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Ecological interactions, local people awareness and practices on rodent-borne diseases in Africa: A review

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ABSTRACT

Several anthropogenic activities exposure humans to the risk of rodent-borne diseases. These activities are but not limited to logging, clearing land for crop cultivation, and consuming rodents. Rodents are a highly diverse mammalian group and harbor many zoonotic diseases. This review focuses on dominant rodent-flea species, rodent-borne zoonotic diseases and awareness and management practices against rodent-borne diseases in Africa. Relevant academic literature spanning from 1974 to 2021 was analysed. Dominant rodent species reported in Africa included:- *Mastomys natalensis* and *Rattus rattus*, while dominant flea species included *Xenopsylla brasiliensis* and *Xenopsylla cheopis*. Rodents were reported as hosts to a wide range of parasites which can be passed to humans. Rodents were also reported as hosts to some protozoans, trematodes, cestodes, nematodes, bacteria and viruses which are transmissible to humans. Some studies conducted in West Africa revealed good knowledge and practices on plague and Lassa fever diseases among respondents, whereas other studies reported poor practices on Lassa fever management. In part of Southern Africa, some studies reported poor knowledge and practices on plague disease. Further research on rodent-borne disease awareness and management strategies in African countries is desirable.

1. Introduction

Understanding the principal determinants of structure and diversity of species in ecological communities so as to protect and restore biodiversity is essential (Hagenah, 2006). For instance, having knowledge on rodent abundance, distribution and diversity will permit the design of appropriate management policies that will target endangered species while sparing the valuable ones (Singleton et al., 2005). The physiological tolerance to environmental conditions has been thought to influence distribution of species, however, the rodent species interaction with other wildlife species can have a distribution impact (Boulangeat et al., 2012). Interactions among species are reported to be either positive (+), negative (-) or neutral (0) for the species involved (Suselbeek, 2014). The intensity and presence of human plague in China has been suggested to have a positive association with the rodent species richness (Sun et al., 2019), although, ecological interactions between known species are often non-linear, and thus, complex (Hagenah, 2006).

Zoonotic diseases are infectious diseases that are naturally or vector borne transmitted from vertebrate animals to humans and vice versa (Wang and Crameri, 2014). These zoonotic diseases are caused by all types of pathogenic agents, including bacteria, parasites, fungi and viruses (Wang and Crameri, 2014). Zoonotic diseases are responsible for some of the severe epidemics (WHO, 2020). It has been reported that zoonotic diseases transmitted by arthropod vectors are greatly affected by climatic change, consequently there has been sporadic outbreaks of zoonotic diseases globally (Ogden, 2017). Global temperatures are reportedly rising and this has greatly been contributed by the anthropogenic emission of greenhouse gasses, thus predicted to have an effect on the distribution of vectors and increase vector-borne zoonotic diseases risk (Naicker, 2011). This effect of global warming is linked to the potential spread of zoonotic viral disease, transmitted by mosquitoes called Chikungunya (Alphavirus), occurring in the following continents: Africa, Asia, Europe and the Americas (Wang and Crameri, 2014). Moreover, temperature increase has been observed to lead to increased transmission of leishmaniasis by sand flies (Ready, 2010 in Naicker, 2011). Recently, it was reported that China had been experiencing a

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zoonotic viral disease hosted by rodents called Hantavirus, caused by anthropogenic human activities (Tian and Stenseth, 2019).

There are several anthropogenic activities influencing zoonotic diseases spread from wildlife to humans. Human population increases lead to encroachment of their settlements into natural habitats, this causes an increased number of contacts between humans and wildlife; thereby perpetrating the ease of transmission of zoonotic diseases (Corvalan et al., 2005). For instance, in Malaysia, the transmission of malaria parasites (*Plasmodium knowlesi*) from Macaques (*Macaca*) to humans was a result of humans encroaching into wildlife area (Singh et al., 2004). Recently, the novel coronavirus (COVID-19) pandemic has been attributed to some horseshoe bats (*Rhinolophus*) from live wet markets where live animals were mostly sold in China (Rodriguez-Morales et al., 2020). Further, political instability, particularly, civil conflict and war leads to breakdown in healthcare infrastructure and public control measures (Halliday et al., 2015), that results in an upsurge of infectious diseases due to poor vector control measures (Khan et al., 2019). For instance, the Democratic Republic of Congo (DRC) has recorded the second highest incidences of plague in Africa due to political unrest (Lofty, 2015).

