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PREVALENCE AND RISK FACTORS OF HUMAN BRUCELLOSIS AMONG ABATTOIR WORKERS IN SUB-SAHARAN AFRICA: A SCOPING REVIEW.

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Summary

This scoping review examined the available literature on the factors contributing to the prevalence of human brucellosis among abattoir workers in Sub-Saharan Africa, recognizing it as a significant zoonotic disease. Six databases (Public Library of Science (PLOS), SCOPUS, ScienceDirect, PubMed/MEDLINE, Web of Science, and Google Scholar) were searched to identify studies conducted and published in English that determined the prevalence of human brucellosis among abattoir workers in Sub-Saharan Africa from January 2000 to December 2022. A total of twenty-nine (29) articles satisfied our eligibility criteria. The articles included in this study were thoroughly examined, and the extracted data from these selected articles were analyzed. The findings of this review reveal that human brucellosis is prevalent among individuals employed in Sub-Saharan African abattoirs. Additionally, this scoping review highlights significant gaps in the availability of epidemiological information regarding human brucellosis among these workers, stemming from inadequate reporting and scarcity of epidemiological data despite the endemic nature of brucellosis in Sub-Saharan Africa. This study also identified risk factors such as inadequate usage of personal protective equipment (PPE) during the slaughter process and prolonged work periods within the abattoir setting.

Keywords: Abattoir workers, Human brucellosis, Risk Factors, Scoping review, Sub-Saharan Africa.

Introduction

Brucellosis is caused by a non-encapsulated, flagellated, facultative non-motile, gram-negative intracellular bacteria. These bacteria, measuring approximately 0.5 to 0.7 by 0.6 to 1.5µm in size, are responsible for a significant zoonotic infection prevalent in developing nations. Approximately 3.5 billion individuals are estimated to be susceptible to contracting at least one or more *Brucella spp* (Bosilkovski et al., 2021; Rossetti et al., 2017).

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On a global scale, the incidence of brucellosis remains notably high, particularly in Africa (Bennett and Bronze, 2022). Current studies across various countries in Africa have unveiled a more extensive prevalence of brucellosis than previously assumed, with factors such as livestock density, animal husbandry practices, and healthcare infrastructures playing a role in the variations observed among nations and regions (Abdussalam & Fein, 1976; Ducrotoy et al., 2014). Brucellosis has been acknowledged as an occupational hazard for individuals employed in abattoirs and slaughter slabs, and involved in activities such as butchery, meat sales, veterinary work (veterinarians/para-veterinarians), livestock farming, and related occupations. These occupational groups often have direct contact with potentially infected animals or animal products (Ayoola et al., 2017; Igawe et al., 2020; WHO, 2020). Human transmission can happen when individuals come into direct contact with blood or placental tissue of infected animals, uterine secretions, as well as unpasteurized milk, and inhalation of contaminated air (Halling & Young, 1994).

One of the challenges in understanding the true prevalence of brucellosis is the underreporting of cases and the lack of comprehensive surveillance systems. This could result in an underestimation of the actual burden of the disease. The commonly cited figure of 500,000 new human cases of brucellosis annually is also suspected to be underestimated (O'Collaghan, 2020). This scoping review aims to offer a comprehensive outline of the available evidence concerning the prevalence and factors contributing to human brucellosis among abattoir workers in Sub-Saharan Africa. This aim was achieved by identifying, mapping, and summarizing the relevant studies to highlight existing gaps and inform future research and public health interventions.

Materials and Methods

This scoping review began with the formation of the research team, which consists of two independent investigators who reviewed the search results. This review was conducted from March to August 2023.

The protocol used in this study was developed by utilizing the model initially proposed by Arksey and O'Malley (2005) and modified by the Joanna Briggs Institute (2015).

The review included the following five key phases: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarizing, and reporting the results. The optional 'consultation exercise' of the framework was not conducted. A detailed review protocol can be obtained from the primary author upon request.

Our selection process adhered to the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist. The selection and mapping were done using the PRISMA-P chart and the percentage agreement between the two investigators (Figure 1).

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Six electronic databases were searched, namely: Public Library of Science (PLOS), SCOPUS, Science Direct, PubMed/MEDLINE, Web of Science, and Google Scholar.

