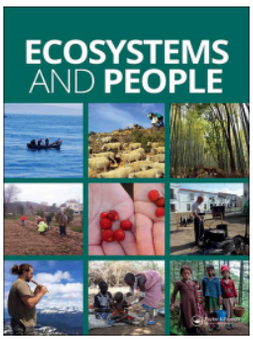

Ecosystems and People

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tbsm22

Local community awareness and practices on *Yersinia pestis* plague disease management in Nkayi and Umzingwane districts, south-western Zimbabwe

Annabel Banda, Edson Gandiwa, Never Muboko, Chiedza N. Mutanga & Clayton Mashapa

To cite this article: Annabel Banda, Edson Gandiwa, Never Muboko, Chiedza N. Mutanga & Clayton Mashapa (2022) Local community awareness and practices on *Yersinia pestis* plague disease management in Nkayi and Umzingwane districts, south-western Zimbabwe, Ecosystems and People, 18:1, 164-173, DOI: 10.1080/26395916.2022.2037714

To link to this article: https://doi.org/10.1080/26395916.2022.2037714

Published online: 03 Mar 2022.

ECOSYSTEMS AND PEOPLE
2022, VOL. 18, NO. 1, 164–173
https://doi.org/10.1080/26395916.2022.2037714

Taylor & Francis
Taylor & Francis Group

RESEARCH

OPEN ACCESS Check for updates

Local community awareness and practices on *Yersinia pestis* plague disease management in Nkayi and Umzingwane districts, south-western Zimbabwe

Annabel Banda [a,b], Edson Gandiwa [a,*], Never Muboko [a], Chiedza N. Mutanga [c] and Clayton Mashapa [a]

[a]Department of Wildlife Ecology and Conservation, School of Wildlife, Ecology and Conservation, Chinhoyi University of Technology, Chinhoyi, Zimbabwe; [b]Department of Crop Science, Gwanda State University, Filabusi, Zimbabwe; [c]Department of Travel and Recreation, School of Hospitality and Tourism, Chinhoyi University of Technology, Chinhoyi, Zimbabwe

ABSTRACT

This study investigated the level of awareness and practices of local communities on *Yersinia pestis* plague disease in Nkayi and Umzingwane districts, south-western Zimbabwe. The research used a two-way case study where Umzingwane district was used as a quasi-control site and Nkayi district the treatment site. Purposive sampling was used to select four villages, i.e. two from Nkayi district (plague endemic area) and two from Umzingwane district (non-plague area). Data were collected through focus group discussions involving 35 respondents held between August 2017 and April 2018. The study respondents confirmed some awareness of zoonotic diseases albeit limited knowledge on specific rodent-borne diseases. Respondents from areas that had previous plague outbreaks (Nkayi district) were more knowledgeable of the disease compared to those from areas without previous known outbreaks (Umzingwane district). Several practises, e.g. use of traps, keeping domestic cats (*Felis catus*) and use of rodenticides to control rodents and educating people on plague disease, were highlighted from both study sites as local plague management strategies. Overall, the study results indicate that the awareness and practices employed by local people in the study area are generally influenced by local contextual factors and past experiences.

ARTICLE HISTORY
Received 14 October 2020
Accepted 25 January 2022

EDITED BY
Brigitte Baptiste

KEYWORDS
Case study; local community awareness; plague disease control; plague endemic area

Introduction

Zoonotic diseases are defined as diseases or infections transmitted between vertebrate animals and humans (WHO 2020). Diseases which are obscured, affecting mostly the rural poor that live in remote places far from health service centres, are termed neglected diseases (Boutayeb 2007). These diseases were once limited to rural areas but are now emerging in cities, for example, the plague and Ebola virus outbreaks in Antananarivo town in Madagascar, a West African country (Nkengasong 2019).

Plague disease (caused by *Yersinia pestis* bacteria) is regarded as a neglected disease and has been reported in 28 African countries, with eight countries currently having active foci (Lotfy 2015). Overshadowed by other major global infections (e.g. viral infections like Chikungunya, Ebola) and financial constraints are possible reasons for plague neglect among African countries (Naicker 2011). Plague diseases' main hosts are rodents and the disease can be transmitted to humans via direct or indirect routes, such as contact with infected rodents or being blood-fed on by infected fleas (Dennis et al. 1999). However, rodents also harbour several other infectious diseases like leptospirosis, leishmaniasis, salmonellosis and viral haemorrhagic fevers (Dennis et al. 1999). Four forms of plague diseases are commonly known, namely, (a) bubonic, (b) septicaemic, (c) pneumonic and (d) pharyngeal (Washington State Department of Health 2019). The first three forms of plague have the following common characteristics: symptoms or signs of fever (abrupt or acute), headache, chills and weaknesses (Washington State Department of Health 2019), while for (d), pharyngitis (CDC 2021; Washington State Department of Health 2019). With a fatality rate of 8% to 10%, appropriate antibiotics and supportive care are useful for treating plague disease (Washington State Department of Health 2019).

There are several determinants that expose people to the plague and some of these are the effects of poverty. For instance, high poverty levels to some sections of the society in Zimbabwe have been reported (Herald 2020; ZimVAC 2021), and this has led some of the affected people to engage in outdoor small-scale economic activities for survival such as artisanal gold panning (Ncube-Phiri et al. 2015), unsafe farming and firewood fetching practices (Mashapa et al. 2019), unfortunately some of these activities raise the chances of acquiring plague disease as contact between people and rodents increases (Barcellos and Sabroza 2001; Halliday et al. 2015). Environmental change and habitat fragmentation,

CONTACT Annabel Banda bandaannabel@gmail.com; annabel.banda@gsu.ac.zw
*Present address: Scientific Services, Zimbabwe Parks and Wildlife Management Authority, P.O. Box CY 140, Causeway, Harare, Zimbabwe

associated with land-use change, can result in changes in the microbial community, with the potential for shifting patterns of transmission of zoonotic pathogens to humans (Goldberg et al. 2008). An earlier study has identified anthropogenic disturbed habitats as the greatest risk for acquiring rodent-borne diseases (Mills 2006). People may rely on rodents for protein supplements, since rodents are known to be a delicacy in Africa (Fiedler 1990), in so doing they may acquire plague disease. However, disease transmission is not only limited to environmental factors but also social factors such as hunting rodents for consumption can place human health at risk (Salmón-Mulanovich et al. 2016).