Natural factors such as one of the global climatic phenomena, the El Nino-Southern Oscillation (ENSO), which consists of warm and hot phases, has aided increased Rift Valley fever outbreaks in East Africa (Gould and Higgs, 2009). Rift Valley fever outbreaks were associated with times following heavy rainfall (Martin et al., 2008). The mosquito vectors transmitting this disease are floodwater breeders whose eggs are deposited when there are heavy rains (Martin et al., 2008). Vector capacity is increased due to heavy rainfall and outbreaks are more likely to occur if vertebrate reservoirs are available (Martin et al., 2008).

Although a worldwide increase in zoonotic diseases has been recorded, there has been under documentation of Africa's zoonotic diseases because of paucity of healthcare and constrained public health care system as a result of inadequate funding and upsurge in conflicts (Naicker, 2011). Additional factors contributing to this under documentation are maladministration, corruption, lack of developmental will and lack of research support (Naicker, 2011). Further, in the tropics, clinicians face a challenge in correctly diagnosing some diseases which have similar symptoms, e,g, brucellosis, leptospirosis, rickettsiosis, bartonellosis, plague, Rift Valley fever and chikungunya (Halliday et al., 2015). Consequently, the true burden of endemic zoonosis is greatly underappreciated and awareness among clinicians and policy makers' remains limited (Halliday et al., 2015). Among humans, non-specific symptoms such as fever, headache, fatigue, and joint or muscle aches are commonly associated with many endemic zoonosis and further, these symptoms are shared with non-zoonotic diseases or conditions such as malaria, typhoid fever and Human Immuno-deficiency Virus (HIV) which are likely to be readily considered by clinicians (Maudlin et al., 2009; Welburn et al. 2015 in Elelu et al., 2019). With the constant occurrence of zoonotic diseases, it is crucial to synthesize existing knowledge and expand research to help inform management practices and policy. Accordingly, the aim of this review was to assess dominant rodent-flea species, rodent-borne diseases occurrence and awareness and management practices against rodent-borne diseases in Africa.

2. Material and methods

Relevant literature was gathered using Google Scholar, HINARI and PubMed covering the period from May 1966 to October 2021 and the searches were carried out between April 2017 and December 2021. The literature search scheme had the following inclusion terms, 'rodent-borne diseases + Africa; rodent species + Africa; flea species + Africa and awareness + practices + rodent-borne diseases. Further, Africa was substituted by individual African country names. Synonyms for awareness and practice were used such as alertness, responsiveness, consciousness, and perception for awareness; does, follows, observes and performs were used in place of practices. The original search yielded 570 articles and after screening through reading the abstracts of each article, 79 articles were considered in this analysis. The selected articles were analyzed in Microsoft Word using a coding system based on the major themes.

3. Findings and discussion

3.1. Dominant rodent and flea species in Africa

M. natalensis and *R. rattus* were the most dominant reported rodent species harbouring plague disease in African countries and having their rodent and flea data easily accessible (Table 1). *Gerbillurus* species were the second dominant rodent species. Further, the most dominant flea

Table 1
Dominant rodent and flea species in Africa.