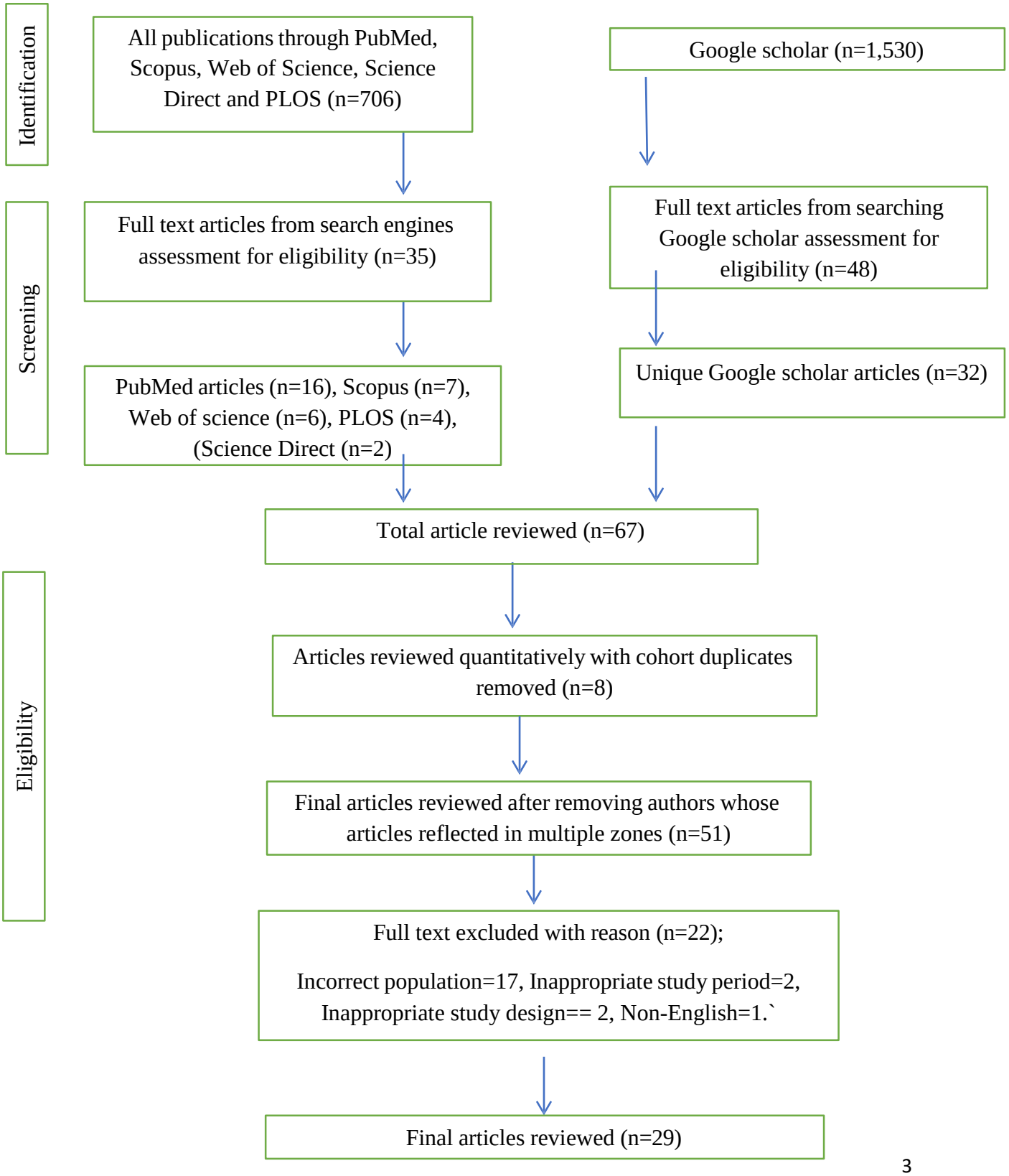

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Figure 1: PRISMA flowchart showing how the selection of articles was done.

