often in Africa.

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Additional files

- File 1: Scoping review of risk assessments in Africa (Endnote file; size 31.4 MB)
- File 2: Other Sources (Excel file; size 11KB)
- File 3: Selected articles JDG reviewed (2) (Endnote file; size 124KB)
- File 4: Full text screening and eligibility screening (Excel file; size 29KB))
- File 5: Data Extraction KOS (Excel file; size 55.8KB)
- File 6: Protocol (PDF file,325KB)

Author contributions to the scoping review

JDG, MQ and KOS conceptualized the scoping review during a Zoom meeting held in March 2021. KOS and JDG identified and selected the articles for review. KOS, JDG, MQ defined the inclusion and exclusion criteria. KOS and JDG assessed the articles for eligibility. KOS designed the data extraction instrument. KOS wrote the scoping review with critical inputs from JDG and MQ.

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Conflicts of interest

The reviewers declare that there are no conflicts of interest arising because of funding or other associated interests of the researchers.

Appendix 1: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist

The PRISMA checklist fillable form below was downloaded from http://www.prisma-statement.org/Extensions/ScopingReviews

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Cover Page & p.4
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	vi
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	1-3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	6

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	9
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	8-9
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	9-11
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	11
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Not performed
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	12
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	13-15
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	15
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Not performed

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	13-22
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	13-22
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	23-28
Limitations	20	Discuss the limitations of the scoping review process.	28
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	29-31
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	37

Appendix 2: Search strategy

PubMed

Search: ("Risk assessment" OR "risk analysis") AND (animal OR livestock) AND (health OR trade) AND (Africa or African)

Filters: from 1920/1/1 - 2021/12/31

(("Risk assessment"[All Fields] OR "risk analysis"[All Fields]) AND ("animals"[MeSH Terms:noexp] OR "animal"[All Fields] OR ("livestock"[MeSH Terms] OR "livestock"[All Fields] OR "livestocks"[All Fields] OR "livestock s"[All Fields])) AND ("health"[MeSH Terms] OR "health"[All Fields] OR "health s"[All Fields] OR "healthful"[All Fields] OR "healthfulness"[All Fields] OR "healths"[All Fields] OR ("trade"[All Fields] OR "traded"[All Fields] OR "trades"[All Fields] OR "trading"[All Fields])) AND ("africa"[MeSH Terms] OR "africa"[All Fields] OR "africa s"[All Fields] OR "africas"[All Fields] OR ("africans"[All Fields] OR "blacks"[MeSH Terms] OR "blacks"[All Fields] OR "african"[All Fields]))) AND (1920/1/1:2021/12/31[pdat])

Translations
animal: "animals"[MeSH Terms:noexp] OR animal[All Fields]
livestock: "livestock"[MeSH Terms] OR "livestock"[All Fields] OR "livestocks"[All Fields] OR "livestock's"[All Fields]
health: "health"[MeSH Terms] OR "health"[All Fields] OR "health's"[All Fields] OR "healthful"[All Fields] OR "healthfulness"[All Fields] OR "healths"[All Fields]
trade: "trade"[All Fields] OR "traded"[All Fields] OR "trades"[All Fields] OR "trading"[All Fields]
Africa: "africa"[MeSH Terms] OR "africa"[All Fields] OR "africa's"[All Fields] OR "africas"[All Fields]
African: "africans"[All Fields] OR "blacks"[MeSH Terms] OR "blacks"[All Fields] OR "african"[All Fields]

Scopus

Search within: Article title, abstract, keywords

Filters: from 1920/1/1 - 2021/12/31

("Risk assessment" OR "risk analysis") AND (animal OR livestock) AND (health OR trade) AND (Africa or African)

Web of Science (v 0.1)

Database: All Databases

Entitlements:

- WOS: 1956 to 2021
- BCI: 2009 to 2021
- CABI: 1910 to 2021
- CCC: 1998 to 2021
- DRCI: 2009 to 2021
- DIIDW: 1966 to 2021
- FSTA: 1969 to 2021
- KJD: 1980 to 2021
- MEDLINE: 1950 to 2021
- SCIELO: 2002 to 2021
- ZOOREC: 1978 to 2021

Searches:

