CULTURAL DRIVERS OF BRUCELLOSIS AND TREATMENT PATHWAYS FOR FEBRILE ILLNESSES AMONG AGRO PASTORALISTS IN KILOMBERO DISTRICT, TANZANIA

CAROLINE MWIHAKI NG'ANG'A

N79/52348/2017

A THESIS SUBMITTED TO THE INSTITUTE OF ANTHROPOLOGY, GENDER AND AFRICAN STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN MEDICAL ANTHROPOLOGY OF THE UNIVERSITY OF NAIROBI

2022

Declaration

This thesis is my original work and has not been submitted to any other university for a degree.

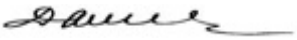
Caroline Mwihaki Ng'ang'a  10th Nov 2022

Signature Date

This thesis has been submitted with our approval as the University Supervisors

Prof. Salome A. Bukachi. -------SBukachi----- 10/11/2022

Signature. Date

Dr. Khamati Shilabukha -  -- 10th Nov 2022

Signature Date

Table of Contents

List of Tables

List of Figures/Maps

List of Pictures

Abbreviations and Acronyms

RVF	Rift Valley Fever
UTI	Urinary tract infection
CBPP	Contagious Bovine Pleuro Pneumonia
FMD	Foot and Mouth Disease
WMA	Wildlife Management Area
FGD	Focus Group Discussion
IDI	In depth Interview
KII	Key Informant Interview
KAP	Knowledge, Attitudes, Practices

Acknowledgements

I would not have accomplished this feat without the support of many. My university supervisors Prof. Salome Bukachi and Dr. Khamati Shilabukha guided me throughout this PhD during proposal writing, data collection and analysis, preparation of manuscripts and this thesis. They have diligently given me constructive and timely feedback. The Afrique One ASPIRE consortium sponsored me fully to do this PHD and am immensely grateful. My supervisors from Afrique One ASPIRE Dr. Kathrin Heitz-Tokpa and Dr. Mangi Ezekiel have supported, guided and nudged me on throughout this rigorous journey. I thank Prof Rudovick Kazwala who led the Brucellosis thematic group in the Afrique ONE ASPIRE consortium for his support, advice and guidance throughout the course of my studies. I am grateful to Dr. Katharina Kreppel and John Gitahi for their help and support in quantitative data analysis. I express my sincere gratitude to the Ifakara Health Institute in Ifakara, Kilombero district for hosting my family and I while I conducted field work in Tanzania. My sincere gratitude also to my research assistants Peter and Sarah who helped me navigate through the villages and faithfully learned and helped in data collection and transcription. I am thankful to all the other fellows in the Brucellosis thematic group for their encouragement. Special thanks to Coletha Mathew and Richard Yapi, the Post Docs in Afrique One-ASPIRE for helping me with the practical details of field work and their overall support.

My special gratitude to the livestock keepers and local authorities in Sagamaganga, Lungongole and Signal villages in Kilombero district, Morogoro Tanzania who allowed me to work in these area for six months. I am thankful for their hospitality and willingness to be interviewed and for allowing me to be part of their lives for the entire period of field work. I am thankful to Rosemary who took care of my children in Ifakara, Tanzania. My immediate and extended families have been very supportive and have cheered me on and I salute them. My children Jebichi, Wambui, Kwizera, Imora and Nashipai have borne many sacrifices that have enabled me to accomplish this feat. My parents David and Scholastica Mwangi and brothers Mwangi and Gitahi and their families have been cheering me on and am immensely grateful. I thank my friends Achieng, Kamau, Kanini, Sammy, Maggie and Dan who have supported me in distinct ways throughout this journey. May God bless you. I thank God who has given me life, energy, good health and strength to complete this work and achieve my dream.

Dedication

This thesis is dedicated to my mother, Scholastica Wambui who has constantly reminded me of my dream of pursuing a PhD while still in my thirties. And to my daughters Jebichi, Wambui, Imora, Kwizera and Nashipai. I hope you have seen and learnt that hard work, determination and diligence pays. May your dreams come true!

Abstract

Cultural Drivers and Treatment Pathways for Brucellosis in Kilombero District, Tanzania

In livestock, brucellosis leads to losses in domestic animals and chronic disease in humans. It has been prioritized for control in Tanzania. Low awareness and risky behavior can hamper the efforts to control this disease. This disease mostly affects agro pastoralists because of their close interaction with livestock, consumption of raw animal products and the handling of aborted material. This study examined the awareness, perceptions, knowledge and behaviour related to brucellosis in Kilombero district guided by the Socio-ecological model. The study was cross sectional with agro pastoralists, local livestock, public health and wildlife officials participating. Quantitative data were collected through 333 structured interviews while qualitative data were collected through 39 in depth interviews, 16 key informant interviews and 7 focus group discussions. Quantitative data was analysed through summary and inferential statistics. Thematic analysis was conducted for the qualitative data.

In this study, only 7.2% of respondents had ever heard of brucellosis in livestock and none had ever heard of the disease in humans. Most of the participants had no knowledge about the disease, its causes, signs and risk factors for humans and domestic animals. The study found that the symptoms associated with brucellosis infection are recognized but are attributed to trypanosomiasis and supernatural reasons instead. Culturally acceptable practices like drinking unpasteurized milk, consuming raw blood, handling aborted material and living in close proximity to livestock are considered normal and are not at all associated with the risk for brucellosis. Communities lack knowledge and have misconceptions regarding this zoonotic disease. Herbs, over the counter drugs were used as an initial course of action during a febrile illness. Traditional healers were used for repeated episodes of febrile illness usually after the use of conventional treatment. Formal healthcare was not used initially unless in cases of severe disease or for little children and older people.

In conclusion, there is low awareness, inadequate knowledge, misconceptions and behaviour risking transmission with brucellosis in Kilombero district among the agro pastoralists. The pluralistic approaches in health care seeking for febrile illnesses can lead to misdiagnosis and inadequate treatment leading to chronic illness, poor productivity and death. This study

proposes regular sensitisation and engagement with the community so as to address these issues in ways that can eventually lead to behaviour change and the adoption of safer practices. This study also suggests that close collaborations between communities, policy makers and scientists are enhanced so that culturally relevant and sustainable brucellosis control programs are implemented.

Publications

Publication 1:

Title: Lay attitudes and misconceptions and their implications for the control of brucellosis in an agro-pastoral community in Kilombero district, Tanzania.

Authors: Caroline M Mburu, Salome A Bukachi, Kathrin H Tokpa, Gibert Fokou, Khamati Shilabukha, Mangi Ezekiel, Bassirou Bonfoh, Rudovick Kazwala, Katharina Kreppel.

Journal: PLOS Neglected Tropical Diseases

Year of Publication: 10th June 2021

Link: *https://doi.org/10.1371/journal.pntd.0009500*

Publication 2:

Title: Determinants of treatment-seeking behaviour during self- reported febrile illness episodes using the socio-ecological model in Kilombero District, Tanzania.

Authors: Caroline M Mburu, Salome A Bukachi, Khamati Shilabukha, Kathrin H Tokpa, Mangi Ezekiel, Gibert Fokou, Bassirou Bonfoh, Rudovick Kazwala.

Journal: BMC Public Health

Year of Publication: 5th June 2021

Link: *https://doi.org/10.1186/s12889-021-11027-w*

Chapter 1: Background to the study

1.1 Introduction

Brucellosis is a zoonotic disease which lowers livestock fertility and can be debilitating and chronic in humans leading to reduced productivity (Assenga 2015; Ducrotoy 2017; Ntirandekura *et al*., 2020). This disease is endemic and neglected in Sub Saharan Africa in wild and domestic animals and is responsible for up to 500,000 human cases each year around the world (Adesokan *et al*., 2013). In wild and domestic animals, it is transmitted via the ingestion of contaminated pasture and water and prevalence of this disease is higher in pastoralist systems where mingling of herds and wild animals is common (McDermott and Arimi 2002; Ntivuguruzwa *et al.,* 2020). In humans, it is transmitted from livestock through the ingestion of raw animal sourced foods and handling of birth materials from livestock directly with bare hands (McDermott and Arimi 2002). Humans can also contract brucellosis via direct contact with infected animals through lesions on the skin or inhalation of infected aerosols (Stoddard *et al.,* 2012). Of all the brucella species, B. *melitensis*, is the most infectious and causes disease in livestock while most human infections are due to B. *abortus* (Stoddard *et al.,* 2012). Serious financial losses occur in livestock due to infertility, low productivity and termination of pregnancies (Godfroid *et al.,* 2011). In extensive livestock systems where dependence on livestock for livelihood is high these losses are especially problematic as they perpetuate poverty. Brucellosis in humans leads to a febrile illness causing fever, headache and aches and if left untreated it can become chronic (Asiimwe *et al.,* 2015).