To create an effective search strategy the PICO framework was used which helped us to generate keywords and form descriptors such as 'Brucellosis', 'Prevalence of Brucellosis', 'Epidemiology of Brucellosis', 'Human Brucellosis', 'Animal Brucellosis', 'Brucellosis among abattoir workers', 'Brucellosis in Sub-Saharan Africa', 'Transmission of Brucellosis in Humans', 'Clinical signs of Human Brucellosis', 'Diagnosis of Brucellosis', 'Treatment of Human Brucellosis', 'Prevention of Brucellosis', 'Control of Brucellosis', 'Risk Factors of Brucellosis', 'Socioeconomic Impact of Brucellosis', 'Brucellosis Intervention Programs', etc.

The inclusion criteria included both quantitative and qualitative studies focusing on the prevalence and risk factors of human brucellosis among abattoir workers in Sub-Saharan Africa, published in English from January 2000 to December 2022.

The exclusion criteria were as follows:

Incorrect population: studies were excluded if the sampled population did not consist of abattoir workers.

Inappropriate study period: any study falling outside the specific study period (2000-2022) was excluded.

Inappropriate study design: excluded studies did not focus on the seroprevalence of human brucellosis among abattoir workers in Sub-Saharan Africa.

Non-English language: this scoping review exclusively included articles published in English language.

Results

In this scoping review, a total of fifty-one (51) research articles were reviewed, and after rigorous assessment, twenty-nine articles were found to meet the inclusion criteria and were consequently included in the final review, and twenty-two articles were excluded.

1. Study participants and characteristics of included studies

The studies included in this review were articles that specifically addressed the seroprevalence and risk factors of human brucellosis among abattoir workers in Sub-Saharan Africa and included 5,958 participants, which consisted of butchers, veterinarians/para-veterinarians, meat sellers, and cattle herders aged between 16-70 years old.

Eleven (11) countries, including Angola, Cameroon, Ethiopia, Ghana, Namibia, Nigeria, Tanzania, Sudan, South Sudan, Uganda, and Zambia, published articles on human brucellosis

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among abattoir workers from January 2000 to December 2022. All included articles were cross-sectional studies with the aim of determining the seroprevalence of human brucellosis antibodies and assessing the possible risk factors among abattoir workers, as shown in Tables 1 and 2.

Table 1: Overview of the characteristics of the included studies (Seroprevalence of human brucellosis among abattoir workers in Sub-Saharan Africa 2000 - 2022).

Country/Region	**Study (Year)**	**Sample size**	**Prevalence**	**Diagnostic methods**	**Brucella species**
Angola (Namibe province)	Mufinda et al, 2017	323	25.70%	RBPT & SAT	*Brucella spp.*
Cameroon (West region)	Kamga et al, 2021	273	22.70%	RBPT & iELISA	*Brucella spp.*
Cameroon (Adamawa region)	Awah-Ndukum et al, 2018	107	17.60%	RBPT & IgG	*Brucella spp.*
Ethiopia (Addis Ababa)	Kassahun et al, 2006	336	4.80%	2-MET	*Brucella spp*
Ethiopia (Central Ethiopia)	Tsegay et al, 2017	149	4.70%	RBPT	*Brucella spp*
Ghana (Kumasi)	Amegashire et al, 2017	220	11.36%	IgG, IgG/IgM ELISA	*Brucella spp*
Namibia (Hardap, Karas, Omaheke and Khomas regions)	Magwedere et al, 2011	137	2.19%	IgG/IgM ELISA	*Brucella spp*
Nigeria (FCT Abuja)	Aworh et al., 2012	224	24.10%	cELISA, IgG/IgM ELISA	*Brucella spp*
Nigeria (Adamawa state)	Atsanda & Agbada, 2001	200	2.5%	RBPT & SAT	*Brucella spp*
Nigeria (Akwa Ibom state)	Owowo et al, 2019	228	30.80%	SAT & IgG/IgM ELISA	*B. abortus*