(TS=(("Risk assessment" OR "risk analysis") AND (animal OR livestock) AND (health OR trade) AND (Africa or African))) AND (PY==("2021" OR "2020" OR "2019" OR "2018" OR "2017" OR "2016" OR "2015" OR "2014" OR "2013" OR "2012" OR "2011" OR "2010" OR "2009" OR "2008" OR "2007" OR "2006" OR "2005" OR "2004" OR "2003" OR "2002" OR "2001" OR "2000" OR "1999" OR "1998" OR "1997" OR "1996" OR "1995" OR "1994" OR "1993" OR "1992" OR "1991" OR "1990" OR "1989" OR "1988" OR "1987" OR "1986" OR "1985" OR "1979"))

Date run: Tue Mar 29 2022 18:02:50 GMT+0400 (Mauritius Standard Time)
Results: 9597

Appendix 3: Data extraction form

Authors	
Title	
Database source	
Year of Publication	
Country/region where Risk Assessment was conducted	
Target species	
Disease/Target process	
Hazard	
Risk assessment methodology	
Is risk assessment related to livestock trade?	
What is the risk question?	
Which steps of the WOAH risk assessment framework are conducted?	
How is risk assessment used?	
Are generic tools used?	
Remarks	

Appendix 4: Publications included in the scoping review.

1. ADAMCHICK, J., RICH, K. M. & PEREZ, A. M. 2021. Assessment of the risk of foot and mouth disease among beef cattle at slaughter from east African production systems. *Viruses,* 13.
2. ADAMCHICK, J., RICH, K. M. & PEREZ, A. M. 2021. Self-Reporting of Risk Pathways and Parameter Values for Foot-and-Mouth Disease in Slaughter Cattle from Alternative Production Systems by Kenyan and Ugandan Veterinarians. *Viruses,* 13.
3. ALEMAYEHU, G., ZEWDE, G. & ADMASSU, B. 2013. Risk assessments of lumpy skin diseases in Borena bull market chain and its implication for livelihoods and international trade. *Tropical Animal Health and Production,* 45**,** 1153-1159.
4. ALHAJI, N. B., BABALOBI, O. O., WUNGAK, Y. & ULARAMU, H. G. 2018. Participatory survey of Rift Valley fever in nomadic pastoral communities of North-central Nigeria: The associated risk pathways and factors. *Plos Neglected Tropical Diseases,* 12.
5. *ALOTO D., BELETE H.2020. Review of Qualitative risk assessment on the introduction of highly pathogenic avian influenza (H5N1) virus in Ethiopia via importation of Sasso breed (Poultry) from France. Int. J. dv. Res. Biol. Sci. 7(6): 8-19
6. CECILIA, H., MÉTRAS, R., FALL, A. G., LO, M. M., LANCELOT, R. & EZANNO, P. 2020. It's risky to wander in September: Modelling the epidemic potential of Rift Valley fever in a Sahelian setting. *Epidemics,* 33.
7. CHAZYA, R., MUMA, J. B., MWACALIMBA, K. K., KARIMURIBO, E., MKANDAWIRE, E. & SIMUUNZA, M. 2014. A qualitative assessment of the risk of introducing Peste des petits ruminants into northern Zambia from Tanzania. *Veterinary Medicine International,* 2014**,** 202618-Article ID 202618.
8. *CHAZYA, R., et al. (2015). "Peste des petits ruminants (PPR) introduction into Northern Zambia from Tanzania via live goat consignment: a quantitative risk assessment study." Int J Sci Agricul **2**: 1-23.
9. DEAN, A. S., FOURNIE, G., KULO, A. E., BOUKAYA, G. A., SCHELLING, E. & BONFOH, B. 2013. Potential Risk of Regional Disease Spread in West Africa through Cross-Border Cattle Trade. *Plos One,* 8.
10. ELSOBKY, Y., NGANWA, D., EL AFANDI, G., BYOMI, A., REDDY, G. & ABDALLA, E. 2021. A quantitative risk assessment to evaluate the efficacy of mitigation strategies to reduce highly pathogenic avian influenza virus, subtype H5N1 (HPAI H5N1) in the Menoufia governorate, Egypt. *Bmc Veterinary Research,* 17.
11. GOUTARD, F., ROGER, F., GUITIAN, F. J., BALANÇA, G., ARGAW, K., DEMISSIE, A., SOTI, V., MARTIN, V. & PFEIFFER, D. 2007. Conceptual framework for avian influenza risk assessment in Africa: the case of Ethiopia. *Avian Diseases,* 51**,** 504-6.
12. GREWAR, J. D., KOTZE, J. L., PARKER, B. J., VAN HELDEN, L. S. & WEYER, C. T. 2021. An entry risk assessment of African horse sickness virus into the controlled area of South Africa through the legal movement of equids. *Plos One,* 16.
13. JORI, F., VOSLOO, W., DU PLESSIS, B., BENGIS, R., BRAHMBHATT, D., GUMMOW, B. & THOMSON, G. R. 2009. A qualitative risk assessment of factors contributing to foot and mouth disease outbreaks in cattle along the western boundary of the Kruger