While brucellosis is eradicated in many western countries it continues to be a major problem in Africa since many of the control efforts have not yet been well undertaken and thus are unsuccessful (Asiimwe *et al.,* 2015). Part of the reason for the minimal success in controlling this disease is inadequate knowledge and cultural perspectives that prevent people from adopting behaviour that protects them against this disease (Godfroid *et al.,* 2011). People do not engage in control efforts for diseases they are unfamiliar with. Studies conducted in various parts of Africa have demonstrated that inadequate knowledge concerning the transmission pathways of brucellosis is common among livestock keepers (Adesokan *et al.,* 2018; Addo *et al.,* 2011; Zhang *et al.*. 2019). Additionally, it has been reported that increased knowledge of a disease does not always lead to safer behaviour (Holt *et al.,* 2011; Kansiime *et al.,* 2014). While knowledge about a disease does not always imply that control efforts will be employed it often improves the acceptability of control efforts especially when cultural and structural

factors are considered. Some have acknowledged that brucellosis control efforts haven't been successful yet, partly because a poor understanding of community awareness and behaviour risking transmission exists (Cash-Goldwasser *et al.,* 2018; Kunda *et al.,* 2007; Mangesho *et al.,* 2017).

The importance of assessing the social and cultural understandings of risk when studying a disease has already been underscored (Decker *et al.,* 2010; Jensen *et al.,* 2005). The uptake of disease control efforts depends in part on the lay understandings of what constitutes risky behaviour and the acceptability of certain practices in communities which may be considered risky by professionals. Pastoralists drink raw milk and live in close proximity to livestock and while these are risk factors for brucellosis they are embedded in their way of life. A higher incidence of brucellosis in both humans and livestock occurs in these agro pastoralist systems (Kiambi *et al.,* 2020; Schelling *et al.,* 2003). Another unique aspect of the pastoralist way of life is that they and their animals live in close proximity to wildlife areas. As land use systems have changed with urbanisation and intensive agriculture pastoralists have moved further into marginal lands inhabited by wildlife in search of pasture and water (Cunningham *et al.,* 2017). In Kilombero district, livestock grazing areas are located next to wildlife conservation areas and the intensive movement of livestock from one district to another occurs through wildlife conservation areas. These perpetuate the transmission of brucellosis across the livestock-wildlife interface through shared pasture and water which are focal transmission points.

In Tanzania, brucellosis is one of the six high priority zoonotic diseases targeted for control (One Health Zoonotic Disease Prioritization for Multi-Sectoral Engagement in Tanzania, 2017). In Tanzania, the prevalence of brucellosis is 1-30% in livestock and 0.7-48.4% in humans (Assenga *et al.,* 2015; Shirima and Kunda, 2016; Mirambo *et al.,* 2018). This high prevalence is due to both human behaviour as well as challenges in instituting control initiatives (Shirima and Kunda, 2016; Mirambo *et al.,* 2018). In Kilombero district where this study was conducted, previous studies estimated a prevalence of 14.3% and 14.6% for brucellosis in cattle and humans respectively (Assenga *et al.,* 2015; James, 2013).

Brucellosis in humans causes a febrile illness with fever, headaches and joint pains being some of the symptoms and is often misdiagnosed as malaria in Tanzania (Chipwaza *et al.,* 2015; Stoddard *et al.,* 2012). It has been established that treatment seeking behaviour for brucellosis

is influenced by people's knowledge and perceptions regarding the disease (Holt *et al.,* 2011; Kansiime *et al.,* 2014). These perceptions often determine the course of action that people take when they suspect or know that they are suffering from an illness. Studies have shown that socio cultural factors do play a key role in determining what sick people make of their symptoms, what those symptoms mean and consequently the course of action to be taken (Mackian, 2004; Rubel and Garro, 1992). In this regard, therefore, it is important to seek to understand treatment seeking behaviour in the context of the broader cultural, social, structural and physical aspects to both understand what enables and constrains individual behaviour and what determines the different treatment pathways undertaken (Mackian, 2004).

There haven't been any anthropological studies on brucellosis before this study in Tanzania and yet people's behaviour plays a significant role in the transmission as well as the uptake of control measures. We need a holistic understanding of brucellosis including the social and cultural factors and not only the prevalence and epidemiological aspects. Local communities need to be involved in the development of relevant and applicable control strategies within their contexts (Mcdermott *et al.,* 2013). This study therefore explored the lay awareness and knowledge on brucellosis in livestock and humans in an agro pastoralist setting in Kilombero district of Tanzania. The agro pastoralists engaged in both livestock keeping and farming as a source of livelihood and they had all immigrated to the district from other parts of the country. It also examined the risk perceptions towards practices risking transmission with the disease related to consumption of raw animal sourced foods, animal handling and the interaction of livestock and wildlife. In the initial phase of the study, it was clear that very few participants had any awareness on brucellosis although participants noted that livestock displayed brucellosis symptoms. However, as brucellosis is one of the febrile diseases already identified in this locality this study sought to explore the treatment seeking behaviour of the community during a febrile illness episode. The participants were majorly from the Wasukuma ethnic group and some were from the Maasai ethnic group.

1.2 Problem statement

The transmission of brucellosis is known to occur especially in livestock keeping communities in both livestock and humans as a result of unsanitary practices (McDermott and Arimi 2002). This includes the handling of aborted foetuses since these often contain a large amount of bacteria (Adesokan *et al.,* 2013; Godfroid *et al.,* 2011; Kansiime *et al.,* 2014; Mangen *et al.,*

2002). Pastoralists also value the consumption of raw milk because it tastes better and has perceived health benefits (Godfroid *et al.,* 2011, Ng'ang'a *et al.,* 2016). Inadequate knowledge on brucellosis regarding animal to human transmission such as through the handling of infected birth materials was found among communities living in Ghana, Uganda and Nigeria (Addo *et al.,* 2011; Adesokan *et al.,* 2013; Kansiime *et al.,* 2014). In studies conducted in Tanzania, it was observed that awareness of brucellosis was low (Asakura *et al.,* 2019; Kunda *et al.,* 2007; Ntirandekura *et al.,* 2018).

Studies have demonstrated that the attitudes and perceptions of communities regarding zoonoses often differ from biomedical observations (Etter *et al.,* 2006; Marcotty *et al.,* 2009). It is critical to determine lay people's awareness and risk attitudes for disease in the design of any control strategies to promote acceptability (Ducrotoy *et al.,* 2017; Kunda *et al.,* 2007; Marcotty *et al.,* 2009; Ng'ang'a *et al.,* 2016). Since risk awareness and perceptions differ between communities and professionals, thus, when people do not know or perceive a behaviour to put them at risk for disease they are not likely to adopt safer practices (Paul, 2016). Additionally, risk factors for any disease have social, political, institutional and biological components and aspects such as gender, age, wealth status and ethnicity do have a bearing on who is most at risk and for which disease (Dzingirai *et al.,* 2017). Brucellosis infections are perpetuated in these contexts because of the close interactions between livestock and wildlife. Reduced access to pasture and water for pastoralists is driving them into areas with wild animals (Kansiime *et al.,* 2014). Brucellosis in humans is often misdiagnosed in Sub Saharan Africa as malaria, an endemic disease in the region (Chipwaza *et al.,* 2015). In contexts where poor health systems exist including Tanzania both traditional and conventional methods of treatment are employed (Amuyunzu-Nyamongo and Nyamongo 2006; Hercik *et al.,* 2019).

Although this zoonotic disease is of importance in Tanzania, most studies have focused on epidemiological factors (Alonso *et al.,* 2016; Assenga *et al.,* 2016; 2015; Carugati *et al.,* 2018; Cash-Goldwasser *et al.,* 2018; Mellau, Kuya, and Wambura, 2009; Mirambo *et al.,* 2018; Mngumi *et al.,* 2016; Mujuni *et al.,* 2018; Sagamiko *et al.*, 2019; Shirima, 2005) with a casual mention that it is crucial to assess community based factors linked to transmission. On the other hand, knowledge, attitudes and practices (KAP) studies conducted in Africa on brucellosis do exist (Addo *et al.,* 2011; Arif *et al.,* 2017; Buhari, 2015; Musallam, Abo-Shehada, and Guitian 2015; Ntirandekura *et al.,* 2018; Obonyo, 2015). However, these kinds of studies have been criticised for not providing the contextual information regarding a disease and thus do not

provide the holistic picture and do not situate these perceptions and practices in the local context (Launiala, 2009). Low quality health services have been noted as a key factor for the self-treatment in febrile episodes in Kilombero district of Tanzania (Chipwaza *et al.,* 2014). However, there is a dearth of studies on the pathways undertaken by the local populations and the rationale behind these.