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Nigeria (Bauchi state)	Igawe et al, 2020	284	34.50%	IgG, IgM, IgG/IgM ELISA	*Brucella spp*
Nigeria (Benue state)	Ofukwu et al, 2007	94	7.60%	RBPT & SAT	*Brucella spp*
Nigeria (Borno state)	Adamu et al, 2015	100	38.50%	RBPT	*B. abortus*
Nigeria (Kwara state)	Bamidele et al, 2020	182	22.20%	RBPT	*Brucella spp*
Nigeria (Lagos state)	Adeyemi, 2018	301	8.97%	RBPT & cELISA	*Brucella spp*
Nigeria (Nasarawa state)	Agada et al, 2018	160	10,00%	RBPT	*Brucella spp*
Nigeria (Oyo state)	Cadmus et al, 2006	11	31.82%	RBPT	*Brucella spp*
Nigeria (Plateau state)	Gusi et al, 2010	101	8.90%	RBPT & SAT	*Brucella spp*
Sudan (Eastern state)	El-Ansary et al, 2001	187	2.17%	SAT	*B.abortus, B. melintesis*
Sudan (Nomadic localities)	Omer et al, 2010	33	9.00%	RBPT	*Brucella spp*
Sudan (Northern state)	Zein et al, 2015	753	26.20%	RBPT & SAT	*Brucella spp*
South Sudan (Bahr el Ghazal region)	Madut et al, 2019	234	32.10%	RBPT & cELISA	*Brucella spp*
Tanzania (Dodoma region)	Luwamba et al, 2019	62	1.61%	RBPT	*Brucella spp*
Tanzania (Mwanza region)	Mirambo et al, 2019	250	48.40%	SAT	*Brucella spp, B. abortus, B. melintesis.*

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Tanzania (Mbeya region)	Sagamiko et al, 2020	425	1.41%	RBPT	*Brucella spp*
Tanzania (Tanga region)	Swai & Schooman, 2009	199	6%	RBPT & cELISA	*Brucella spp*
Uganda (Kampala and Mbarara districts)	Nabukenya et al, 2013	232	10.30%	SAT	*Brucella spp*
Zambia (Southern province)	Mubanga et al, 2021	153	20.30%	cELISA & iELISA	*Brucella spp*

RBPT: Rose Bengal plate test; SAT: Serum Agglutination Test; c-ELISA: Competitive enzyme-linked immunosorbent assay; i-ELISA: indirect enzyme-linked immunosorbent assay, CFT: Complement fixation test; 2-MET: 2-Mercaptoethanol; IgM: Immunoglobulin M; IgG: Immunoglobulin G.

2. Risk factor analysis

Information on the risk factors for human brucellosis from the included articles was obtained by questionnaire interview of all participants (abattoir workers) by the authors. The questionnaires were carefully designed to capture variables including: socio-demographic details, knowledge about brucellosis, occupational data of the participants, lifestyle, and clinical history related to brucellosis.

Information gathered from the questionnaires reveals that the majority of abattoir workers were males aged between 16-70 years old. This is because cattle handling, milking, butchering, and other abattoir activities are mostly done by men in Sub-Saharan Africa. Abattoir workers within the ages of 20-35 were mostly affected by brucellosis and had a poor educational background, while those above 40 years were least infected. Abattoir workers with higher education, such as tertiary education, seem to be less at risk of infection. This can be attributed to their infrequent involvement in animal rearing and slaughtering of animals, as they often serve in supervisory or advisory capacities (Owowo et al., 2019).

The clinical signs of human brucellosis as manifested by abattoir workers in Sub-Saharan Africa includes: regular headache, constantly treating malaria, waist and joint pains, shivering, fatigue, lower back pain, fever, and malaise (Amegashie et al., 2017; Awah-Ndukum et al., 2018; Igawe et al., 2020; Kassahun et al., 2006; Madut et al., 2019; Magwedere et al., 2011; Mirambo et al., 2018; Mufinda et al., 2017; Nabukenya et al., 2013; O'Collaghan, 2020). The risk factors identified in this study are listed in Table 2.

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Table 2: Risk factors of brucellosis among abattoir workers in Sub-Saharan Africa.