National Park. *Revue Scientifique Et Technique-Office International Des Epizooties,* 28**,** 917-931.

14. KNIGHT-JONES, T. J., NJEUMI, F., ELSAWALHY, A., WABACHA, J. & RUSHTON, J. 2014. Risk assessment and cost-effectiveness of animal health certification methods for livestock export in Somalia. *Preventative Veterinary Medicine,* 113**,** 469-83.
15. LATIF, A. A., NKABINDE, B., PEBA, B., MATTHEE, O., PIENAAR, R., JOSEMANS, A., MARUMO, D., LABUSCHAGNE, K., ABDELATIEF, N. A., KRÜGER, A. & MANS, B. J. 2019. Risk of establishment of canine leishmaniasis infection through the import of dogs into South Africa. *Onderstepoort Journal of Veterinary Research,* 86**,** e1-e11.
16. MAGALHAES, R. J. S., GOUTARD, F., DEMISSIE, A., IGEZU, L., JOBRE, Y., ROGER, F. & PFEIFFER, D. U. 2007. *Quantitative assessment of the risk of introduction of HPAI H5N1 to Ethiopia via the legal import of day-old-chicks*.
17. MAKUNGU, C. & MWACALIMBA, K. K. 2014. A quantitative risk assessment of bovine theileriosis entering Luapula Province from Central Province in Zambia via live cattle imports from traditional and commercial production sectors. *Preventive Veterinary Medicine,* 116**,** 63-74.
18. NAPP, S., CHEVALIER, V., BUSQUETS, N., CALISTRI, P., CASAL, J., ATTIA, M., ELBASSAL, R., HOSNI, H., FARRAG, H., HASSAN, N., TAWFIK, R., ABD ELKADER, S. & BAYOMY, S. 2018. Understanding the legal trade of cattle and camels and the derived risk of Rift Valley Fever introduction into and transmission within Egypt. *Plos Neglected Tropical Diseases,* 12.
19. OLIVE, M. M., GOUTARD, F., DEMISSIE, A., YIGEZU, L. M., JOBRE, Y. & ROGER, F. 2007. *Qualitative risk assessment of the introduction of H5N1 virus in Ethiopia by the commercial trades*.
20. *SERGEANT, E. (2015). Import Risk Analysis: Sable antelope from Zambia into South Africa.
21. SERGEANT, E. S., GREWAR, J. D., WEYER, C. T. & GUTHRIE, A. J. 2016. Quantitative Risk Assessment for African Horse Sickness in Live Horses Exported from South Africa. *Plos One,* 11.
22. SQUARZONI-DIAW, C., ARSEVSKA, E., KALTHOUM, S., HAMMAMI, P., CHERNI, J., DAOUDI, A., KARIM LAOUFI, M., LEZAAR, Y., RACHID, K., SECK, I., OULD ELMAMY, B., YAHYA, B., DUFOUR, B., HENDRIKX, P., CARDINALE, E., MUNOZ, F., LANCELOT, R. & COSTE, C. 2021. Using a participatory qualitative risk assessment to estimate the risk of introduction and spread of transboundary animal diseases in scarce-data environments A Spatial Qualitative Risk Analysis applied to foot-and-mouth disease in Tunisia 2014-2019. *Transboundary and Emerging Diseases,* 68**,** 1966-1978.
23. SUTMOLLER, P., THOMSON, G. R., HARGREAVES, S. K., FOGGIN, C. M. & ANDERSON, E. C. 2000. The foot-and-mouth disease risk posed by African buffalo within wildlife conservancies to the cattle industry of Zimbabwe. *Preventative Veterinary Medicine,* 44**,** 43-60.
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contagious bovine pleuropneumonia through live cattle imported from northwestern Ethiopia. *Preventive Veterinary Medicine,* 122**,** 61-69.