A number of factors affect the state of best practices and knowledge, especially local ecological knowledge (LEK), on the management of plague disease and some of these include the state of flux and fluidity of people as they migrate due to hardships or poverty. This usually results in people with prior knowledge of plague disease to be displaced, which in turn affects the people's level of perceptions and attitudes. Shirima et al. (2010) reported that peoples' attitudes and perceptions on zoonosis are influenced by the level of public awareness about the disease within a given locality. This points to the need for equipping local communities and development partners with necessary skills to promote behavioural change and equip African countries to manage emerging and re-emerging zoonosis diseases more efficiently (Nkengasong 2019).

LEK assessment has been widely conducted in natural resource conservation and socio-ecological systems (Gandiwa et al. 2014; Lima et al. 2017; Tarakini et al. 2018; Kupika et al. 2019). However, this type of assessment is limited with regard to plague diseases (Ngulube et al. 2006; Salmón-Mulanovich et al. 2016; Kugeler et al. 2017; Nyirenda et al. 2017). Accordingly, the present study assessed the levels of LEK with relation to plague disease awareness and management practices in south-western Zimbabwe.

LEK is defined as knowledge obtained by local communities which are unique to a particular custom in a given society (Senanayake 2006; Milupi et al. 2017). To improve local zoonotic disease management, the sharing of LEK can be helpful as it guarantees the continuity of information to subsequent generations of people (Ossai et al. 2020). LEK may be dispersed verbally by elderly people to younger people as they grow or may also be acquired through observations (Edwards and Heinrich 2006; Milupi et al. 2020).

Nkayi district is among the three districts (Hwange and Lupane districts included) that have had plague outbreaks in Zimbabwe. Between 1974 and 1975, plague outbreaks in Nkayi were confined to the Shangani River (Munyenyiwa et al. 2019). Between 1981 and 1985, human cases were recorded in Matabeleland, North Province, and *Tatera leucogaster* was again found positive with *Y. pestis* (Dennis et al. 1999). Nkayi district and Umzingwane district are in the same agro-ecological region IV experiencing similar semi-arid climatic conditions which were observed to be ideal for plague disease occurrence (Andrianaivoarimanana et al. 2013). Understanding human community interactions with their immediate ecosystems and their knowledge on zoonotic diseases can provide insights on their endemicity in an area (Rivière-Cinnamond et al. 2018; Athni et al. 2021). Endemicity of a disease in an area can result in improved knowledge of it (Rakotosamimanana et al. 2021). It is therefore necessary to assess the readiness of people in curbing plague disease in case it re-emerges as it has been observed to do (Dennis et al. 1999; WHO 2016; Melman et al. 2019). Plague disease shares signs/symptoms with malaria, typhoid and Human Immunodeficiency Virus (HIV)/Acquired Immuno-Deficiency Syndrome (AIDS), thus posing a challenge to diagnose by both health practitioners and people (Elelu et al. 2019). The objectives of this study were to (i) investigate the local people's level of awareness and practices in relation to plague diseases management and (ii) assess the use of LEK and its influence on common practices related to plague diseases management in the districts of Nkayi (plague endemic area) and Umzingwane (plague non-endemic area) districts, south-western Zimbabwe.

Materials and methods

Study area

The study was carried out in a total of four villages, with two villages in each of Nkayi and Umzingwane districts in south-western Zimbabwe (Figure 1). Both districts occur in natural region IV with mean minimum and maximum temperature and rainfall ranges of 11–20°C and 19–26°C and 450–650 mm, respectively (Mugandani et al. 2012). Nkayi district's (boundary extents 18.992°S, 28.9005°E, area = 4 381 km^2) population was reported in 2012 to be 109,135 people (23 persons per km^2) while Umzingwane district (boundary extent −20.347°S, 28.9499°E, area = 2780 km^2) had 62,990 people (23 people km^2) (Zimstat 2013). Umzingwane district is largely constituted of artisanal small-scale gold miners, while Nkayi district is dominated by small-scale farmers who mainly grow maize and legumes for subsistence (Dube et al. 2014; Ncube-Phiri et al. 2015).

Nkayi district had about 17 health facilities (this includes hospitals) (Zikhali 2018), while Umzingwane district had 18 health facilities (this includes one hospital and a proposed clinic) (Umzingwane RDC, n.d). Nkayi district had 90 primary schools and 35 secondary schools (Nkayi RDC n.d), whereas in Umzingwane district had 45 primary schools and 17 secondary schools and (Umzingwane RDC n.d). Nkayi district comprises 30 wards, which were further divided into 156 villages (Zikhali 2018), while Umzingwane district has 20 wards