These gaps are what this study sought to assess by providing in-depth insights on the lay knowledge, awareness and risk perceptions on brucellosis and treatment seeking behaviour for febrile illnesses in an agro pastoralist community in Kilombero district in Tanzania. Thus, this study sought answers to the following questions:

1. What is the awareness, knowledge and attitudes on brucellosis among the agro pastoralists in Kilombero district?
2. What are the risk perceptions for human brucellosis and practices related to consumption of animal products and animal handling practices in Kilombero district?
3. What are the risk factors for brucellosis due to environmental interactions in the human-livestock-wildlife interface in Kilombero district?
4. What are the treatment pathways for febrile illness among the agro pastoral communities in Kilombero district?

1.3 Research Objectives

1.3.1 General objective

To establish the cultural drivers for brucellosis and the treatment pathways for febrile illnesses in the Kilombero dsitrict of Tanzania.

1.3.2 Specific Objectives

1. To determine the awareness, knowledge and attitudes on brucellosis among the agro pastoralists in Kilombero district.
2. To describe the risk perceptions for human brucellosis and consumption of animal products and animal handling practices in Kilombero district.
3. To explore the risk factors for brucellosis due to environmental interactions in the human-livestock-wildlife interface in Kilombero district.
4. To assess the treatment pathways for febrile illnesses among the agro pastoral communities in Kilombero district.

1.4 Rationale for the study

Brucellosis leads to livestock losses through abortions, still births and infertility which has a big impact on pastoralists households as they depend on animals for food, income and social wellbeing. While quantitative studies demonstrating the burden of the disease in these contexts are laudable, we need anthropological studies to provide meaning to observed behaviour and attitudes. There is an increasing recognition that communities must be involved in the control of this disease both in animals and humans (Ducrotoy *et al.,* 2017). The global One Health Initiative too, underscores the importance of addressing zoonotic diseases by controlling them at their animal source through multi-disciplinary collaborations which must include communities (Assenga *et al.,* 2015). The control of brucellosis in low resource settings is based on the adoption of sanitary practices such as boiling milk and handling of birth materials with protective equipment (Ducrotoy, 2017). For livestock keepers to undertake these practices they must not only be aware of the risks but consider these risks significant enough to warrant a change in behaviour.

Delays in seeking appropriate medical care and the consultation of unqualified professionals are barriers to the suitable management of fever causing illnesses. Behavioural factors based on local beliefs and barriers towards access to proper health care are some of the key factors hampering management of these diseases. Exploratory studies such as this one provide clarity on the reasons why the various options are sought and ways to promote health promoting practices.

This study aimed at generating anthropological evidence for enhancing the control efforts of brucellosis in Tanzania in particular and Africa in general. Insights into lay awareness and knowledge on brucellosis and risk perceptions on consumption of animal products, animal handling as well as interaction of livestock and wildlife are discussed. This study also explored the treatment pathways for febrile illnesses among agro pastoralists to aid in community engagement and to promote attention to broader barriers in the proper management of febrile diseases. The study was conducted in three villages in Kilombero district among livestock keeping communities. This thesis also recommends suitable approaches to improve the uptake of relevant brucellosis management measures. This study will also add to the body of knowledge on the social aspects of brucellosis and febrile illnesses.

1.5 Scope and Limitations of the study

This study was conducted in the Kilombero district of Tanzania among agro pastoralists only. It explored the awareness, attitudes, practices on brucellosis in livestock and humans and the treatment seeking behaviour for febrile diseases. The study was cross sectional and descriptive in design utilising both quantitative and qualitative methods. Livestock keepers as well as health, veterinary, wildlife and forest public officials participated in this study. The study was guided by the socio ecological theory to gain a holistic understanding of the local attitudes and behaviour.

Brucellosis is a broad subject that requires studying the bacteria itself, modelling its epidemiology, understanding the host-pathogen association and diagnosis. The focus of this study though was to understand the knowledge, perceptions, environmental interactions and treatment pathways of the local communities. The study assessed treatment seeking behaviour during self-reported febrile illness episodes in the past, no tests were conducted to ascertain the presence of disease and recall bias might have affected the study results. The quantitative findings can be generalised for Kilombero district but the qualitative findings were only relevant for the study context. These detailed results however, can be used comparatively with studies in similar settings. The researcher being Kenyan conducting the research in Tanzania could speak Swahilli which is widely spoken in both countries but did not speak the native languages in the study region which was a barrier with especially older participants who were only fluent in their mother tongue. To address this though, the researcher engaged research assistants who were fluent speakers of the local languages, Swahili and English to assist in collecting and transcribing the data.

1.6 Assumptions of the study

1. The awareness, knowledge and attitudes of the agro pastoralists played a role in the perpetual transmission of brucellosis to humans and animals in Kilombero district.
2. The risk awareness and practices of the agro pastoralists in Kilombero district related to consumption of animal products and animal handling pre-disposed them to brucellosis.
3. Certain interactions between humans, livestock and wildlife increased the chances of transmission of brucellosis disease across the species in Kilombero district.

4. Lay understandings of febrile disease aetiology influenced the treatment seeking behaviour of the agro pastoralists in Kilombero district.

1.7 Definition of Key Terms

Brucellosis: A bacterial disease-causing abortions, infertility, reduced milk production and still births in sheep, goats, and cattle and febrile illness in humans. It can be either acute or chronic in people. Humans get infected by handling livestock without protective equipment and through the ingestion of raw animal sourced foods.

Zoonotic disease: This is any disease that can be transmitted from animals to humans.

Febrile Illness: A disease whose primary symptoms include sudden onset of fever, headache, chills, joint pains and abdominal pain.

Animal husbandry: This is the production, management and care of domestic animals.

Livelihood: This refers to a person's means of securing the necessities of life.

Agro pastoralists: These are people who both keep livestock and farm as a means of livelihood.

Awareness: An individual having ever heard of brucellosis in livestock or/and humans.

Knowledge: A correct understanding of brucellosis as a zoonotic disease, its symptoms in humans, livestock and wildlife, causes, risk factors and transmission dynamics.

Risk factors: These are the actions as recognised by the biomedical fraternity that increase an individual's chance of being infected with a particular disease.

Perceived risk factors: These are the perceptions of individuals related to their understanding of the practices that increase a person's chance of contracting a certain disease.

Risk behaviour: Actions which increase a person's likelihood of being infected with a disease.

Cultural drivers: Lay beliefs, perceptions, knowledge, attitudes and practices related to a particular subject.

Treatment pathways: The course(s) of action taken by individuals in seeking health care when they suspect or are suffering from a particular disease.

Chapter 2: Literature Review

2.1 Introduction

This chapter reviews the epidemiological, social science and anthropological literature relevant to brucellosis. This section starts with an overview of brucellosis in livestock, wildlife and humans. It addresses the strategies for control in Africa and perspectives on the lay awareness and knowledge on the disease. The diverse perceptions of risk with a focus on professional and lay perspectives related to the consumption of animal sourced foods and animal handling practices are discussed. The livestock-wildlife interactions are elucidated and their role in sustaining brucellosis transmission across species and the different narratives around this issue. Lastly, literature on the pluralistic approaches for the treatment of febrile illnesses is explored and the theoretical framework used for this study is explained.