Risk factor identified	**Description**	**References**
Low Knowledge & Awareness	Limited knowledge of brucellosis transmission and a lack of biosafety awareness.	Mufinda et al., 2017; Kamga et al., 2021; Madut et al., 2019; Zein et al., 2015
Occupational Exposure	Frequent contact with blood, tissues, aborted fetuses, placenta, or carcasses during slaughter or evisceration.	Kassahun et al., 2006; Agada et al., 2018; Igawe et al., 2020; Gusi et al., 2010; Luwumba et al., 2019
Lack of Personal Protective Equipment (PPE)	Failure to use gloves, aprons, boots, or masks; butchers working with bare hands and open wounds.	Tsegay et al., 2017; Awah-Ndukum et al., 2018; Sagamiko et al., 2020; Aworh et al., 2011; Cadmus et al., 2006
Consumption of Raw or Unpasteurized Animal Products	Drinking raw milk, eating raw meat or offal (liver, kidney), and fresh cheese.	Mufinda et al., 2017; Magwedere et al., 2011; Adeyemi, 2018; El-Ansary et al., 2001; Nabukenya et al., 2013
Poor Hygiene & Biosafety Practices	Unsafe handling of infected animal parts, improper disposal of abortion remains, and lack of detergents/disinfectants.	Kassahun et al., 2006; Agada et al., 2018; Mufinda et al., 2017
Demographic Factors	Males are mostly affected; younger age (18–35 years) is more susceptible; long duration of work (>5–10 years) is linked with higher risk.	Bamidele et al., 2020; Amegashie et al., 2010; Nabukenya et al., 2013; Mubanga et al., 2021

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Educational Level	Illiteracy or primary-level education associated with higher risk.	Kamga et al., 2021; Amegashie et al., 2010; Mirambo et al., 2018

3. Prevalence of Human Brucellosis among Abattoir Workers in Sub-Saharan Africa.

A total of 1,062 out of 5,958 abattoir workers tested positive for human brucellosis, representing 17.82% of the overall prevalence in Sub-Saharan Africa. The prevalence of human brucellosis among abattoir workers exhibited variations from one country to another, as shown in Figures 2 and 3.

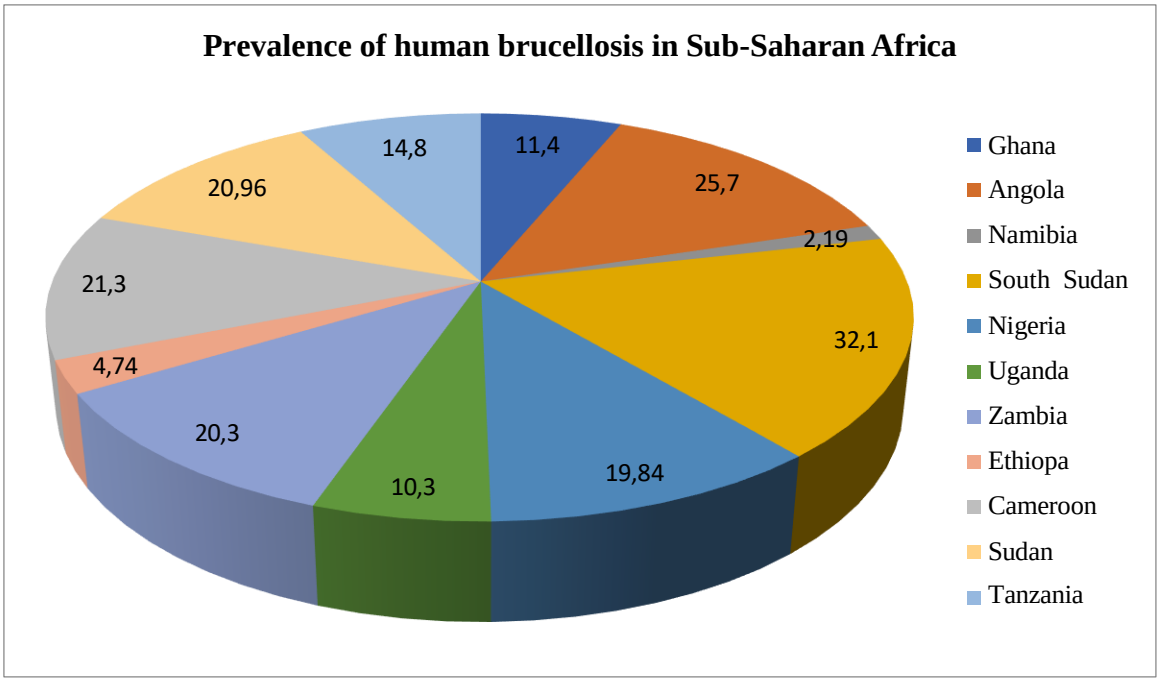

Figure 2: Pie chart showing the prevalence of brucellosis in Sub-Saharan Africa.