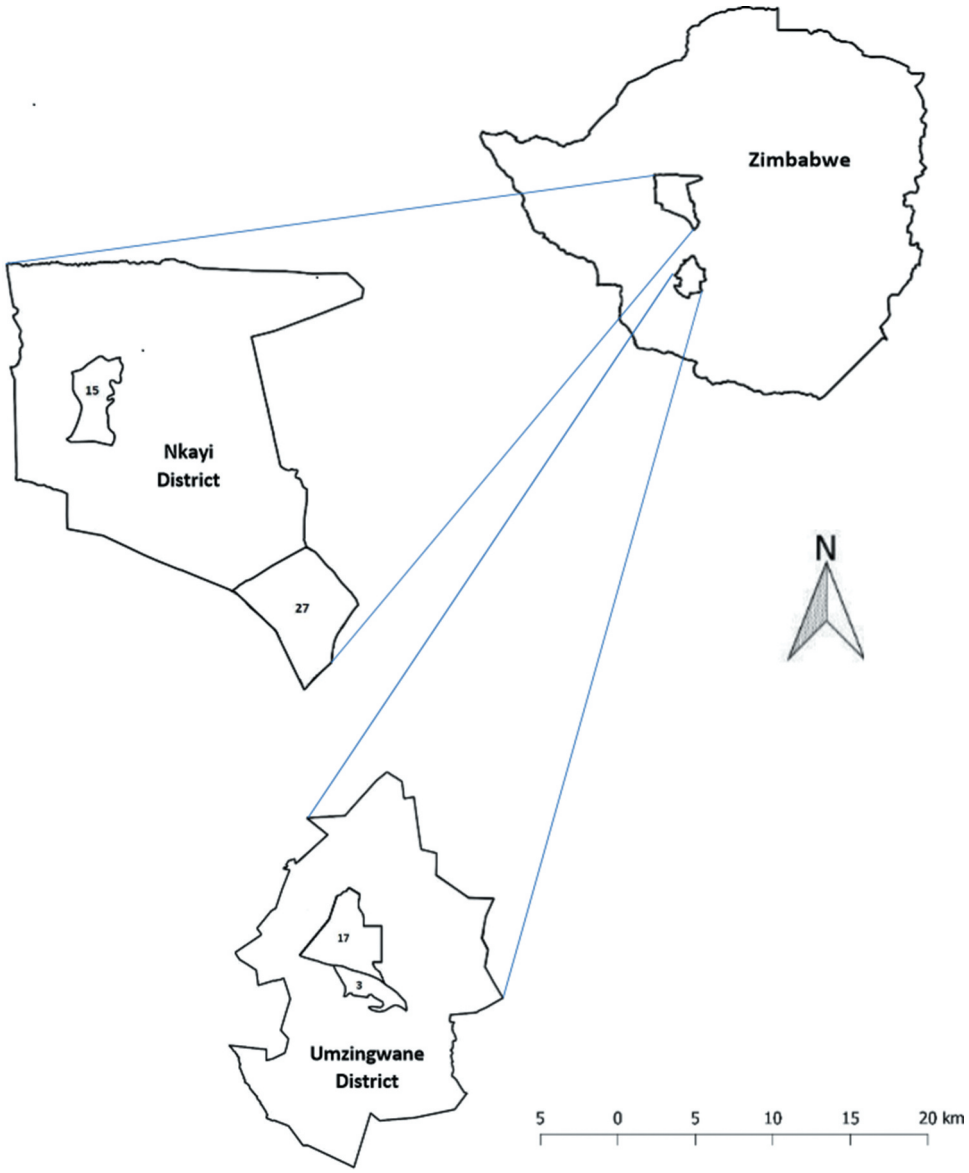

Figure 1. Location of Nkayi and Umzingwane districts in Zimbabwe. Notes: 15, 27, 3 and 17 represent Monki, Mathoba, Nhlekiyane and Crocodile wards, respectively.

and 107 villages (Umzingwane RDC, nd). There was a high prevalence of female-headed households in Nkayi (40%) mainly due to the migration of men who seek economic opportunities in cities and neighbouring countries (Dube et al. 2014).

Research approach

A multi-method qualitative design was adopted (Collier and Elman 2008) with exploratory and explanatory-oriented questions used to gather cross-sectional data on the local people's knowledge and practices on rodent-borne and plague diseases in relation to zoonotic diseases management. The study adopted a two-way case study (Zainal 2007) which involved a quasi-control site (Umzingwane district) with no previous record of plague disease outbreak. The Nkayi district was the treatment due to the presence of previous records of plague disease in this area. Purposive sampling was utilised to select four villages, two from Nkayi district (plague endemic area) and two from Umzingwane district (non-plague endemic area). Mathoba and Monki villages were highlighted by the senior health technician to be some of the villages that experienced plague. Monki village lies near the Shangani River, where plague diseases were confined between 1974 and 1975 (Munyenyiwa et al. 2019). Crocodile and Nhlekiyane villages were observed to be having high influx of people undertaking illegal gold mining in the past. Anthropogenic activities perpetrated by humans have been observed to be drivers to different rodent epidemics (Bordes et al. 2015; Halliday et al. 2015).

Data collection and sample selection

Data were collected using focus group discussions (FGDs) from August 2017 to April 2018 in two villages

per district, [(Mathoba and Monki villages – Nkayi) and (Crocodile and Nhlekiyane villages – Umzingwane)]. FGDs were used because they provide collective responses and clarify the significant habits that perpetrate the feelings, attitudes and behaviours of members in a community (Rabiee 2004). Prior to study respondents' selection and conducting FGDs, permission to undertake the study was obtained from the respective local district councils and the traditional leadership i.e. village heads facilitated purposive selection of the focus group discussants. Each focus group had at least eight people with gender not used when selecting the participants.

A total of four FGD were held, i.e. two in each district, totalling 35 people (Table 1). We controlled for uniformity of ethnic values among the focus group discussants by standardising that study respondents should have stayed within the study area for ≥5 years (Rabiee 2004) and discussions were conducted at the homesteads of village heads, which was convenient for most discussants. Each focus group had a facilitator, i.e. the principal investigator, a question reader and a notes taker who were selected among the discussants. The question reader and notes taker were oriented by the facilitator on how best to administer FGDs. FGDs were guided by a FGD guide with some open-ended questions in the native language (Ndebele). The focus group guide contained questions on awareness and practices on zoonotic, rodent-borne and plague diseases.

LEK variables investigated included the following: (i) awareness on zoonotic disease, (ii) zoonotic disease control measures, (iii) presence of rodent vendors, (iv) knowledge on types of rodent-borne diseases, (v) rodent-borne disease that had occurred, (vi) norms and taboos associated with rodent consumption, (vii) organisationsinvolved in the awareness campaigns and (viii) native name for plague and flea bites occurrence. Practices recorded included the following: (i) practices adopted after awareness on zoonotic diseases, (ii) local diagnoses and treatment of zoonosis, (iii) harvesting of rodents, (iii) interacting with rodents, (iv) control methods of rodents' population and (v) any plague cases reported and its time of occurrence. Pre-testing of the focus group guide was carried out in April 2017 at Habane Township (Umzingwane district) with non-study area respondents to ensure that all questions were explicit before a final version of questionnaires was prepared for sampling. The focus group guide had a brief description of scientific words in the questionnaires, for example elaborating, zoonotic disease, rodents and plague disease. Participants' consent to participate in the study was obtained verbally.