2.2 Overview of brucellosis

Brucellosis is a serious zoonotic disease that is caused by bacteria of the genus *Brucella* and affects humans, livestock and wildlife all over the world (Ducrotoy *et al.*, 2017). It is considered one of the neglected diseases and is endemic in Africa, Asia and Latin America (Marcotty *et al.*, 2009; Miedany *et al.*, 2020). Although there are several *Brucella* species, different strains of brucella seem to prefer different hosts (Racloz *et al.,* 2013; Schelling et al., 2003; Sayer, 2016). For example, Brucella *melitensis*, affects goats and sheep and is responsible for most cases of the human disease worldwide (Marcotty *et al.*, 2009; Sayer, 2016). In livestock the brucella species , B. *melitensis* and B. *abortus,* are the most common in cattle, sheep and goats (Racloz *et al.,* 2013). Nevertheless although this disease is host specific, infections across species do occur especially with B. *melitensis* (Mustafa and Hassan, 2010). Brucellosis in livestock often localizes in the reproductive tract of the animal leading to late term abortions and retained placenta as well as epididymitis and orchitis in males (WHO and FAO, 2006). Significantly, the udder of lactating cows is usually permanently infected and thus brucella bacteria are regularly shed in the milk (WHO and FAO, 2006). In addition, studies have also demonstrated that in some cases brucellosis can be present in livestock for a long time without any clinical manifestations (Racloz *et al.,* 2013). Brucellosis causes infections in wild animals including buffaloes, hippopotamus, giraffes, waterbucks and wildebeests in Africa (Alexander *et al.*, 2012; Godfroid, 2002; Schlundt and Erasmus, 1988; Schlundt, Kock, and Fisher, 2002) and bisons and elk in North America (Joly and Messier, 2005). Brucella *abortus* and brucella *melitensis* are the main species of brucella that infect wild animals and can be passed on to cattle and small ruminants respectively and vice versa (Godfroid, 2002).

This disease can lead to abortions and reduced fertility in wild animals (Enström *et al.,* 2017; Schlundt and Erasmus, 1988).

Although brucellosis is the most common zoonotic disease in the world there are few fatalities (Pappas *et al.,* 2006). In most cases it is an acute illness but can also be a chronic debilitating disease where there can be up to a year of persistent symptoms (WHO and FAO, 2006). The World Health Organization has observed that brucellosis leads to 500,000 cases of human infections every year although many other cases often go unreported (Adesokan *et al.,* 2013; Racloz *et al.,* 2013; Sayer, 2016). Transmission to humans can originate from cattle, sheep, goats, pigs, camels, yaks, dogs and buffaloes (WHO and FAO 2006).. People acquire brucellosis mainly through the ingestion of raw milk and contact with the fluids secreted during calving and abortions (Adesokan *et al.,* 2013; Schelling *et al.,* 2003). Other possible means of transmission include inhalation of infected aerosols, inoculation of the conjunctival sac of the eyes, tissue transplantation and sexual transmission (Bouley *et al.,* 2012; Racloz *et al.,* 2013; Franc *et al.,* 2018).

2.3 Strategies for Brucellosis control in Africa

The highest incidence of brucellosis in Africa, is found in agro pastoral and pastoral systems in both humans and livestock although an increase in transmission has been noted in urban areas (Assenga *et al.,* 2015; Bouley *et al.,* 2012; Schelling *et al.,* 2003). Brucellosis is endemic in many parts of Africa and is a disease of concern to livestock keepers in extensive livestock production systems (Schelling *et al.,* 2003). Studies in Chad, Ethiopia and Somalia (Racloz *et al.,* 2013) found a disease prevalence of between 2% and 5.5% among cattle, sheep and goats respectively. Brucellosis is a common disease in East Africa in both livestock and humans. A review of prevalence studies in East Africa found an animal level prevalence of 0.2%-43.8% in cattle, 0%-20% in goats and 0%-13.8% in sheep and 0%-35.8% in human.(Djangwani *et al.,* 2021). A seroprevalence of 0-15% in livestock has been identified in various parts of Tanzania (Assenga *et al.,* 2015; Stoddard *et al.,* 2012).

Most studies on brucellosis have been conducted by epidemiologists and natural scientists with social sciences excluded (Cavalerie *et al.,* 2021). Some have advocated for the inclusion of anthropologists as they provide detailed information about specific contexts including the historical, economic, cultural and physical dynamics (Hastings, 2016; Porter, 2006). However,

it is often the case that biomedical knowledge is prioritized over social scientific insights (Porter, 2006). Anthropological knowledge is lauded in the control of zoonotic diseases because it moves away from simplistic solutions and considers the complexities of human society. Through ethnographic research, data on specific contexts is elucidated and relevant solutions are advanced which are more acceptable and practical in that context. When public health solutions are promoted without a proper understanding of context they can be rejected by communities. For example, opposition to disease control strategies has happened in Tanzania for urinary schistosomiasis and soil transmitted helminths due to miscommunication between implementers and the communities (Hastings, 2016). Sadly, the assumption that lay people will simply adopt recommended disease control strategies continues to influence public health policy (Hastings, 2016). Community priorities, local knowledge and beliefs are often not considered in the development of disease control measures. Often as other studies have shown communities want problems addressed in a holistic manner and thus working with communities which anthropologists are suited to do is critical (Dzingirai, *et al.,* 2017; Hastings, 2016; Konan *et al.,* 2019; Mtuy *et al.,* 2021).

Over 70% of the rural poor in the world depend wholly or in part on livestock for their livelihood (Schelling *et al.*, 2003). Pastoralists livelihoods are impacted by the reduced productivity of their herds due to brucellosis and many do not have access to adequate veterinary services (Healy Profitós *et al.,* 2013). Brucellosis is critical in livestock management because it leads to significant economic consequences as a result of reduced milk yield, low fertility and abortions, placenta retention, low resale value, reduced draught power and hygromas in many parts of Africa (Mcdermott *et al.*, 2013; Racloz *et al.*, 2013). These losses lead to impoverishment among livestock keepers who are already battling difficulties including loss of pasture, drought, other livestock diseases and poor access to animal health services.

Although the consequences of brucellosis in livestock are dire leading to significant economic losses, in Africa, intentional control programs are haphazard and poorly implemented (McDermott and Arimi, 2002). Endemic diseases like brucellosis impact millions of poor and marginalized people but they do not get much attention as diseases with the potential for global epidemics (Cunningham *et al.,* 2017). In many developed countries including Japan, Canada, Australia, many European countries and the United States of America (USA), brucellosis has been eradicated in livestock (Ali *et al.,* 2017; Sayer, 2016) and consequently in humans.

Nevertheless, these countries continue to closely monitor their livestock because there is the risk of reintroduction of brucellosis through the importation of livestock (Sayer, 2016). The eradication of brucellosis in these countries has been achieved through vaccination of livestock, culling of infected livestock and pasteurization of milk ((Cunningham, Scoones, and Wood 2017). These strategies that have been used to eradicate brucellosis in developed countries depend to a large scale on the availability of resources to implement long term vaccination, culling of diseased livestock and compensation to farmers all of which are impractical in Africa due to limited resources.

In resource limited settings, some have advocated for the utilization of sanitary practices to control brucellosis such as boiling milk, using gloves to assist in parturition, screening of new animals, controlled livestock movement and proper disposal of birth materials all of which are difficult to implement in pastoralists settings (Djangwani *et al.,* 2021; Ducrotoy, 2017). This is not uncontested however as it is premised upon livestock keepers' perceptions on the necessity of these practices and the availability of the required equipment. Anthropological studies help to uncover in depth perspectives on how people relate with animals, consumption practices, health beliefs and environmental interactions in local contexts (Wolf, 2015). In addition, for a holistic perspective on disease we must also look at social and economic inequalities that have a big contribution towards disease and ill health (Brown *et al.* , 2017). It is well known that the consumption of raw milk among many livestock keeping communities is a common and valued practice and close proximity to livestock is esteemed(Ng'ang'a *et al.,* 2016). The emotional attachment that livestock keepers have with their livestock and local beliefs on what constitutes a diseased animal can be barriers to any effective control strategy (Godfroid, 2017; McDermott and Arimi, 2002; Smits, 2013).

The continuous interaction of humans, livestock and wildlife and cultural practices that continue to perpetuate human infections are barriers to the control of brucellosis (Affognon *et al.,* 2017; Kansiime *et al.,* 2014; Mai *et al.,* 2012). However, these factors have not been delineated and critically assessed. A few social scientific studies have noted that beliefs including that raw milk tastes better than pasteurized milk and co habitation with livestock to protect them from wildlife are barriers to the control of zoonotic diseases (Marcotty *et al.,* 2009; Ng'ang'a *et al.,* 2015). Anthropology among the social sciences disciplines is known for examining the reasoning behind people's behavior and situating this in the broader micro and

macro contexts. In their examination of the role of anthropology in interdisciplinary research on zoonoses, some note that an understanding of the "complex webs of causality between humans and animals" is needed if any disease control strategies are to be successful (Keck and Lynteris, 2018). This has to go beyond an assessment of what the lay people know and think about the disease in question but to the larger macro and micro processes that enable or constrain individual behavior. Long term engagement with communities and a clear elucidation of cultural perspectives is well within what anthropologists are trained to do to address the multidimensional problems in the human – livestock- wildlife interface (Healy-Profitós *et al.,* 2016).