Appendix 5: Publications excluded with reason.

5.1. Study not a risk assessment but a risk factor analysis, risk mapping, risk overview, risk communication.

1. *ALLEPUZ, A., et al. (2015). Risk Factors for Foot-and-Mouth Disease in Tanzania, 2001–2006. *Transboundary and Emerging Diseases* **62**(2): 127-136.
2. *BAYISSA, B., et al. (2011). Study on seroprevalence, risk factors, and economic impact of foot-and-mouth disease in Borena pastoral and agro-pastoral system, southern Ethiopia. *Tropical animal health and production **43**(4): 759-766*
3. BOUKARY, A. R., SAEGERMAN, C., ABATIH, E., FRETIN, D., ALAMBÉDJI BADA, R., DE DEKEN, R., HAROUNA, H. A., YENIKOYE, A. & THYS, E. 2013. Seroprevalence and potential risk factors for Brucella spp. infection in traditional cattle, sheep and goats reared in urban, peri urban and rural areas of Niger. *PLoS One,* 8**,** e83175.
4. CLEMENTS, A. C. A., PFEIFFER, D. U., MARTIN, V., PITTIGLIO, C., BEST, N. & THIONGANE, Y. 2007. Spatial risk assessment of Rift Valley fever in Senegal. *Vector-Borne and Zoonotic Diseases,* 7**,** 203-216.
5. DION, E. & LAMBIN, E. F. 2012. Scenarios of transmission risk of foot-and-mouth with climatic, social and landscape changes in southern Africa. *Applied Geography,* 35**,** 32-42.
6. *HUANG, Z. Y., et al. (2017). Regional level risk factors associated with the occurrence of African swine fever in West and East Africa. *Parasites & Vectors* 10(1): 1-8.
7. KABUUKA, T., KASAIJA, P. D., MULINDWA, H., SHITTU, A., BASTOS, A. D. S. & FASINA, F. O. 2014. Drivers and risk factors for circulating African swine fever virus in Uganda, 2012-2013. *Research in Veterinary Science,* 97**,** 218-225.
8. KOLACZINSKI, J. H., REITHINGER, R., WORKU, D. T., OCHENG, A., KASIMIRO, J., KABATEREINE, N. & BROOKER, S. 2008. Risk factors of visceral leishmaniasis in East Africa: A case-control study in Pokot territory of Kenya and Uganda. *International Journal of Epidemiology,* 37**,** 344-352.
9. KOUAM, M. K., BIEKOP, H. M. F., KATTE, B. & TEGUIA, A. 2019. Risk factors of Salmonella infection in laying hens in Menoua Division, Western region of Cameroon (Central Africa). *Comparative Immunology, Microbiology, and Infectious Diseases,* 67.
10. KRACALIK, I. T., KENU, E., AYAMDOOH, E. N., ALLEGYE-CUDJOE, E., POLKUU, P. N., FRIMPONG, J. A., NYARKO, K. M., BOWER, W. A., TRAXLER, R. & BLACKBURN, J. K. 2017. Modeling the environmental suitability of anthrax in Ghana and estimating populations at risk: Implications for vaccination and control. *Plos Neglected Tropical Diseases,* 11.
11. MESSINA, J. P., MOORE, N. J., DEVISSER, M. H., MCCORD, P. F. & WALKER, E. D. 2012. Climate Change and Risk Projection: Dynamic Spatial Models of Tsetse and African Trypanosomiasis in Kenya. *Annals of the Association of American Geographers,* 102**,** 1038-1048.
12. MINANI, S., DORNY, P. & TREVISAN, C. 2021. Prevalence and risk assessment of porcine cysticercosis in Ngozi province, Burundi. *Veterinary Parasitology- Regional Studies and Reports,* 23.