Data analysis

Most of the field transcribed data were screened word for word, and recorded data were transcribed verbatim in the native Ndebele language. Data were translated into English prior to processing and were cleaned by removing unclear responses before documenting the final output. Thematic analysis was conducted in Microsoft Word; a thematic coding framework was designed based on the major content themes recorded from study responses. Open-ended responses with multiple responses were presented as percentages of responses either in the respective districts or in the respective villages. Confidence Intervals (CI) were used to determine the range of the mean of focus group participants (FGP) per a specific village and specific variable, i.e. awareness and practices responses using Microsoft Excel.

Results

Local community awareness on plague diseases

Most focus group discussants in Nkayi district (58.33%) had heard of zoonotic diseases, while in Umzingwane district (27.7%) a much lower percentage of study

Table 1. Characteristics of the focus group discussants in Nkayi and Umzingwane districts.

		Nkayi district				Umzingwane district			
		Mathoba		Monki		Crocodile		Nhlekiyane	
Variable		N	%	N	%	N	%	N	%
Sex	Female	5	63	4	50	4	50	5	45
	Male	3	38	4	50	4	50	6	55
Age (years)	<20	0	0	1	13	0	0	0	0
	21–40	0	0	0	0	4	50	2	18
	41–60	3	38	2	25	1	13	2	18
	61–80	4	50	4	50	2	25	6	55
	>80	1	13	1	13	1	13	1	9
Level of education	Primary	6	75	6	75	2	25	6	55
	Secondary school	2	25	2	25	6	75	5	45
	College and above	0	0	0	0	0	0	0	0
Main occupation	Subsistence farming	0	0	4	50	5	63	7	64
	Sole trader	0	0	1	13	0	0	1	9
	Health and education professionals	0	0	2	25	0	0	0	0
	Small-scale mining	0	0	0	0	1	13	0	0
	Pensioner	0	0	0	0	1	13	2	18
	Unemployed/Unoccupied	8	100	1	13	1	13	1	9

Table 2. Plague disease awareness among FGP in villages across the study area.

		Nkayi district		Umzingwane district	
Variable	Sub-variable	Mathoba	Monki	Crocodile	Nhlekiyane
Disease	Rabies	x	x	x	x
	Anthrax		x	x	
	Plague	x	x		
Awareness organisation	Division of Veterinary Service (DVS)	x	x	x	x
	Ministry of Health and Child Care (MoHCC)	x			
	Ministry of Primary and Secondary Education (MoPSE)		x		
	World Vision (non-governmental organisation)	x			
Knowledge of zoonotic diseases	Yes	x	x	x	
	No			x	x
Zoonotic diseases encountered	Anthrax	x	x	x	
	Plague	x			
	Rabies	x	x	x	
Presence of rodent vendors	Yes		x	x	
	No	x			x
Norms and taboos on rodents' eating	None	x	x	x	x
	Present				
Interacting with rodents	Yes	x	x	x	x
	No				
Where do they interact with rodents	Home	x		x	x
	Field			x	x
	Wild	x	x	x	
Have heard about plague	Yes	x	x		
	No			x	x
Any plague occurrence, when	Yes	x	x		
	No			x	x
	1994–1995	x			
Native name for plague	Umkhuhlane wamagundwane		x		
Experiencing flea bites	Yes			x	x
	No	x	x		
Time of day when bitten by fleas	Anytime			x	x
	Night			x	
Flea bite season	Hot/dry				x
	Cold/dry			x	

Notes: x represents a positive response; blank – no response.

respondents reported to be aware of zoonotic diseases (Table 2). Rabies was the common zoonotic disease mentioned, other zoonotic diseases highlighted were anthrax and plague. The Department of Veterinary Services (DVS) under the Ministry of Lands, Land Reform Resettlement (MLLRR) was the main organisation involved in zoonotic awareness as mentioned by all the discussants. The Ministry of Health, Labour and Child Care (MoHLCC) was also reported to be involved in zoonotic diseases awareness by only one (n = 1; 12.5%) focus group discussant in Mathoba village. Most (n = 10; 90.9%) of the Nhlekiyane village focus group discussants indicated that they did not recall any zoonotic disease occurrence.

Only one Mathoba focus group discussant (n = 1; 12.5%) was able to identify plague as a rodent-borne disease, whilst the Nhlekiyane, Crocodile and Monki focus group discussants could not identify any rodent-borne disease(s) irrespective of indicating awareness of the rodent-borne disease. Respondents from Crocodile and Monki villages reported the existence of rodent vendors in their communities, while those from Nhlekiyane and Mathoba villages reported no existence of rodent vendors. There were no norms or taboos that were associated with rodent consumption which were mentioned by all focus group discussants (Table 2). Study respondents from all four villages reported that they commonly interacted with rodents' in various ways, both in their homesteads and in the wilderness, i.e. in Nkayi district, a greater number of study respondents reported interacting with rodents, while in Umzingwane, a fair number also reported interacting with rodents. Most study respondents from Umzingwane district have not heard about plague diseases, whereas a fair number of study respondents in Nkayi district highlighted to have heard about plague disease and mentioned its previous occurrence between 1994 and 1995. Study respondents at Monki village in Nkayi stated that they had a native name for plague, i.e. '*Umkhuhlane wamagundwane*' (rats' disease). A lower number of discussants from Umzingwane district mentioned the presence of flea bites in hot/dry and cold/dry seasons, while only one person from Nkayi district acknowledged the same.

The following were the ranges of the 95% CI of the true average mean on plague awareness among the FGP in the study villages: 41.21–58.79 (Mathoba village), 54.01–72.46 (Monki village), 35.73–62.87 (Crocodile village) and 35.67–80.42 (Nhlekiyane village).