In the recent past brucellosis control strategies have been developed in several East African countries including Tanzania (Nantima *et al.,* 2019; Munyua *et al.,* 2016; The United Republic of Tanzania, 2015). These focus largely on biomedical solutions with minimal attention to social cultural factors which are known to determine the success or failure of a disease control program (Hastings, 2016; Mtuy *et al.,* 2020). Epidemiology has a strength in that it studies the broad aspects affecting a population but anthropological studies are more nuanced, paying attention to complex intricacies including long held assumptions and individual dynamics and thus can aid in the development of more nuanced attentive strategies (Porter, 2006). Another challenge in the control of brucellosis is that most of these strategies are spearheaded from the global north which compromises the relevance and applicability of the findings in the local contexts (Cavalerie *et al.,* 2021).

It is important to consider how humans and their livestock interact with the ecosystem on a daily basis so as to develop better disease control strategies. To achieve this there is need for a multi-sectorial collaboration among communities, authorities and policy makers to better understand this local disease-ecosystem-livelihood interaction to reduce disease risk and burden and to develop a holistic disease control strategy (Leach *et al.,* 2017). In their study among pastoralists in Uganda for example, (Kansiime *et al.,* 2014) found out that certain cultural practices increased the likelihood of the participants to acquire brucellosis. These included consumption of unpasteurized milk, the use of dried cow dung as fuel and assisting livestock during calving (Kansiime *et al.,* 2014). Other factors included the close interaction between their livestock and wildlife especially during the drought season when they took their livestock to the wildlife parks for pasture. This close contact between livestock and wildlife

increased the likelihood of brucellosis transmission from the wildlife to livestock and eventually to humans (Kansiime *et al.,* 2014).

Another challenge in brucellosis control in Sub Saharan Africa is keeping small ruminants alongside cattle which continually ensures transmission across species (Bamaiyi, 2016). In Africa sick animals are not culled such as those with visible hygromas or with a history of abortion and so they continue to infect other animals in the herd and this has been attributed to the low resale value associated with ill animals (Healy Profitós *et al.*, 2013; Hegazy *et al.*, 2015; Mai *et al.*, 2012). Indeed this has been noted in countries such as Egypt where farmers don't notify authorities of suspected brucellosis positive livestock in their herds for fear of the subsequent culling and low compensation (Hegazy *et al.,* 2015). Pastoral communities also often live in very isolated areas and thus the implementation of control strategies is impaired especially in African countries which have poor mobility and insufficient animal health workers (Boukary *et al.*, 2013; Enström *et al.*, 2017). This is why some researchers have proposed that addressing governance issues and improving social wellbeing and accelerating economic development might be useful (Holt *et al.,* 2011; Racloz *et al.,* 2013). This is because the prevention and control of brucellosis is related to the availability of resources to vaccinate livestock as well as compensation of pastoralists for any livestock culled. In addition, in order to control brucellosis in humans the disease must first be controlled in animals (Bouley *et al.,* 2012; Holt *et al.,* 2011). There currently exists a vaccine against brucellosis in livestock but none for humans or pigs as well as wildlife (Godfroid *et al.,* 2011). In most countries in Africa vaccination of livestock against brucellosis is hardly done on a regular basis other than in South Africa (Ducrotoy *et al.,* 2017). Vaccination of livestock against brucellosis must be accompanied by other strategies like test and slaughter which require the involvement of the livestock keepers (Ducrotoy *et al.,* 2017).

Other useful strategies that can be utilized include the animal and human health officials working collaboratively and also understanding the perceived risk factors for human brucellosis in order to develop context specific control strategies. In addressing brucellosis in humans several studies have advocated for enhancing the clinicians' understanding of brucellosis as well as providing them with the diagnostic kits to enable them better manage brucellosis (Bouley *et al.,* 2012). Additionally, it is important to address the human/animal/ecosystem interface if brucellosis is to be successfully eradicated since human

infections almost always arise from livestock (Godfroid *et al.,* 2011). Community participation is very central in the control of brucellosis and careful engagement with local people so that they are educated in culturally and contextually relevant ways that can lead to long term behavior change through creative and locally adaptable solutions (Mazet *et al.,* 2009).

2.4 Perspectives on lay awareness and knowledge of brucellosis

It has already been underscored that it is crucial to explore community perceptions regarding diseases in order to provide targeted interventions (Liao *et al.,* 2009). A proper conceptualization of the attitudes by lay people on diseases is crucial because to prevent these diseases requires that the population follows through with any mitigation approaches (Liao *et al.,* 2009). For example, what a community or an individual perceive to be the causes of a disease might influence what control strategies they are willing to employ (Pedroso *et al.,* 2008; Walter *et al.,* 2004). When community explanations for disease are different from those by clinicians and public health practitioners noncompliance with any preventive practices and resistance to behavior change are likely to occur (Bardosh *et al.,* 2017; Hastings, 2016; Ng'ang'a *et al.,* 2016). Researchers, (Liao *et al.,* 2009) in South East and East Asia observed that lay attitudes towards the H5N1 avian influenza were that it was an old disease and thus they did not pay it much regard. It was considered to be a normal part of life and they did not feel the disease deserved all the attention it was getting (Liao *et al.,* 2009). Consequently, these kinds of perceptions can hamper sensitization efforts. In another study on malaria in a rural community in Kenya, residents were not quick to seek medical treatment when they suspected they had malaria but attempted home remedies first (Nyamongo, 2002). This was dependent on people's perception of illness severity as well as the length of the illness (Nyamongo, 2002). To ensure success, public health interventions therefore, must include the perspectives of the communities involved in order to get their buy in and this can be achieved through a clear understanding of the socio-cultural context (Liao *et al.,* 2009; Raude and Setbon, 2009).

It is well understood that there is inadequate awareness and knowledge on brucellosis in many parts of Africa (Adesokan *et al.,* 2013; Kansiime *et al.,* 2014; John *et al.,* 2008; Ntirandekura *et al.,* 2020; Onono *et al.,* 2019; Zhang *et al.,* 2019). Pastoralists in Nigeria had poor knowledge regarding the causes and symptoms of brucellosis in both livestock and humans (Adesokan *et al.,* 2013). In Uganda one study found insufficient knowledge regarding the causes, symptoms and risk factors for human brucellosis (Kansiime *et al.,* 2014). For example only 53% of the

respondents in that study had some knowledge on the symptoms, causes, risk factors, treatment and prevention of human brucellosis while only 19% of the respondents could correctly identify the signs of brucellosis in livestock (Kansiime *et al.,* 2014). Nevertheless, over 90% of the respondents in this study were aware that eating undercooked meat, eating game meat and consuming raw milk increased a person's chance of contracting brucellosis and more than 60% were also aware that the livestock could be infected with brucellosis after consuming contaminated pasture (Kansiime *et al.,* 2014). This can be attributed to the fact that human brucellosis is endemic in most parts in Uganda (Kansiime *et al.,* 2014).

Many of these studies conducted on brucellosis are epidemiological or knowledge, attitudes and practices survey and these often recommend that public education is required to sensitize people on brucellosis (Buhari, 2015; Singh *et al.,* 2019; Zhang *et al.*, 2019). Knowledge, Attitudes and Practices (KAP) studies are often used to guide education campaigns and yet they do not provide contextual information (Castro *et al.,* 2013). Understanding the values and norms that undergird certain practices is important if there is to be a significant success in addressing brucellosis in sub-Saharan Africa. For instance, in their study in Baringo (Kenya) regarding a zoonosis (Mutua *et al.,* 2017) found that the communities studied had their own indigenous ways of accessing if the meat from a diseased animal was safe to eat or not through boiling it in herbs for a long time or placing a piece of the meat near certain ants and if the ants avoided the meat then the humans would avoid it too. This kind of information is difficult to obtain in a KAP study but is useful in understanding the perspectives of the communities involved. KAP studies usually perceive cultural factors as the impediments to the implementation of control strategies and this prevents the more critical examination of political, economic and power structures that are at play (Parker and Harper, 2006). In contrast, ethnographic studies through participant observation explore local knowledge and beliefs but within the context of macro level processes eliciting insights that cannot be obtained through questionnaires (Moritz *et al.,* 2013). Ethnographic studies also elicit intracultural variations in knowledge within a population which problematizes the common discourse in KAP studies of uniformity in knowledge and awareness.