Country	Dominant rodent species and habitat type	Dominant flea species	References
Tanzania (East Africa) non-endemic foci	*M. natalensis* (S); *Mus spp.* (S)	*D. lypusus* (S); *X. brasiliensis* (S); *C. calceatus* (S)	McCauley et al. (2015)
Uganda (East Africa), endemic foci	*R. rattus* (S, D); *A. niloticus* (S, P); *M. natalensis* (S, P); *Lemniscomys spp* (P); *Lophuromys flavopunctatus* (P); L. *sikapusi* (P)	*Ctenophthalmus spp.* (S, D); *D. lypusus*(S, D); *X. brasiliensis* (S, D); *X. cheopis* (S); *X. nubica* (S); *Stivalius torvus* (S)	Eisen et al. (2012); Amatre et al. (2009); Borchert et al. (2007)
Kenya (East Africa) not clear	Habitat type not clear, however, rodent species with fleas were- *Graphiurus microtis; Praomys dectroum*	*Listropsylla basilewskyi* (S)	Oguge et al. (2009)
Zambia (Southern Africa) endemic foci	*Gerbillurus spp.* (P); *R. rattus* (P); *Mastomys spp* (P); Saccostomus spp (P)	*Xenopsylla spp.*	Nyirenda et al. (2020); Hang'Ombe et al. (2012)
Zimbabwe (Southern Africa), endemic and non-endemic foci	*M. natalensis; T. leucogaster*; Aethomys chrysophilus	*X. brasiliensis* (S, D); *D. lypusus* (S, D); *C. calceatus* (S, D)	Taylor et al. (1981); Banda et al. (2021)
Madagascar (Southern Africa) endemic foci	*R. rattus* (S, D)	*Synopsyllus fonquerniei* (S); *X. cheopis* (D); *X. brasiliensis; Pulex irritans* (D)	Mahmoudi et al. (2021); Rahelinirina et al. (2017); Miarinjara et al. (2016); ECDC (2014)
Namibia (Southern Africa)-not clear	(Rodent species collected from domestic, peridomestic and sylvatic habitats) *Gerbilliscus leucogaster; Gerbillurus paeba; Thallomys nigricauda; Rhabdomys pumilio*	(Flea species collected from domestic, peridomestic and sylvatic habitats) *Xenopsylla brasiliensis; Xenopsylla cheopis; Xenopsylla hirsute; Xenopsylla trispinis; Dinopsylla ellobius; Dinopsylla zuluensis; Epirimia aganipes; Listropsylla aricinae*	Mfune et al. (2013)
Mali (West Africa) non-endemic foci	*M. natalensis* (D) *R. rattus* (D)	*X. cheopis* (D) *X. nubica* (D)	Schwan et al. (2016)

NB: S-sylvatic (wild); P-peri-domestic; D-domestic; endemic foci (research conducted in a plague endemic place); non-endemic (research conducted in non-endemic area).

species implicated in plague transmission were *X. brasiliensis*, with *Xenopsylla cheopis* being second dominant, followed by *Dinopsyllus lypusus* and *Ctenophthalmus* species.

In a study conducted in Morogoro, Tanzania, Massawe et al. (2008) reported that soil texture was an important factor influencing the abundance and distribution of *M. natalensis* in the field. The lowest capture of rodents occurred on sandy-clay soils and the highest capture was observed on both sandy-clay-loam and sandy-loam soils. As well, rainfall was observed to influence rodent population abundance. Short early rains were observed to cause an increase in rodent population in both sandy-clay-loam and sandy-loam soils, while in sandy-clay soil they began to increase later in the season. During the dry season (from July to October 2000), Massawe et al. (2008) reported that population densities of rodents increased again among different soil types. Based on the study, it was concluded that *M. natalensis* preferred loamy-textured soils compared to clay-textured soils. Even though soil type has an effect on rodent abundance, seasonality also determines the abundance of rodents (Makundi et al., 2005).

Makundi et al. (2005) reported that rodent abundance fluctuated seasonally, especially for *M. natalensis* in three localities and *Tatera leucogaster* in southwest Tanzania. In southwest Tanzania, population peaks of *M. natalensis* and *T. leucogaster* were reached in the dry season (June–September). In contrast, in central Tanzania, *M. natalensis* reached its peak during the months of July to November and the species reproduced seasonally. Breeding activity of *M. natalensis* was observed to be associated with the onset of the rains and its population peaked in the dry season. *M. natalensis* is a known reservoir of plague (Isaacson et al., 1983).

Y. pestis was reported to have been first spread by *R. rattus* (Roof, Ship or House rat) via ship voyages (Skinner and Chimimba, 2005). From ships, *R. rattus* went ashore, thus, passing the disease to wild rodents via fleas, and at present, the disease has quite a number of foci in different countries (Dennis et al., 1999). The environment has a great influence on flea abundance since three quarters of its life cycle is off host. The effects of both abiotic (Khokhlova et al., 2004) and biotic factors (Metzger & Rust, 1999; Krasnov et al., 2001; Osacar-Jimenez et al., 2001; Stark, 2002) on abundance of fleas has been investigated. *X. brasiliensis* flea species is native to Africa south of the Sahara. It is the most common vector of plague on the continent compared to *X. cheopis* (Haeselbarth et al., 1966). This species has spread to other parts of the world such as Brazil and India. It is a competent plague vector, especially in rural environments. *X. brasiliensis* is intolerant of high temperatures but is resistant to drought conditions (Haeselbarth et al., 1966). It occurs on *R. rattus* and these have been responsible for transmitting plague world-wide. It also occurs on small mammals and this has made it difficult to determine its original wild host. It is postulated that the original wild host were rats with climbing abilities which lived in hollow trees, on the surface under shelter or in similar situations, such as is found the African bush rat (*Aethomys chrysophilus*), the multimammate rat (*Praomys natalensis*), the Namaqua rock rat (*Aethomys namaquensis*) and the black tailed tree rat (*Thallomys paedulcus*) (Haeselbarth et al., 1966). *X. cheopis* is a known common parasite of synanthropic rats, the house rat (*R. rattus*). It is found in all warmer areas of the world. It is a very efficient vector of *Y. pestis* and it is mainly responsible for transmission of plague among domestic rodents, and especially after the death of its natural host, to humans (Hang'ombe *et al.*, 2012).