Local community plague disease control practices

Some of the practices for controlling zoonosis mentioned by study respondents included dipping, chemical injections, indoor chemical spraying, keeping cats (*Felis catus*) and visiting health service facilities (Table 3). Respondents gave variable responses on the extent of being able to diagnose anthrax in humans, i.e. Monki (n = 1; 12.5%), Mathoba (n = 3; 37.5%), Nhlekiyane (n = 0; 0%) and Crocodile (n = 2; 25%), also being able to diagnose rabies in dogs (*Canis lupus familiaris*), Crocodile (n = 3; 37.5%) and Nhlekiyane (n = 4; 36.4%). In contrast, some respondents from Mathoba village (n = 4; 50%) mentioned that they could not diagnose any zoonotic disease and relied on health service institutions. Most focus group discussants from both districts indicated that they could not treat people with zoonotic diseases.

A lower proportion of the FGP from both districts mentioned that some local people consumed rodents, noteworthy was in Umzingwane district, where a greater number of participants in Nhlekiyane village indicated non-consumption of rodents (n = 10; 90.9%). Use of dogs and traps for hunting rodents or rabbits were some of the methods reported by focus group discussants. Respondents indicated that they controlled rodents through use of traps, rodenticides and domestic cats. Some of the approaches to minimise plague disease suggested by study respondents included reducing rodent population by using rodenticides, traps and cats, taking suspected plague cases to hospital and promoting health care education on plague disease.

Accordingly, the following were the 95% CI of the true mean on plague management practices among the FGP for the study villages: 34.88–57.62 (Mathoba village), 42.25–66.68 (Monki village), 33.43–57.82 (Crocodile village) and 36.75–64.57 (Nhlekiyane village).

Discussion

Study respondents exhibited good knowledge on some zoonotic diseases, poor knowledge on rodent-borne disease and plague disease. Respondents demonstrated good practices on some zoonotic disease management, fair practices on management of rodent-borne diseases and plague diseases. In general, respondents from both Nkayi and Umzingwane districts were aware of some zoonotic diseases like rabies and anthrax. Rabies and other zoonotic diseases such as anthrax are diseases well-known especially among cattle owners in Zimbabwe (Chikerema et al. 2013; Gadaga et al. 2016). Accordingly, the study area lies in an agro-ecological zone that is dominated by cattle rearing in Zimbabwe (Mugandani et al. 2012), thus

Table 3. Plague disease management in Nkayi and Umzingwane districts.

		Nkayi District		Umzingwane District	
Variable	Sub variable	Mathoba	Monki	Crocodile	Nhlekiyane
Zoonotic disease management practices	Vaccinating animals	x	x	x	x
	Dipping				x
	Disease treatment		x		
	Indoor spraying	x			
	Keeping domestic cats			x	
	Visiting health facilities	x			
Local diagnosis of zoonotic diseases	Rabies among people	x	x	x	
	Rabies in domestic dogs	x	x	x	
	Anthrax among people	x	x	x	
Local treatment of zoonotic diseases	None for people	x	x	x	x
	None for animals			x	
Rodents a delicacy	Yes	x	x	x	x
	No				x
Rodents harvesting methods	Cages				x
	Traps	x	x	x	
	Domestic dogs	x	x	x	
	Catapult	x		x	
	Big stones			x	
	Bucket system	x		x	
Controlling mice/rats' population	Yes	x	x	x	x
	No				
Rodents controlling methods	Traps	x	x	x	x
	Rodenticides	x		x	x
	Cats	x	x	x	
	Bucket system			x	
Presence of local plague treatment	Yes				
	No	x	x	x	x
Plague management	Killing mice/rats	x		x	x
	Suspects taken to hospital	x		x	
	Educating people	x	x	x	

Notes: x represents a positive response; blank – no response.

the high vigilance of the DVS and its associated awareness programmes. The high level of awareness among study participants signified the effectiveness of awareness programmes and mass media (radio, television and newspapers) in disseminating information to people across the study area (Gadaga et al. 2016). Noteworthy was the relative variation in local awareness on plague disease, for instance, which has been observed to be something common among human communities given the inherent dilution in culture, norms, religion and education from one area to another (Adlina et al. 2013). Elsewhere as well, relative variations and low level of knowledge on rodent-borne diseases was reported in Madre de Dios, Peru (Salmón-Mulanovich et al. 2016).

The study results recorded that local people have developed strategies over the years which have been incorporated in the daily practices to minimise exposure and transmission of zoonotic diseases unknowingly and these practises include reducing rodent densities around the households either biologically or using rodenticides as chemical control. Evidence of human consumption of rodents was recorded in this study as has been reported before in tropical regions where some rodent species are consumed as a source of protein (Fiedler 1990). Local people usually derive information through life experiences with events, from stories passed over time as oral evidence across generations (Gilchrist et al. 2005; Berkström et al. 2019). This was evident in this study as participants from Nkayi district, a district with previous outbreak of plague (Manungo et al. 1998; Dennis et al. 1999), had a good awareness of the disease compared to those from Umzingwane district.

Some FGP reported to experience flea bites mostly during hot/dry and cold/dry season, such seasonal flea bites variations particularly in the summer and winter was also reported by Zimba et al. (2012). The study confirmed the importance of LEK in shaping people's awareness and practices over time and its ability to complement scientific evidence where such evidence is not readily available (Hopping et al. 2016). However, due to the existing programmes on various educational subjects, communities can also get knowledge about events that never occurred in their local environments.

The study highlighted though, that villagers have adopted the keeping of cats as a low-cost method of controlling rodents in their homesteads. Domestic cat ownership as a rodent control method has been reported elsewhere, e.g. Madre de Dios, Peru (Elton 1953; Salmón-Mulanovich et al. 2016; Mahlaba et al. 2017). Companion animals, primarily domestic cats and dogs, can either be reservoirs/hosts of zoonosis or carriers of zoonotic disease vectors like fleas and ticks to humans from infected wild animals, thereby presenting health risks (Kruse et al. 2004; Friend 2006; Overgaauw et al. 2020). However, the same companion animals play an important role as indicators for plague outbreaks in case they fall sick (Manungo et al. 1998) as these have a higher interaction with rodents and are also highly sensitive to emerging diseases (Friend 2006). Hence, developing an integrated disease surveillance and management system is essential to ensure that any potential outbreak is controlled.