Even more importantly, it is evident that enhancing knowledge does not always lead to a change in behaviour. In Uganda, pastoralists in spite of their knowledge on the risk factors for brucellosis, continued to consume raw milk and handle aborted materials without any

protection (Kansiime *et al.,* 2014). Similarly, in Egypt Holt *et al.,* (2011) observed that in spite of the significant degree of knowledge on brucellosis a majority of the people still continued to engage in risky practices such as handling aborted materials without any protection. In Tanzania the Maasai valued the cultural practices of ingesting raw milk and raw meat than they were concerned about risk of infection with zoonoses even though they knew they could potentially get sick (Mangesho *et al.,* 2017). The Maasai in this region considered raw milk to help one to stay fuller for longer and raw blood as helpful for replenishing the blood lost after circumcision or childbirth (Mangesho *et al.,* 2017). In this regard therefore, for the Maasai in this region milk, blood and meat have formed the main part of their diet since time immemorial and so they could not understand how one could get sick as a result of consuming them. In addition, studies on other zoonoses such as Rift Valley fever (RVF) have also demonstrated the significant role played by cultural practices which are more valued than the fear of infection with a zoonotic diseases (Mutua *et al.,* 2017; Ng'ang'a *et al.,* 2016).

Consequently therefore, anthropologists observe that is not enough to simply educate people on diseases, addressing the structural and other systemic barriers is key and likely to lead to the uptake of safer disease control measures at the individual and community level (Bardosh *et al.,* 2017). This has not been without challenges as some have felt that unfortunately the role of anthropological enquiry has been limited to simply explaining perceptions and promoting public health measures (Keck and Lynteris, 2018). This orientation stems from the dominant model in public health where disease is said to be caused by several distinct factors one of which is culture (Campbell, 2020). This model has been criticized by anthropologists because it delineates lay knowledge and awareness as if it was a discrete object aside from the entire human experience (Campbell, 2020; Keck and Lynteris, 2018; Parker and Harper, 2006). They advocate instead for a close examination of cultural factors in a more holistic and integrated perspective that explores not only knowledge and beliefs but also the structural and broader level factors that affect what people do or do not do. The design of sustainable and practical approaches to address zoonoses therefore needs the insights that both natural and social sciences have to offer (Parker and Harper, 2006). Locally acceptable disease control measures are more likely to be adopted especially strategies that make sense to local populations and are realistic in the context of their livelihoods. For instance, it is not rational to expect pastoralists to use gloves to assist in livestock parturition when purchasing them will compromise household income. In their study of the social aspects related to the transmission of cystic

echinococcosis in Morocco, (Bardosh *et al.,* 2016) note that risk perceptions were ambiguous and tied to the low prioritization of this disease which was not considered to have a big impact on their livelihoods. People are therefore often more willing to take preventive actions when the socio-economic impact from their point of view is significant enough to warrant the adoption of different practices.

2.4 Contested notions of risk and risky behaviours

The notion of risk in public health is contested by some because it highlights some as "risky groups" as has been seen in studies on HIV/AIDs which has contributed to stigmatization (Henderson *et al.,* 2017; Porter, 2006). This categorization of certain behavior and people as risky is confusing to people because their lives and practices do make sense in their culture and context. In epidemiology, risk is something quantifiable and objective while for social scientists they tend to consider it as something that is embedded in personal and cultural experience(Farmer, 1996; Kriger, 2021; Trostle and Sommerfeld, 1996). Thus, in contrast to the "individualized notions of risk" pervasive in epidemiology, anthropologists opine that situating risk in the socio cultural and political economic conditions within which people live is more useful (Trostle and Sommerfeld ,1996). The simplistic model of risk as a rational and individual model is criticized for its failure to address the complexities of ethnicity, gender, age, nationality among other factors that determine how risk is known and experienced (Lupton and Tulloch, 2002). Perceptions of risk are based on complex factors and must be contextualized to specific contexts to be adequately understood. What people perceive of the risk from different practices is based on an internal logic that makes sense in the context of their socio ecological environment and has been passed down generations. What people consider to be risky or not is based on their individual experiences and on the culture and nation where they come from. These epistemologies of risk are constructed based on people's cultural, ecological and political backgrounds and there is no one size fits all approach to what is considered risky or not (Lupton and Tulloch, 2002).

Human behavior plays a big role in the transmission of brucellosis to humans and certain behavior have been identified as increasing the risk of contracting brucellosis. These behavior include consumption of raw milk and uncooked meat, cohabitation with livestock and handling aborted materials (Adesokan *et al.,* 2013). (Kansiime *et al.,* 2014). The consumption of raw milk and dairy products especially poses a risk to humans because there are large amounts of

brucella bacteria that are shed in milk. In addition, birth materials too have been found to have large concentrations of the brucella bacteria (Holt *et al.,* 2011). Other studies on other zoonotic diseases have identified consumption practices that increase the likelihood of people contracting a zoonoses such as the consumption of mutton fat to treat Rift Valley fever (RVF) among pastoralists in Kenya and the lack of any protective gear when disposing off aborted animals (Mutua *et al.,* 2017; Ng'ang'a *et al.,* 2016). And yet, most pastoralists do not consider the handling of aborted fetuses to be a significant risk factor for zoonotic disease (Owange *et al.,* 2014). In spite of this greater risk Adesokan *et al.*, (2013), in their study in Nigeria, noted that a majority of the livestock workers had little information on the risk factors for brucella infection in humans. This shows that communities often engage in risky practices as part of their cultural practices. Cohabitation with livestock which is common among many pastoralists and agro pastoralists also increases the likelihood of human infection with brucellosis due to the possibility of increased circulation with infected aerosols (Ali *et al.,* 2017; Adesokan *et al.,* 2013). In addition, this cohabitation is more likely to occur among poorer people who are also more likely to practice other risky practices such as handling aborted fetuses with their bare hands (Kansiime *et al.,* 2014). Pastoralists value livestock and do not consider they or their products dirty and and asking them to use gloves to protect themselves from brucellosis may not make sense to them at all.

Studies have demonstrated the importance of assessing the social and cultural understandings of risk when studying disease (Dzingirai *et al.,* 2017; Marcotty *et al.,* 2009). This is because the risk factors for a disease have social, political, institutional and biological components and factors such as gender, age, wealth status and ethnicity do have a bearing on who is most at risk for which disease (Dzingirai *et al.,* 2017). The role of perceptions and attitudes regarding any disease have also been identified as playing a role in determining whether people take any preventive actions against the disease especially where certain behavior place them at risk (Marcotty *et al.,* 2009). Therefore, understanding these perceptions is helpful so as to design culturally acceptable control measures. While the common approach to address what are considered to be low risk perceptions is community education this alone is not sufficient to produce behavior change because risk is embedded in people's lived experiences and determined by their socio ecological environment (Trostle and Sommerfeld, 1996). One strategy in community advocacy that would be beneficial would be to sensitize communities on why some diseases are asymptomatic for example in the case of Rift valley fever and not

all who consume raw milk will suffer from brucellosis (Allen and Parker, 2011). Unfortunately communication strategies are often very patronizing and not detailed so that local people are left with a lot of misconceptions and no clarity on the diseases in question (Allen and Parker, 2011). Indeed scientists have underscored the need to enhance trust between policy makers and local populations through proper communication and avoiding blaming them for what are sometimes termed by health practitioners as "backward" and "retrogressive" practices (Samuelsen *et al.,* 2013). Community engagement therefore must be comprehensive, continuous and respectful of local knowledge since people are not "empty slates" but have local ways of "knowing" and the use of local people to educate and sensitize their own community members should be encouraged (Bardosh 2018; Kisoka *et al*., 2016) . Proper and impactful community engagement therefore would not just entail "talking" to people but also answering their questions, addressing their misconceptions and assuaging their fears (Allen and Parker, 2011).

Health problems are indeed complicated and there is often no "one size fits all" strategy that works but every strategy must be placed within context and thus the need for a holistic approach looking not only at the agents of transmission but people's behavior and perceptions (Albert and Laberge, 2017; Allen and Parker, 2011; Zvonareva *et al.*, 2019). For example in their study in Cameroon (Moritz *et al.,* 2013) found that the unavailability of government veterinary services led to the livestock keepers experimenting with often substandard livestock medicines for diseases and eventually attributing certain hard to treat infections to the supernatural. Elsewhere, socio cultural values and behavior have been associated with the emergence of infectious diseases globally and calls for a closer understanding of these factors have been raised (Alhaji *et al.*, 2018; Cash-Goldwasser *et al.*, 2018; Dzingirai *et al.*, 2017). Anthropological studies therefore are able to study the broader contextual issues that influence people's behavior in specific contexts (Bardosh, 2018; Samuelsen *et al.*, 2013). These studies thus place a big emphasis on meanings and local realities which is crucial if we are to gain in-depth insights on local patterns of disease transmission (Bardosh, 2018). While quantitative and epidemiological studies identify the "what" of a disease the qualitative studies clarify the "how" and "why" of disease spread such as risk perception and this is crucial in zoonotic disease control (Bardosh *et al*., 2017; Samuelsen *et al*., 2013). Furthermore, those most at risk of zoonotic diseases are often dealing with other life threatening health conditions and may not perceive zoonotic diseases as worthy of all the attention they get (Allen and Parker, 2011;

Kisoka *et al.,* 2016). This "reconceptualization of the social" entails a close examination of the ways in which people interact with animals and the environment on a daily basis and how these interactions influence disease transmission (Brown *et al.,* 2015). Thus, a detailed examination of both the beliefs and the factors underlying those beliefs must be understood such as poverty which limits what people can and cannot do.