In terms of specific countries, the prevalence of human brucellosis among abattoir workers has been documented in various regions. Namibe province in Angola (Mufinda et al., 2017], the Ashanti region (Kumasi) in Ghana (Amegashie et al., 2017), the Bahr el Ghazal region in South Sudan (Madut et al., 2019), and the Southern Province in Zambia (Mubanga et al., 2021). Similarly, two regions in Cameroon, Adamawa and the West region (Awah-Ndukum et al., 2018; Kamga et al., 2021), as well as two provinces in Ethiopia, Central Ethiopia and Addis Ababa (Tsegay et al., 2017; Kassahun et al., 2006), the Eastern state (El-Ansary et al., 2001; Nomadic localities (Omer et al., 2010) and the Northern states (Zein et al., 2015) in Sudan, and the Southern

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Province in Zambia (Mubanga et al., 2021) have reported cases. Similarly, four regions in Tanzania, Dodoma, Mwanza, Mbeya, and Tanga regions (Luwumba, 2019; Mirambo et al., 2019; Sagamiko et al., 2020; Swai & Schoonman, 2009; Tsegay et al., 2017), have also reported cases. Notably, eleven states in Nigeria, Abuja (FCT) (Aworh et al., 2012), Plateau state (Gusi et al., 2010), Kwara state (Bamidele et al., 2020), Nasarawa state (Agada et al., 2018), Benue state (Ofukwu et al., 2007), Borno state (Adamu et al., 2015), Bauchi state (Igawe et al., 2020), Adamawa state (Atsanda & Agbede, 2001), Akwa Ibom state (Owowo et al., 2019), Oyo state (Cadmus et al., 2006) and Lagos state (Adeyemi, 2018) have reported cases as shown in figure 2.