The study focused on a small geographic area which limits generalisation to other areas within the agro-ecological region IV. Time and funding limitations somehow influenced the sampling intensity as per the original plan despite meeting the study overall objectives. There was limited access to recent plague cases data, thus the researchers' study sites in Nkayi were informed by 1994 plague data (unpublished) and personal communication with the principal environmental health technician. This type of study also did not warrant large geographic areas as it was about people's level of knowledge and practices of which any acceptable sample would suffice.

Conclusion

The study investigated the local people's level of awareness and practices on plague disease management in Nkayi and Umzingwane districts, southwestern Zimbabwe. The study concludes that Monki and Mathoba focus group discussants had fair knowledge on plague disease as opposed to Nhlekiyane and Crocodile. Considering the plague occurred in Nkayi district that implies the observed knowledge could be a result of LEK as well. The occurrence of a disease in an area also helps people acquire knowledge of it, thereby improving on their skills of combating it. Villages from both districts demonstrated fair plague management skills. Rodents consumption and population control may place them at risk of acquiring plague disease if not done on informed decision. It was concluded that mere good practices like controlling rodents using cats, traps and rodenticides can aid in reduced occurrence of plague disease among humans, even with limited knowledge on plague disease, its outbreak among humans was minimal in both plague endemic and non-endemic areas. The study recommends the following: (i) developing an integrated system for plague disease surveillance, monitoring and management encompassing LEK and conventional scientific approaches for the study area and (ii) creating an inventory of the intangible cultural heritage of the study areas and help document this for future references as this may complement the scientific approaches to disease surveillance and management.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Annabel Banda http://orcid.org/0000-0002-0144-6026
Edson Gandiwa http://orcid.org/0000-0003-0708-350X
Never Muboko http://orcid.org/0000-0001-7512-0697
Chiedza N. Mutanga http://orcid.org/0000-0002-3684-9052
Clayton Mashapa http://orcid.org/0000-0002-9266-8459

References

Adlina AH, Jawan JA, Sri Rahayu I, Normala O, Mohd Hadzrul M. 2013. Traditional knowledge and environmental conservation among indigenous people in Ranau, Sabah. Global J Incorporated USA. 13(3):4–12.

Andrianaivoarimanana V, Kreppel K, Elissa N, Duplantier JM, Carniel E, Rajerison M, Jambou R, Roy CR. 2013. Understanding the persistence of plague foci in Madagascar. PLoS Negl Trop Dis. 7(11):1–8. doi:10.1371/journal.pntd.0002382.

Athni TS, Shocket MS, Couper LI, Nova N, Caldwell IR, Caldwell JM, Childress JN, Childs ML, De Leo GA, Kirk DG, et al. 2021. The influence of vector-borne disease on human history: socio-ecological mechanisms. Ecol Lett. 24(4):829–846. doi:10.1111/ele.13675.

Barcellos C, Sabroza PC. 2001. The place behind the case: leptospirosis risks and associated environmental conditions in a flood-related outbreak in Rio de Janeiro. Cadernos de Saúde Pública/Ministério Da Saúde, Fundação Oswaldo Cruz, Escola Nacional de Saúde Pública. 17:59–67. doi:10.1590/s0102-311x2001000700014.

Berkström C, Papadopoulos M, Jiddawi NS, Nordlund LM. 2019. Fishers' local ecological knowledge (LEK) on connectivity and seascape management. Front Mar Sci. 6 (MAR):1–10. doi:10.3389/fmars.2019.00130.

Bordes F, Blasdell K, Morand S. 2015. Transmission ecology of rodent-borne diseases: new frontiers. Integr Zool. 10(5):424–435. doi:10.1111/1749-4877.12149.

Boutayeb A. 2007. Developing countries and neglected diseases: challenges and perspectives. Int J Equity Health. 6(20):4pp. doi:10.1186/1475-9276-6-20.

CDC. 2021. Protect yourself from plague. Fort Collins (CO): Centers for Disease Control and Prevention. https://www.cdc.gov/plague/resources/235098_Plaguefactsheet_508.pdf.

Chikerema SM, Matope G, Pfukenyi DM. 2013. Awareness and attitude toward zoonoses with particular reference to anthrax among cattle owners in selected rural communities of Zimbabwe. Vector-Borne Zoonotic Dis. 13(4). doi:10.1089/vbz.2011.0916.

Collier D, Elman C. 2008. Qualitative and Multi-Method Research: organizations, publication, and reflections on integration. In: Box-Steffensmeier JM, Brady HE, Collier D, editors. Oxford handbook of political methodology. UK: Oxford University Press; p. 780–795.

Dennis DT, Gage KL, Gratz N, Poland JD, Tikhomirov E. 1999. Plague manual–epidemiology, distribution, surveillance and control. Plague Manual: Epidemiol Distrib Surveillance and Control. 74(51–52):447.

Dube T, Tui SH, and Rooyen AV. 2014. Socioeconomics discussion paper series baseline and situation analysis report : integrating crop and livestock production for improved food security and livelihoods in rural Zimbabwe. ICRISAT - Socioeconomics Discussion Paper Series. 29. doi:10.3140/RG.2.1.3404.1843.

Edwards SE, Heinrich M. 2006. Redressing cultural erosion and ecological decline in a far North Queensland aboriginal community (Australia): the Aurukun ethnobiology database project. Environ Dev Sustainability. 8 (4):569–583. doi:10.1007/s10668-006-9056-1.

Elelu N, Aiyedun JO, Mohammed IG, Oludairo OO, Odetokun IA, Mohammed KM, Bale JO, Nuru S. 2019. Neglected zoonotic diseases in Nigeria: role of the public health veterinarian. Pan Afr Med J. 32(January). doi:10.11604/pamj.2019.32.36.15659.