3.2. Rodent borne diseases in Africa

Gratz (1997) reviewed the burden of rodent-borne diseases in Africa south of the Sahara and the main findings were as follows: eight (8) viral diseases taking note of Crimean-congo Haemorrhagic fever, Lassa fever, Rift valley fever/ Hemorrhagic fever with renal syndrome and West Nile fever. The most common rodent hosting the viral disease were *Mastomys* spp. Seven (7) bacterial diseases were highlighted, noteworthy, being Rat bite fever, Leptospirosis, Plague and Salmonellosis with the common bacterial host being *Rattus* spp., *Mastomys* spp. and *Arvicanthis* spp. in descending order. Two (2) diseases caused by protozoa were reported, i. e., Leshmaniasis and Toxoplasmosis. *Tatera* spp. were the most mentioned protozoan disease host, followed by *Arvicanthus* spp., *Acomys* spp. and *Mastomys* spp. Further, Rickettsia disease agent causing four diseases and *Mastomys* spp. was the major host of these agents (Gratz, 1997).

Toxoplasma is a single zoonotic protozoan affecting most of the warm-blooded animals and some fish (Dubey et al., 2011). The protozoan infects several rodent hosts, including mice, squirrels and rats (Table 2), however, the prevalence of the parasite in Africa is not known. The transmission mechanism that could involve blood (trachyzoites), muscles (bradyzoites) and feces (sporozoites) makes it easy for a wide variety of animals to be infected (Odeniran and Ademola, 2016). *Toxoplasma gondii* an intracellular apicomplexan protozoan has an exceptionally broad host range, making it one of the most "successful" protozoan parasites on earth (Boothroyd & Grigg, 2002 cited in Webster, 2007).

Rodents are host to Leishmaniasis a vector-borne disease caused by blood and tissue dwelling protozoan parasite belonging to the genus *Leishmania* (CDC, 2020). Animal reservoirs like rodents are important for maintaining infectious in various places, and hence, playing a crucial role for zoonotic and rural disease transmission (Alemayehu and Alemayehu, 2017). Sylvatic (wild) rodents are some of the most common host, however, the disease is transmitted to humans when flies and reservoir host like rodents share the same environment (Alemayehu and Alemayehu, 2017). In Africa, leishmaniasis is endemic to countries mostly in the North, Central, East and the Horn of Africa (Boakye et al., 2005). Of the 12 species of Schistosoma found in Africa only four (4) are regularly reported as infectious to humans; these are *Schistosoma mansoni, Schistosoma haematobium, Schistosoma intercalatum* and *Schistosoma guineensis*. However, majority of human cases infection by *Schistosoma* are caused by the first two, with which *S. mansoni*, relatively commonly observed in African rodents, although usually at lower prevalence levels than seen in Latin American or Caribbean transmission settings (Hanelt et al., 2010).

Alveolar echinococcosis usually occurs in a wildlife cycle among foxes, other carnivores and small mammals (mostly rodents) (WHO, 2018). A number of herbivores and omnivores act as intermediate hosts of cestoda echinococcus, they become infected by ingesting the parasite eggs in contaminated food and water, and then the parasite develops into larval stages in the viscera (WHO, 2018). *Echinococcus multilocularis* is an alveolar echinococcosis form which together with cystic echinococcosis are of medical and public health relevance in humans (WHO, 2018).