13. MOKOELE, J. M., JANSE VAN RENSBURG, L., VAN LOCHEM, S., BODENSTEIN, H., DU PLESSIS, J., CARRINGTON, C. A., SPENCER, B. T. & FASINA, F. O. 2015. Overview of the perceived risk of transboundary pig diseases in South Africa. *Journal South African Veterinary Association,* 86**,** 1197.
14. MOLIA, S., BOLY, I. A., DUBOZ, R., COULIBALY, B., GUITIAN, J., GROSBOIS, V., FOURNIÉ, G. & PFEIFFER, D. U. 2016. Live bird markets characterization and trading network analysis in Mali: Implications for the surveillance and control of avian influenza and Newcastle disease. *Acta Tropica,* 155**,** 77-88.
15. MSIMANG, V., WEYER, J., ROUX, C. L., KEMP, A., BURT, F. J., TEMPIA, S., GROBBELAAR, A., MOOLLA, N., ROSTAL, M. K., BAGGE, W., CORDEL, C., KARESH, W. B., PAWESKA, J. T. & THOMPSON, P. N. 2021. Risk factors associated with exposure to crimean-congo haemorrhagic fever virus in animal workers and cattle, and molecular detection in ticks, South Africa. *PLoS Neglected Tropical Diseases,* 15.
16. MUMA, J. B., SAMUI, K. L., OLOYA, J., MUNYEME, M. & SKJERVE, E. 2007. Risk factors for brucellosis in indigenous cattle reared in livestock-wildlife interface areas of Zambia. *Preventive Veterinary Medicine,* 80**,** 306-317.
17. MUMA, J. B., SAMUI, K. L., SIAMUDAALA, V. M., OLOYA, J., MATOPE, G., OMER, M. K., MUNYEME, M., MUBITA, C. & SKJERVE, E. 2006. Prevalence of antibodies to Brucella spp. And individual risk factors of infection in traditional cattle, goats and sheep reared in livestock-wildlife interface areas of Zambia. *Tropical Animal Health and Production,* 38**,** 195-206.
18. MUNYEME, M., MUMA, J. B., SKJERVE, E., NAMBOTA, A. M., PHIRI, I. G. K., SAMUI, K. L., DORNY, P. & TRYLAND, M. 2008. Risk factors associated with bovine tuberculosis in traditional cattle of the livestock/wildlife interface areas in the Kafue basin of Zambia. *Preventive Veterinary Medicine,* 85**,** 317-328.
19. MUSA, I. W., ABDU, P. A., SACKEY, A. K. B. & OLADELE, S. B. 2013. Studies of some risk factors for re-introduction and spread of highly pathogenic avian influenza in two states of Nigeria. *Nigerian Veterinary Journal,* 34**,** 890-897.
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Annexe A: Diseases previously listed as OIE List A diseases.

Source:https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-diseases/old-classification-of-diseases-notifiable-to-the-oie-list-a/

- Foot and mouth disease
- Swine vesicular disease
- Peste des petits ruminants
- Lumpy skin disease
- Bluetongue
- African horse sickness
- Classical swine fever
- Newcastle disease
- Vesicular stomatitis
- Rinderpest (Now considered eradicated)
- Contagious bovine pleuropneumonia
- Rift Valley fever
- Sheep pox and goat pox
- African swine fever
- Highly pathogenic avian influenza

Annexe B: Research ethics approval

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Veterinary Science

Research Ethics Committee 08 November 2021

CONDITIONALLY APPROVAL

Ethics Reference No	**REC114-21**
Protocol Title	**A scoping review of the use of risk assessment in animal health and trade related issues in Africa**
Principal Investigator	**Dr KO Samoisy**
Supervisors	**Prof M Quan**

Dear Dr KO Samoisy,

We are pleased to inform you that your submission has been conditionally approved by the Faculty of Veterinary Sciences Research Ethics committee, subject to other relevant approvals.

Please note the following about your ethics approval:

1. Please use your reference number (REC114-21) on any documents or correspondence with the Research Ethics Committee regarding your research.
2. Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, monitor the conduct of your research, or suspend or withdraw ethics approval.
3. Please note that ethical approval is granted for the duration of the research as stipulated in the original application for post graduate studies (e.g. Honours studies: 1 year, Masters studies: two years, and PhD studies: three years) and should be extended when the approval period lapses.
4. The digital archiving of data is a requirement of the University of Pretoria. The data should be accessible in the event of an enquiry or further analysis of the data.

Ethics approval is subject to the following:

1. The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.
2. **Applications using Animals**: FVS ethics recommendation does not imply that AEC approval is granted. The application has been pre-screened and recommended for review by the AEC. Research may not proceed until AEC approval is granted.

Conditionally approved.
Please note - Researcher agreements: Only a postgraduate student can be granted the rights to publish a dissertation/thesis.

We wish you the best with your research.

Yours sincerely

PROF M. OOSTHUIZEN
Chairperson: Research Ethics Committee

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