Elton CS. 1953. The use of cats in farm rat control. The British J Anim Behav. 1(4):151–155. doi:10.1016/S0950-5601(53)80015-8.

Fiedler LA (1990). Rodents as a food source. Proceedings of the Fourteenth Vertebrate Pest Conference 1990March, California. 149–155. [accessed 2018 Apr 27]. https://digitalcommons.unl.edu/vpc14

Friend M. 2006. Disease emergence and resurgence : the wildlife-human connection. In: Friend M, Hurley JW, Nol P, Wesenberg K, editors. Disease emergence and resurgence: the wildlife-human connection (May, p.400pp). Reston (VA): USGS National Wildlife Health Center in cooperation with the U.S. Fish and Wildlife Service; pp. 3–18.

Gadaga BM, Etter EMC, Mukamuri B, Makwangudze KJ, Pfukenyi DM, Matope G. 2016. Living at the edge of an interface area in Zimbabwe: cattle owners, commodity chain and health workers' awareness, perceptions and practices on zoonoses. BMC Public Health. 16(1):1–10. doi:10.1186/s12889-016-2744-3.

Gandiwa E, Zisadza-Gandiwa P, Muboko N, Libombo E, Mashapa C, Gwazani R. 2014. Local people's knowledge and perceptions of wildlife conservation in southeastern Zimbabwe. J Environ Prot (Irvine, Calif). 05(6):475–481. doi:10.4236/jep.2014.56050.

Gilchrist G, Mallory M, Merkel F. 2005. Can local ecological knowledge contribute to wildlife management ? Case studies of migratory birds. Ecol Soc. 10(1):12pp.

Goldberg TL, Gillespie TR, Rwego IB, Estoff EL, Chapman CA. 2008. Forest fragmentation as cause of bacterial transmission among nonhuman primates, humans, and livestock, Uganda. Emerg Infect Dis. 14 (9):1375–1382. doi:10.3201/eid14.9.071196.

Halliday JEB, Allan KJ, Ekwem D, Cleaveland S, Kazwala RR, Crump JA. 2015. One health: endemic zoonoses in the tropics: a public health problem hiding in plain sight. Vet Rec. 176(9):220–225. doi:10.1136/vr.h798.

Health WSDO. 2019. Plague-reporting and surveillance guidelines. Issue December. Washington, USA: Washington State of Department of Health; 9pp.

Herald. (2020, June 10). Poverty datum line rises. *The Herald*. [accessed 2020 Jun 10]. https://www.herald.co.zw/poverty-datum-line-rises-3/

Hopping KA, Yangzong C, Klein JA. 2016. Local knowledge production, transmission, and the importance of village leaders in a network of Tibetan pastoralists coping with environmental change. Ecol Soc. 21(1):16pp.

Kruse H, Kirkemo A-M, Handeland K. 2004. Wildlife as source of zoonotic infections. Emerg Infect Dis. 10 (12):2067. doi:10.3201/EID1012.040707.

Kugeler KJ, Apangu T, Forrester JD, Griffith KS, Candini G, Abaru J, Okoth JF, Apio H, Ezama G, Okello R, et al. 2017. Knowledge and practices related

to plague in an endemic area of Uganda. Int J Infect Dis. 64(2017):80–84. doi:10.1016/j.ijid.2017.09.007.

Kupika OL, Gandiwa E, Nhamo G, Kativu S. 2019. Local ecological knowledge on climate change and ecosystem-based adaptation strategies promote resilience in the Middle Zambezi Biosphere Reserve, Zimbabwe. Scientifica. doi:10.1155/2019/3069254

Lima MSP, Oliveira JEL, de Nóbrega MF, Lopes PFM. 2017. The use of local ecological knowledge as a complementary approach to understand the temporal and spatial patterns of fishery resources distribution. J Ethnobiol Ethnomed. 13(1). doi:10.1186/s13002-017-0156-9.

Lotfy W. 2015. Current perspectives on the spread of plague in Africa. Res Rep Trop Med. (May):21. doi:10.2147/rrtm.s63522.

Mahlaba TAM, Monadjem A, McCleery R, Belmain SR, Allen BL. 2017. Domestic cats and dogs create a landscape of fear for pest rodents around rural homesteads. PLoS ONE. 12(2):1–9. doi:10.1371/journal.pone.0171593.

Manungo P, Peterson D, Todd C, Mthamo N, Pazvakavambwa B. 1998. Risk factors for contracting plague in Nkayi district, Zimbabwe. Cent Afr J Medi. 44(February 2020):173–176.

Mashapa C, Gandiwa E, Muboko N. 2019. Socio-economic and ecological outcomes of woodland management in mutema-musikavanhu communal areas in save valley, southeastern lowveld of Zimbabwe. J Anim Plant Sci. 29(4):1075–1087.

Melman SD, Ettestad PE, Vinhatton ES, Ragsdale JM, Takacs N, Leonard PM, Master SS, Lucero VS, Kingry LC, Petersen JM, et al. 2019. Human case of bubonic plague resulting from the bite of a wild Gunnison's prairie dog during translocation from a plague endemic area. Zoonoses Public Health. 65(1): e254–e258. doi:10.1111/zph.12419.Human.

Mills JN. 2006. Biodiversity loss and emerging infectious disease: an example from the rodent-borne hemorrhagic fevers. Biodiversity. 7(1):9–17. doi:10.1080/14888386.2006.9712789.

Milupi ID, Moonga MS, and Chileshe B. 2020. Traditional Ecological Knowledge and Sustainable Practices among the Lozi-speaking people of Zambia Keywords. Multidiscip J Lang Soc Sci Educ. 3(1):24–42.