Although bacterial diseases were partially controlled, multi-drug resistance has been reported to have developed in these organisms, as has been seen with *Y. pestis* causative agent of plague (Chanteau et al., 1998; Lotfy, 2015). The main hosts for plague are rodents and the disease is transmitted mainly by ectoparasite fleas (Dean et al., 2018; Bramanti et al., 2019). There are many other important zoonotic viruses with a significant impact on public health that have emerged or re-emerged (Wang and Crameri, 2014). Some of the viral diseases harboured by rodents are lassa fever, lymphocytic and chorio-menengitis (Sambri et al., 2013). The geographical ranges of zoonotic pathogens such as West Nile virus, chikungunya virus and dengue virus are expanding, with movement of vectors into newly established habitats, this causes the mixing of previously isolated vectors and introduces the agents to new potential vectors (Sambri et al., 2013).

About two thirds of emerging diseases are zoonotic in nature (Thompson, 2000). This therefore, implies that emerging zoonotic diseases are among the most important public health threats today (Mahy and Brown, 2000). Wild animals serve as a major reservoir for the transmission of zoonotic agents between humans and animals, hence playing a vital role in the epidemiology of zoonotic diseases (Odeniran and Ademola, 2016).

Table 2
Rodents host status and harboured parasite species.

Causative agent/ species/ disease	Rodents	Host type	Number of hosts	References
Protozoan *Toxoplasma gondii* Leishmaniasis	Mice (*Mus musculus* and *Peromyscus species*); rabbits (*Sylvilagus flovidanus*); squirrels (*Sciurus* species); rats (*Rattus norvegicus* and *Sigmodon hispidus*); *Mastomys erythroleucus; Tatera gambiana; A. niloticus*	Intermediate host Reservoir	Multiple host (MH)	Zarnke et al. (2001); Boakye et al. (2005); Webster (2007); WHO (2010)
Trematoda *Schistosoma mansoni; S. bovis;S. Matthei*	Six genera of rodents (*Pelomys, Lophuromys, Mastomys, Aethomys, Dasymys and Rattus*)	Intermediate host	MH	Schwetz (1956); Hanelt et al. (2010)
Cestodes *Echinococcus multilocularis*	Small rodents (*Rattus tanezumi, R. rattus, R. norvegicus, Mastomys coucha*)	Intermediate host	MH	Odeniran & Ademola (2016); WHO (2018); Julius et al. (2021)
Nematodes *A.contonensis, Gongylonema sp., C. hepaticum*	Rodents *R. norvegicus, R. rattus, M. natalensis*	Accidental host	MH	De Bruyne *et al.* (2006); El-Sherbini & El-Sherbini (2011); Archer et al. (2017)
Bacteria *Y. pestis*: Plague Leptospirosis Rat-bite fever Salmonellosis Tularemia Bartonella	Rodents *M. natalensis, R. rattus, Rattus tanezumi Arvicanthis abysinnicus, Lemniscomys striatus, Mus minutoides*, Musk rats, ground squirrels, beavers, Saccostomys mearnsi	Definitive host Reservoir host	MH	Neerinckx et al. (2008); WHO (2010); Young et al. (2014); WHO (2016); CDC (2017); Julius et al. (2021)
Virus Lassa fever Lymphocytic Chorio-meningitis Hepacivirus Mokola virus (lyssavirus)	*M. natalensis* species complex House mouse (*M. musculus*) *Graphiurus kelleni Lophuromys Gerbilliscus leucogaster*	Definitive host	MH	Meerburg et al. (2009); Schwan et al., 2016); CDC (2017); Bletsa et al. (2021); Julius et al. (2021); McMahon et al. (2021); Min et al. (2021)

Developed countries generally have well-documented records of zoonotic diseases while less developed countries in Africa happen to be lagging behind with such information (Naicker, 2011). There are quite several reasons why Africa is behind with zoonotic diseases documentation, some of which has been mentioned prior. Africa has few laboratories with the ability to execute direct pathogen isolation or detection in acutely ill patients by blood culture or by molecular diagnostic assays such as nucleic acid amplification by polymerase chain reaction (PCR) (Petti et al., 2006 in Halliday et al., 2015). A huge number of biodiversity is unexplored in Africa, as has been seen by the discovery of yet unknown species of arenavirus, the Lujo virus in Zambia (Briese et al., 2009).