2.5 Livestock wildlife interactions as a risk factor for brucellosis

Brucellosis in wildlife is reported to be a spillover from livestock due to the interaction of livestock and wildlife in many areas in Africa (Ducrotoy *et al.,* 2017). In a study conducted in Kenya, eland and oryx were found to be infected with brucellosis (Paling *et al.,* 1988). Indeed a study showed that proximity of livestock and wildlife to each other does lead to the circulation of brucellosis in an area (Enström *et al.,* 2017). In the African context, domestic animals share habitats with wild animals for pasture and watering and this increases the risk of cross species transmission (Enström *et al.,* 2017; Kansiime *et al.,* 2014). This happens especially in the dry season when herders move their livestock into protected areas in search of pasture (Kansiime *et al.,* 2014). Wildlife therefore, can be a source of infection directly to livestock which subsequently lead to human infections or directly to humans especially where wild animals are slaughtered for meat (Alexander *et al.,* 2012). The slaughtering of wild animals such as buffaloes for meat potentially exposes humans to brucellosis since the disease has been shown to be transmitted through abrasions and cuts on the skin (Alexander *et al.,* 2012). This interaction must be considered in the control of brucellosis in Africa through the control of the movement of livestock. Controlling the disease in humans therefore starts with limiting the transmission through wild animals and livestock (Enström *et al.,* 2017). However, this is a challenge to implement because agro pastoralists depend on livestock for livelihood and they might resist this kind of control. A proper understanding of when these interactions occur and who is most at risk is crucial as is sensitization on the potential threats to human health to communities.

Studies have shown that there is increased contact between humans, livestock and wildlife which is increasing the possibility of transmission of disease from animals to humans (Godfroid, 2017; Salerno *et al.,* 2017). In one study, it was observed that the increased contact between wildlife and livestock led to increased cases of human brucellosis (Kansiime *et al.,* 2014). In this study, pastoralists relocated more than 15,000 cattle to the Lake Mburo National

Park in Uganda for pasture and water increasing the contact between wild animals such as buffaloes and impala with livestock (Kansiime *et al.,* 2014). In another study in Uganda, the risk of acquiring a febrile illness was associated with human wildlife interactions (Salerno *et al.,* 2017). In Tanzania, there is continued interaction between wildlife, livestock and humans thus placing people at a greater risk of infection from brucellosis (Assenga *et al.,* 2015). This has also been shown to be true in other African countries (Kansiime *et al.,* 2014; Muma *et al.,* 2007). This occurs as a result of increased contact during grazing as well as overcrowding of livestock in the temporary dwellings that pastoralists put up during the dry season when they move their livestock to national parks and game reserves (Muma *et al.,* 2006). On the other hand, in areas where pastoralism is common, livestock routinely grazed together with buffalo, wildebeests and impala which is a risk factor for livestock being infected with brucellosis especially through pasture and water that has been contaminated (Muma et al., 2007).

Therefore, human behavior influences the transmission and spread of brucellosis from wildlife to humans and livestock. This behavior though must be understood in the context of ecosystem services because as some have shown, when livestock and wildlife are allowed to graze freely in an ecosystem it sustains the productivity and diversity of the wildlife too (Russell *et al.,* 2018). East African pastoralists in particular, have co-existed with livestock and wildlife for centuries and this interaction has been mutually beneficial and has been successful. Increasingly policy makers and scientists are advocating for the development of disease control methods that have a serious consideration of how people interact with their immediate environment especially because this interaction is different based on gender, age and thus people are exposed differently to illness (Dzingirai *et al*., 2017; Leach *et al*., 2017). Therefore questions such as who goes to what spaces and why and what animals are present in those spaces become very important (Dzingirai, Bett, *et al.,* 2017). Interactions in the human-animal-environment interface occur in the context of people's social lives and thus anthropological studies can contribute in the understanding of how, when and why these interactions occur (Ortega *et al.,* 2022). It is this complexity and its attendant challenges that has led some to propose the integration of social sciences into policy advice aimed at addressing zoonoses (Leach and Scoones, 2013). They reject the current narrative that excludes some forms of knowledge and argue that an understanding of the "local cultural logics" is required to develop suitable interventions in any setting (Leach and Scoones, 2013). It is recognized that social scientists can contribute to an understanding of risk perceptions related to human wildlife

interactions by elucidating the beliefs, values and attitudes of the population (Decker *et al.,* 2010). While human wildlife interactions can lead to the transmission of zoonotic pathogens this has to be balanced with conservation and ecological mutualism between local populations and wildlife (Messmer, 2020).

2.6 Pluralistic approaches for the treatment of febrile illnesses

In Sub Saharan Africa, febrile illnesses are some of the major causes of disease (D'Acremont *et al.*, 2014). Febrile illnesses are diseases which are often accompanied by fever. Fever is often a sign of disease but it can also be part of the body's way of fighting an infection (Ogoina, 2011). Other symptoms that accompany the fever are joint pains, tiredness, headache and stomach pain (Chipwaza *et al.*, 2015). Various diseases, all common in Africa cause these symptoms including malaria, brucellosis, dengue fever, chikungunya, Rift valley fever, leptospirosis, typhus, typhoid fever, pneumonia and urinary tract infections (Chipwaza *et al.*, 2014; Hercik *et al.*, 2018). These diseases are caused by different agents including mosquitoes. Risk factors for febrile illness causation also include use of contaminated food and water, consumption of raw animal products and contact with livestock and wildlife. Furthermore, these diseases are difficult to diagnose clinically because of similar presentation and co-infections which are common (Hercik *et al.*, 2018; Mchomvu *et al.*, 2019). Already, studies have demonstrated that a big proportion of febrile patients often don't receive the right diagnosis and treatment in Sub-Saharan Africa (Ahorlu *et al.*, 2007; Animut *et al.*, 2009). In addition, most of the cases of fever inducing illness are diagnosed and treated as malaria in Tanzania in spite of evidence that malaria transmission has declined (D'Acremont *et al.*, 2014; Chipwaza *et al.* 2014).

Brucellosis which presents as a febrile illness is endemic throughout Sub Saharan Africa and is often misdiagnosed as malaria with very few febrile patients getting tested for brucellosis (Ducrotoy *et al.,* 2017b; Pappas *et al.,* 2006). The major clinical signs of brucellosis are undulant fever, extreme fatigue, sweating, headaches, joint pains and weight loss (Bouley *et al.,* 2012; Racloz *et al.,* 2013). These chronic symptoms can lead to various serious complications affecting the muscles, heart, skeleton and even the central nervous system with bone and joint pains being the most common complications (Kansiime *et al.,* 2014; Schelling *et al.,* 2003). This disease in pregnancy can lead to intrauterine transmission to the unborn baby or to an abortion (WHO and FAO, 2006). Some studies have estimated the prevalence of

human brucellosis to be between 3% and 8% in Sub Saharan Africa (Bouley *et al.,* 2012). In one particular study, a prevalence of 3.5% for brucellosis in humans was found in Chad where raw milk is valued and generally consumed (Schelling *et al.,* 2003). In Krygyztan, a higher brucellosis seroprevalence was found in humans and livestock with most humans suspected to have obtained the infections from sheep (Bonfoh *et al.,* 2012). Other studies in various parts of Africa have shown that there is a higher prevalence ranging from 1% to 60% for human brucellosis among pastoralists, agro-pastoralists and livestock handlers (Adesokan *et al.,* 2018; Asiimwe *et al.,* 2015; Nabukenya *et al*., 2013). On the other hand, brucellosis in humans also leads to the loss of productivity because of the time lost from work related activities as a result of illness (Seleem *et al.*, 2010). There is no vaccine available for human brucellosis and so the disease is controlled by minimizing transmission from animals through milk pasteurization and safer animal handling behavior (Ducrotoy *et al.,* 2017).