Milupi I, Somers MJ, Ferguson JWH. 2017. Local ecological knowledge and community- based management of wildlife resources : a study of the Mumbwa and Lupande Game Management areas of Zambia. December. doi:10.4314/sajee.v.33i1.3

Mugandani R, Wuta M, Makarau A, Chipindu B, Gweru SR, Pleasant M, Pleasant M. 2012. Re-classification of agro-ecological regions of Zimbabwe in conformity with climate variability and change. Afr Crop Sci J. 20(2):361–369. doi:10.4314/acsj.v20i2.

Munyenyiwa A, Zimba M, Nhiwatiwa T, Barson M, Foley J. 2019. Plague in Zimbabwe from 1974 to 2018: a review article. PLoS Negl Trop Dis. 13(11):1–17. doi:10.1371/journal.pntd.0007761.

Naicker PR. 2011. The impact of climate change and other factors on zoonotic diseases. Arch Clinl Microbiol. 2 (2):2–7. doi:10.3823/226.

Ncube-Phiri S, Ncube A, Mucherera B, Ncube M. 2015. Artisanal small-scale mining: potential ecological disaster in Mzingwane district, Zimbabwe. Jamba: J Disaster Risk Studies. 7(1). doi:10.4102/jamba.v7i1.158.

Ngulube TJ, Mwanza K, Njobvu CA, Muula AS. 2006. Knowledge, attitudes and public health response towards plague in Petauke, Zambia. Trop Doct. 36(4):223–225. doi:10.1258/004947506778604779.

Nkengasong JN. 2019. How African can quell the next disease outbreaks: as mobility increase, so must investiments in national public-health institutions and local leadership. Springer Nat. 567:147. doi:10.1038/d41586-019-00789-4.

Nyirenda SS, Hang'ombe BM, Machang'u R, Mwanza J, Kilonzo BS. 2017. Identification of risk factors associated with transmission of plague disease in Eastern Zambia. Am J Trop Med Hyg. 97(3):826–830. doi:10.4269/ajtmh.16-0990.

Ossai EN, Onwe OE, Okeagu NP, Ugwuoru AL, Eze TK, Nwede AS (2020). Knowledge and preventive practices against Lassa fever among heads of households in Abakaliki metropolis, Southeast Nigeria: a cross-sectional study. *Proceedings of Singapore Healthcare, Singapore*. doi:10.1177/2010105819899120.

Overgaauw PAM, Vinke CM, Hagen MAEV, Lipman LJA. 2020. A one health perspective on the human–companion animal relationship with emphasis on zoonotic aspects. Int J Environ Res Public Health. 17(11):3789. doi:10.3390/IJERPH17113789.

Rabiee F (2004). Focus-group interview and data analysis. *Proceedings of the Nutrition Society, 2004, UK*; pp. 655–660. doi:10.1079/PNS2004399.

Rakotosamimanana S, Rakotoarimanana FJ, Raharimanga V, Taglioni F, Ramamonjisoa J, Randremanana RV, Rajerison M, Rakotomanana F. 2021. Influence of sociospatial determinants on knowledge, attitudes and practices related to the plague in a population living in endemic areas in the central highlands, Madagascar. BMC Public Health. 21(1):1–11. doi:10.1186/s12889-021-11101-3.

Rivière-Cinnamond A, Santandreu A, Luján A, Mertens F, Espinoza JO, Carpio Y, Bravo J, Gabastou JM. 2018. Identifying the social and environmental determinants of plague endemicity in Peru: insights from a case study in Ascope, la Libertad. BMC Public Health. 18(1):1–11. doi:10.1186/s12889-018-5062-0.

Salmón-Mulanovich G, Powell AR, Hartinger-Peña SM, Schwarz L, Bausch DG, Paz-Soldán VA. 2016. Community perceptions of health and rodent-borne diseases along the Inter-Oceanic Highway in Madre De Dios, Peru. BMC Public Health. 16(1):1–10. doi:10.1186/s12889-016-3420-3.

Senanayake SGJN. 2006. Indigenous knowledge as a key to sustainable development. J Agric Sci. 2(1):87. doi:10.4038/jas.v2i1.8117.

Shirima GM, Fitzpatrick J, Kunda JS, Mfinanga S, Kazwala RR, Kambarage DM, Sarah C. 2010. The role of livestock keeping in human brucellosis trends in livestock keeping communities in Tanzania. Tanzanian J Health Res. 12(3):10. doi:10.4314/thrb.v12i3.51261.

Tarakini T, Guerbois C, Wencelius J, Mundy P, Fritz H. 2018. Integrating local ecological knowledge for waterbird conservation: insights from kavango-Zambezi transfrontier conservation area, Zimbabwe. Trop Conserv Sci. 11. doi:10.1177/1940082918803810

WHO. 2016. Plague around the world, 2010-2015. *Weekly epidemiological record/health section of the secretariat of the league of nations*. 91(8):89–93. [accessed 2019 Sep 18]. https://www.who.int/wer/2016/wer9108.pdf?ua=1

WHO. 2020. Zoonoses. Geneva (Switzerland): World Health Organization. [accessed 2021 Mar 12]. https://www.who.int/news-room/fact-sheets/detail/zoonoses

Zainal Z. 2007. Case study as a research method. Jurnal Kemanusiaan. 9:1–6.

Zikhali W. 2018. Perspectives of infrastructure development: an analysis of three wards in Nkayi district, Zimbabwe. IMPACT: Int J Res Appl Nat Social Sci. 6(6):33–46.

Zimba M, Loveridge J, Pfukenyi DM, Mukaratirwa S. 2012. Seasonal abundance and epidemiological indices of potential plague vectors dinopsyllus lypusus (Siphonaptera: hystrichopsyllidae) and ctenophthalmus calceatus (Siphonaptera: ctenophthalmidae) on rodents captured from three habitat types of Hatcliffe and Dzivarasekwa suburbs of Harare, Zimbabwe. J Med Entomol. 49 (6):1453–1459. doi:10.1603/ME11231.

Zimstat. (2013). *Census 2012: preliminary report*. 123.

ZimVAC. (2021). *V A C Z I M B A B W E*. [accessed 2021 Oct 23]. https://fscluster.org/zimbabwe/document/2021-rural-livelihood-assessment-report