Rodents are a key mammalian group found in many environments throughout the world and constituting more than 40% of the known mammalian species (Krijger, 2020). Rodents scavenge for food and are coprophagous, they are at risk of ingesting infective agents of diseases, for example, parasite eggs and disease causing invertebrates (El-Sherbini and El-Sherbini, 2011). Therefore, rodents can acquire the five groups of disease agents currently known to humankind, thereby contributing to the emerging and re-emerging infectious zoonotic diseases (Friend, 2006). Furthermore, mechanical spread of parasites by rats may pose a particularly high risk for disease transmission in slums and informal settlements in urban and peri-urban areas where in some settlements there are poor sanitary systems (Archer et al., 2017). More than 30 million poor rural and urban dwellers in sub-Saharan Africa are dependent on meat from wild animals for rituals or for trade (Mukaratirwa, 2011 cited in Odeniran and Ademola, 2016), thus increasing the likelihood of acquiring zoonotic diseases.

3.3. Local peoples' awareness and practices on rodent-borne zoonotic diseases

Kugeler et al. (2017) conducted a multi-stage cluster-sampled survey in West Nile of Uganda to assess the knowledge of symptoms and causes of plague and health care-seeking practices among 420 households. A greater percentage (84%) of the respondents could accurately describe plague symptoms and as well a substantial percentage (75%) connected plague with fleas and dead rats (Table 3). In case of possible plague, a higher number of respondents indicated that they would seek health care at a clinic; though plague-like symptoms were reportedly common, some people seldomly went to the clinic. Overall, people in the plague-endemic region of Uganda had higher level of understanding of plague.

Ngulube et al. (2006) study in Petauke, Eastern Province of Zambia where previously an outbreak of plague disease had occurred investigated the knowledge, attitude and public health response towards plague. Of the local community respondents, 43% did not know the origin of the plague disease (Ngulube et al., 2006). Respondents were not knowledgeable on the relation of rats and fleas and plague disease. A greater number of the respondents believed that plague was a result of witchcraft. Respondents indicated not to favor the use of rodenticides because they were implicated to be used to poison people. In order to be able to control the outbreak of plague, witchcraft fears were removed by correctly diagnosing plague disease, this further aided collaboration between the formal health sector and the local community (Ngulube et al., 2006).

Nyirenda et al. (2017) identified risk factors of plague using questionnaire interviews and focus group discussion (FGD) in Sinda and Nyimba districts of eastern Zambia. A total of 144 questionnaires were administered to individual respondents and 20 groups consisting of 181 discussants. The study concluded that the sociocultural human behavioural factors especially hunting, transportation, and preparation of rodents before their use for food exposed many villagers in the study area to flea bites and as a result the risk of being infected with plague.

Banda et al. (2022) assessed the knowledge and practices on plague disease in Nkayi and Umzingwane districts, Zimbabwe. Data was

Table 3
Investigations on awareness and practices on plague and Lassa fever diseases among African countries.

Rodent-borne diseases	Region/ Country	Awareness outcome	Practice outcome	References
Plague	West Nile of Uganda	-respondents were highly knowledgeable -a greater percentage (84%) of participants could accurately describe the plague symptoms −75% of respondents connected plague with fleas and dead rats	-many respondents showed good practices on plague -a greater number of respondents indicated that they would seek health at a clinic in case of a possible plague infection -most study respondents reported plague like symptoms but they rarely went to the clinic	Kugeler et al. (2017)
Plague	Eastern Province of Zambia	-most of the respondents were poorly knowledgeable on plague disease −43.4% of the local community respondents did not know the origins of the plague disease -a greater number of respondents were poorly knowledgeable on the relation of rats and fleas and plague disease - a higher number of the respondents believed that plague was because of witchcraft	-many respondents indicated poor practices on plague disease -greater number of respondents indicated not to favor the use of rodenticides because they were implicated to be used to poison people	Ngulube et al. (2006)
Plague	Sinda and Nyimba districts of eastern Zambia	Awareness research not done	-many respondents showed poor practices on plague disease -most of the respondents indicated that they ate rodents as part of their regular diet -many participants indicated that some people carried rodents in small bags, hunters' pockets and in carcass skewers on the shoulder of the hunter	Nyirenda et al. (2017)
Plague	Nkayi and Umzingwane districts in south-western Zimbabwe	-Nkayi district respondents were greatly aware of plague disease -Umzingwane district respondents were poorly knowledgeable of plague disease -knowledge level contextual and based on past experiences	-fairly good practices like keeping cats, using rodenticides and traps -higher percentage of respondents do not consume rodents	Banda et al. (2022)
Lassa fever (LF)	Abakalaki metropolis Nigeria	most respondents had greater knowledge of LF -respondents indicated that their main source of information were television and radio -a greater percentage of respondents indicated that rats could transmit LF to humans -a greater percentage of respondents showed poor knowledge on LF	-a higher number of respondents demonstrated good practices -fewer percentage of respondents ate rats	Ossai et al. (2020)
LF	Ile-Ife southwest Nigeria	-most of the residents pointed out that the radio was their main source of information	-a greater number of residents showed poor practices on LF	Olowookere et al. (2017)
LF	Kaduna State Nigeria	- most respondents had greater knowledge of LF ¯-a greater percentage of respondents indicated that rats could transmit LF to humans	- a higher number of respondents demonstrated good practices -most respondents revealed that they will go the hospital if they have LF symptoms -many of the respondents agreed that it is good to wash hands	Onwunhafua (2018)