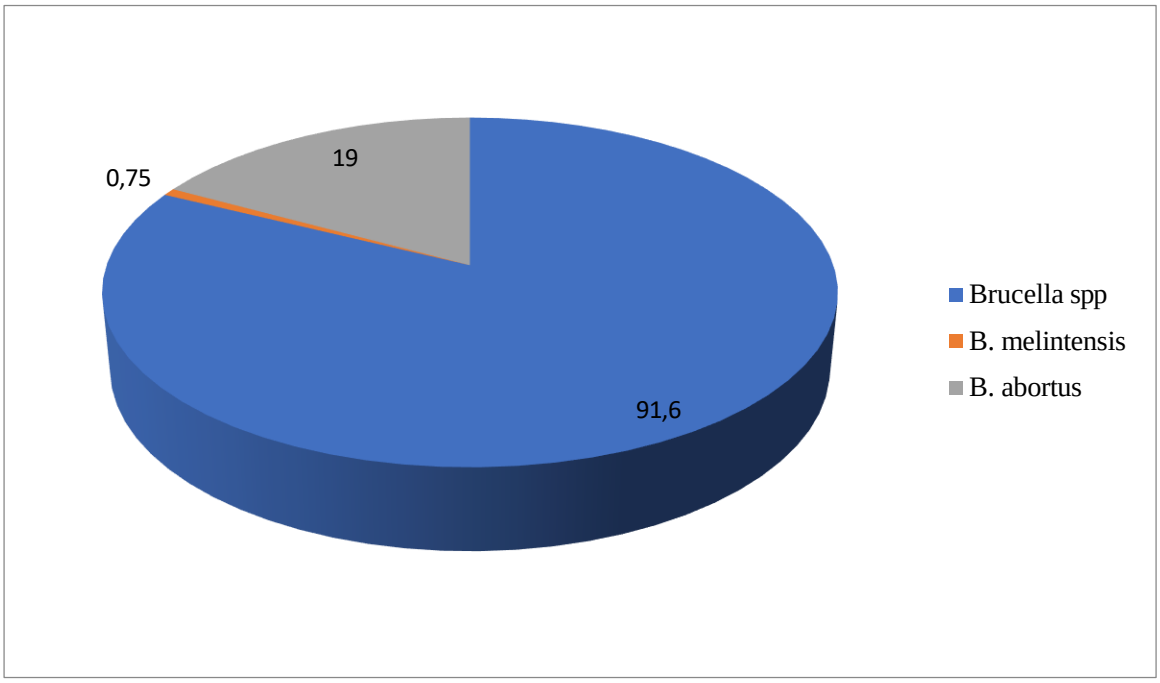

Figure 3: Prevalence of *Brucella species* in Sub-Saharan Africa.

Discussion

The findings of this scoping review indicate a shortage of data regarding human brucellosis among abattoir workers in Sub-Saharan Africa. Only eleven countries reported *Brucella* infections in abattoir workers. In this study, the total prevalence of brucellosis among abattoir workers in Sub-Saharan Africa was 17.82%, which is similar to the 16% reported in Africa by Mia et al in 2022. The slight discrepancy in the prevalence rate in our study when compared to that reported by Mia et al (2022) may be attributed to differences in the inclusion criteria. This study considered articles published from 2000-2022, whereas Mia et al (2022) reviewed articles published from 2010-2016.

Another potential factor contributing to this variation is the dissimilarity in the study population. The human brucellosis prevalence reviewed by Mia et al (2022) concentrated on

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individuals who had contact with animals or animal products. These include individuals from veterinary clinics, slaughterhouses, agricultural employees, dairy cow owners, and pastoralists, which constitutes a larger and more diverse group. In contrast, our study reviewed the prevalence of human brucellosis among only abattoir workers, a smaller group that includes veterinarians/para-veterinarians, butchers, animal handlers, and meat sellers.

In this review, Nigeria stands out with the highest incidence of human brucellosis among abattoir workers between 2006- 2021. 11 publications recorded a prevalence rate of 19.76%, which shows the endemicity of brucellosis in Nigeria and this could be linked to lack of awareness by abattoir workers regarding the importance of wearing personal protective equipment (PPE) while working in the abattoir and frequent contact with animal blood and body parts and consumption of unpasteurized milk and meat (Adamu et al., 2015, Cadmus et al., 2006, Gusi et al., 2010).

Tanzania also recorded a notable incidence of human brucellosis with 4 publications between 2009 -2019, with a prevalence rate of 14.85%. Human brucellosis is endemic in Tanzania and can be associated with activities such as the slaughter of livestock, direct contact with aborted fetuses, and refusal to wear personal protective equipment (PPE) by abattoir workers (Cash-Goldwasser, 2018; Mirambo et al., 2018).

Sudan recorded a prevalence rate of 20.96% among abattoir workers in 3 publications. Sudan has been recognized as endemic for human brucellosis (Mohammed & Idris 2016), with butchers consuming raw meat (livers and kidneys) and refusing to wear personal protective clothing (PPE) while slaughtering animals. These practices have contributed to the increased risk of *Brucella* infection among abattoir workers (El-Ansary et al., 2001; Zein & Sabahelkhier, 2015).

Cameroon recorded a prevalence rate of 21.32% among abattoir workers in 2 publications in 2009 and 2018. The risk of human brucellosis among abattoir workers has been linked to having a poor educational background, refusal to wear PPE, and close contact and handling of fetus and uterine content during slaughter (Awah-Ndukum et al., 2018; Kamga et al., 2021; Swai & Schoonman, 2009). It is worth noting that there is a paucity of information available about human brucellosis among abattoir workers in Cameroon.

Ethiopia recorded a prevalence rate of 4.74% from 2 publications. Having a low level of awareness on brucellosis and their consumption of unpasteurized meat and milk contributes to the high risk of *Brucella* infection among abattoir workers (Kassahun et al., 2006; WHO, 2020).