collected through focus group discussion involving a total of 35 respondents. Awareness on zoonotic diseases was acknowledged albeit poor knowledge on specific rodent-borne diseases. Respondents where plague once occurred (Nkayi district) were more knowledgeable of plague disease compared to those who reside in plague non-endemic area (Umzingwane district). Several practices were being employed to control rodent population at home, indicating fair plague management strategies. The study therefore revealed contextual factors and past experiences as important determinant of plague control and practices.

Ossai et al. (2020) determined the knowledge and preventive measures against Lassa fever (LF) among heads of households in Abakaliki metropolis southeast Nigeria. The authors utilized a descriptive cross-sectional study using a four-stage sampling design. The majority of the respondents (60%) demonstrated good knowledge and preventive practices. Olowookere et al. (2017) assessed the knowledge, attitude and practices towards LF control and prevention among residents of IIe-Ife, southwestern Nigeria. Descriptive cross-sectional study was conducted among approved randomly selected adults using an interviewer administered questionnaire and data was analyzed using descriptive and inferential statistics. The study concluded that the knowledge, attitude, as well as preventive practices to LF were poor, therefore it is obligatory to increase public education and improve hygienic practices. Onwunhafua (2018) determined the knowledge, attitude and practice relating to LF among shop owners in a militatry barrack in Kaduna state, Nigeria. Structured questionnares were administered to 200 respondents by face to face interviews. The study concluded that the respondents had good knowledge, positive attitude and practices towards LF.

Rodent-borne diseases that have earned pandemic or epidemic status are plague, Lassa fever and Tularemia (WHO, 2021). Countries with greater plague cases are the DRC, Madagascar and Peru (WHO, 2021). Lassa fever is an animal-borne (zoonotic), acute viral illness endemic in parts of West Africa including Sierra Leone, Liberia, Guinea and Nigeria (CDC, 2019). Most neighbouring countries are also at peril, as the animal vector for Lassa virus, the "multimammate rat" (*Mastomys natalensis*) is dispersed all over the region (CDC, 2019). This illness, Lassa fever was discovered in 1969 in Lassa town, in Borno state and was named after the town in Nigeria where the first cases occurred (CDC, 2019). Tularemia is a bacterial disease that can infect people and animals like rabbits, hares, and rodents which are especially vulnerable and often die in large numbers during outbreaks (CDC, 2018). People can become infected in several ways, including: tick and deer fly bites, skin contact with infected animals, drinking contaminated water, inhaling contaminated aerosols or agricultural and landscaping dust and laboratory exposure (CDC, 2018). Tularemia has been reported in most countries of the northern hemisphere, but so far not from the southern hemisphere and it is endemic in Russian Federation, Kazakhstan and Turkmenistan, thus the African continent is not affected (WHO, 2007).

4. Conclusion

This review concludes that *M. natalensis* and *R. rattus* are the dominant reported rodent species in Africa, while the dominant flea species are *X. brasiliensis* and *X. cheopis*. Further, it is concluded that rodents harbor many zoonotic parasites like protozoans, trematodes, cestodes, nematodes, bacteria and viruses and most of the diseases caused by these parasites have not been eradicated to date. African local peoples' awareness on plague and LF and their control practices towards these rodent-borne diseases varies across countries pointing to the importance of further research across the African landscapes to contribute to the improved management and policy development towards rodent-borne diseases.

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

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