Namibia documented a prevalence of 2.19% in a single publication from 2011 (Magwedere et al., 2011). Abattoir workers who consume raw cow or goat milk are at risk of contracting brucellosis. It is worth noting that there is a shortage of data on human brucellosis among abattoir workers in Namibia. Possibly, due to the low awareness level on the zoonotic potential of brucellosis.

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Uganda documented a prevalence rate of 10.3% from one publication in 2013. Consumption of raw meat and cow ghee and infrequent use of full personal protective equipment (PPE) and prolonged employment in the abattoir exceeding five years has been attributed to *Brucella* infection among abattoir workers (Nabukenya et al., 2013).

South Sudan documented a prevalence rate of 32.1% in a single publication in 2019. There is currently a shortage of available data on the prevalence of human brucellosis in South Sudan. However, Madut et al (2019) attributed having poor knowledge about brucellosis and poor hygienic practices to the risk of contracting *Brucella* infection among abattoir workers in South Sudan.

Angola recorded a prevalence rate of 25.7% from one publication in 2017. Brucellosis has been identified as a public health concern in Namibe, Angola (Mufinda et al., 2017), the only region in Angola that has reported cases of brucellosis. The identified risk factors are; consuming unpasteurized milk and dairy products, and improper disposal of aborted materials (Mufinda et al., 2017).

Ghana recorded a prevalence rate of 11.4% from one publication in 2017. Workers who have no educational background and work in the meat processing unit of the abattoir, such as butchers and line operators, and have worked for 10-19 years in the abattoir, are at risk of contracting *Brucella* infection (Amegashie et al., 2017).

Zambia documented a prevalence rate of 20.3% from one publication in 2021. Abattoir workers who are continuously exposed to animal parts, including blood, tissue, fluids, and aerosols, and do not utilize personal protective equipment (PPE) face an elevated risk of exposure to *Brucella* pathogen in Zambia (Mubanga et al., 2021). There is insufficient documentation of human brucellosis among abattoir workers in Zambia.

Numerous authors highlighted a significant link between the duration of employment (prolonged employment at the abattoir) and an increased risk of chronic infection. Workers who have spent extended periods consistently exposed to the body fluids of potentially infected animals are more likely to become infected (Amegashie et al., 2017). It was also observed that abattoir workers between the ages of 20-35 years were predominantly susceptible to brucellosis (Mubanga et al., 2021). It is important to note that this scoping review is the first to investigate the prevalence of human brucellosis among abattoir workers in Sub-Saharan Africa.

This scoping review provided a comprehensive overview of the existing literature on the prevalence and risk factors of human brucellosis among abattoir workers in Sub-Saharan Africa.

Gaps in the existing research were identified in this study, and this can guide future research priorities in this field. The key findings of this study were summarized using tables and charts, thereby making it easy for researchers and policymakers to grasp the state of knowledge on the prevalence and risk factors of human brucellosis among abattoir workers in Sub-Saharan Africa.

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The findings from this scoping review can inform policy decisions and guide public health interventions in the Sub-Saharan African region. This is particularly important for a disease like brucellosis with its significant public health implications.

There are some limitations encountered in this scoping review. Scoping reviews do not generally assess the quality of individual studies. Hence, the methodological rigor of the included studies was not thoroughly evaluated. Conducting this scoping review was time-consuming due to the large volume of literature that was searched to select the included articles. Epidemiological data from the grey literature were notably limited in many countries across Sub-Saharan Africa. However, we successfully obtained data from all four regions in Sub-Saharan Africa, providing a comprehensive representation of the prevalence of human brucellosis among abattoir workers in the region.

Conclusion

This scoping review shows that brucellosis remains an important occupational health problem among abattoir workers in Sub-Saharan Africa, with a reported prevalence of 17.82%. Only 11 countries provided data, and Nigeria recorded the highest incidence. The findings indicate underreporting and a lack of epidemiological data.

The main risk factors identified were direct contact with infected animals and animal products, inadequate use of protective equipment, and long working hours.

Most studies were cross-sectional and did not compare abattoir workers with other occupational groups, leaving knowledge gaps about specific risks and biological factors. Overall, there is a clear need for more detailed research and improved reporting systems to better understand and control human brucellosis among abattoir workers in the Sub-Saharan African region.

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