Fever causing illnesses are common in Tanzania firstly because malaria is endemic in the country (Chipwaza *et al.,* 2014). Secondly, unsanitary practices in the consumption of raw milk and meat and animal handling also increase the likelihood of contracting fever causing diseases. Agro pastoralists in particular are at increased risk of contracting zoonotic diseases that manifest as febrile illnesses due to their consumption of raw animal products and unhygienic animal handling behavior (Tumwine *et al.,* 2015). The unavailability of diagnostic equipment and clinical attention on only a few febrile illnesses leads to people suffering through misdiagnosis often limited to malaria (Chipwaza *et al.,* 2014). Other studies in Tanzania have demonstrated that malaria is the most commonly suspected illness when people present with febrile symptoms and other diseases are rarely investigated (D'Acremont *et al.,* 2014; Hercik *et al.,* 2018) . In South central Tanzania where this study was conducted, malaria is endemic but there is evidence that though under diagnosed other febrile illnesses including leptospirosis, dengue fever and brucellosis do exist (Chipwaza *et al.,* 2015).

It has been identified that socio-cultural factors do play a key role in determining what sick people make of their symptoms, what those symptoms mean and, consequently, the course of action that they take (Mackian, 2004; Mshana *et al.,* 2008.; Rubel and Garro, 1992). For example, for certain illnesses people often choose to go to untrained traditional healers and more so if those diseases are chronic (Mackian, 2004). On the other hand, consideration should not only be made for the social and cultural context but also an understanding of the health care

challenges that people face daily (Launiala, 2009). Consequently, the treatment pathways that are utilized by people are often determined by several factors including socio-cultural, political economic and physical as well as the organization of the health care system which includes accessibility, cost and distance (Shaikh and Hatcher, 2005). In their study on Malaria in pregnant women in Malawi, (Launiala, 2009) found that they needed to study malaria within a context in which people were actually more concerned about other issues related to pregnancy such as miscarriages, maternal deaths, witchcraft and sexually transmitted diseases (STDs), and not malaria. This helps to provide a better context and understanding of why people choose certain courses of action for their health challenges. One study showed that there often is a big delay in seeking medical attention in Tanzania when people suspect they are suffering from brucellosis (Bouley *et al.,* 2012). In addition, in sub-Saharan Africa there are a number of febrile illnesses which have similar symptoms to brucellosis such as malaria, typhoid, tuberculosis (Kunda *et al.,* 2007). This makes it hard for the patients to identify what they are suffering from and to enable them to seek prompt treatment. Therefore, the lay notions of illness and how that informs the various strategies sought needs to be well understood.

Only a few studies in Tanzania have focused on behavioral and ecological factors as determinants of treatment seeking behavior with most elucidating financial aspects and accessibility to health facilities as the key issues. The complexity of health care access and health seeking behavior has already been underscored and criticism made for the reductionistic approach of many analysis which tends to separate personal choices from larger political economic and structural issues (Kamat, 2006). In their study in Northern Tanzania, those who kept livestock for livelihood and lived in remote areas were found to be the ones who delayed the most in going to health facilities when ill, in some cases for up to three months from the onset of the symptoms (Kunda *et al.,* 2007). In that study, the researchers concluded that the probable reason for this delay was because the initial symptoms were not considered to be a big deal (Kunda *et al.,* 2007). In spite of this delay though, the majority (88%) of the ill in this study sought help from a health facility (Kunda *et al.,* 2007). On the other hand, in their study in the Morogoro region of Tanzania, Chipwaza *et al.,* (2014) observed that majority of the participants were not aware of other febrile illnesses other than malaria. Participants in this study also reported that they used a pluralistic system of health care in case of a fever, ranging from traditional healers to health facilities and self-medication with over the counter drugs (Chipwaza *et al.,* 2014). Additionally, due to the inadequate diagnostic facilities in most of the

hospitals in sub-Saharan Africa brucellosis cases are often correctly treated once the patients fail to respond to malaria or typhoid treatment (Kunda *et al.*, 2007).

There are limited studies which have explored health seeking behavior regarding febrile illnesses in Tanzania and most are health facility based (Kunda *et al.*, 2007). However, the limitations of such studies is that they tend to cater to only those who visit the health facilities and leave out those who seek care through medicines bought from shops or from local healers (Burton *et al.*, 2011). Similar community based studies such as this one have been helpful in the conceptualization of health seeking behavior concerning febrile illness in different localities (Amuyunzu-Nyamongo and Nyamongo 2006b; Kamat, 2008; Nyamongo, 2002) . Qualitative studies in particular are able to capture comprehensive information governing treatment seeking actions. The decision making process when one is ill with a fever causing disease is therefore a carefully guided process influenced by societal values, financial ability, the kind of care available in health facilities and structural factors (Adhikari *et al.*, 2019; Adinan *et al.*, 2017; Kamat, 2006). Consequently, people often determine the kind of care to seek based on many aspects including awareness, available finances, beliefs on disease causation, disease progression and other practical considerations (Mutua *et al.,* 2016; Ng'ang'a *et al.,* 2016). In many parts of Africa, shops and indigenous treatments are preferred due to their affordability and ease of access (Amuyunzu-Nyamongo and Nyamongo 2006; Muela *et al.,* 1998). In Kilombero district, in the case of fevers in children they were promptly taken to a medical facility or they used over the counter medication (Dillip *et al.,* 2009).

In order to understand peoples everyday experiences related to their health seeking behavior, it is important to acknowledge and recognize the complexities of their actions and behavior (Senior and Chenhall, 2013). Central to this is an understanding of individual health seeking behavior in the context of the broader cultural, social and physical contexts to both understand what enables and constrains an individual and determines the treatment pathways they choose to take (Mackian, 2004). Medical anthropology situates health beliefs into the broader context and provides nuanced information on the reasons behind the courses of action that are taken when people fall ill (Shabani, 2015). Notably, when we understand treatment pathways in this manner then we are able to develop health messages that are accessible, acceptable, effective and cost effective (Mackian, 2004; Oberländer and Elverdan, 2000; Shaikh and Hatcher, 2005).

Improved access and affordability of health services is also critical in enhancing the utilization of health services.

2.7 Theoretical framework

2.7.1 Socio ecological model

The socio-ecological model is part of other ecological models in the social sciences and public health which focus on the interaction of people with their physical, social and cultural environments (Glanz *et al.,* 2008). Social and ecological factors are all too often neglected in research on disease prevention (Konan *et al.*, 2019). This model was proposed in the 1970s by Urie Brofenbrenner who argued that human behavior is affected by several layers of influence (Bronfenbrenner, 1977; McLeroy *et al.*,1988). This model has five basic tenets (Glanz *et al.,* 2008; Stokols *et al.,* 2013) which are:

i. Health behavior is influenced at multiple levels by the physical environment, beliefs about disease causation, social environments as well as by personal attributes.
ii. The environmental contexts are significant determinants of health behavior.
iii. There exists an interaction across the different levels to influence behavior.
iv. Socio-ecological models ought to be behavior specific.
v. In order to improve health, there should be multi-level interventions since these interventions are the most effective in changing behavior at the individual level.

The earliest proponents of this model argued that there is environmental influence on human behavior at various levels which include the micro level comprising family and work groups. The next is the meso level which comprises of school, church and peer groups followed by the exo group which is the larger social system, while the last level is the macro level which consists of the cultural beliefs (Bronfenbrenner, 1977). In later years these levels were modified to: intrapersonal (individual) factors which include knowledge, attitudes, behavior and skills; interpersonal factors such as formal and informal social networks including family, friendships and work groups; institutional factors such as rules, regulations and social institutions; community factors which are the relationships among organizations, institutions and formal networks; and public policy which consists of the local, state and national laws and policies (McLeroy *et al.,* 1988; Townsend and Foster, 2013; Yeom *et al.,* 2008).

The socio ecological model is useful therefore in understanding human behavior by focusing on several layers of influence and can aid in the development of sustainable and locally relevant solutions (Mehtälä *et al.*, 2014). In research this model was initiated to explain human behavior but was later adjusted as a model to guide interventions (Glanz *et al.,* 2008). In health interventions, this model postulates that for there to be behavioral changes relevant in any intervention a combination of individual level, environmental level and policy level interventions need to be made (Mehtälä *et al.*, 2014; McLeroy *et al.,* 1988). In this regard therefore, individuals are motivated to make healthy choices because the environment and the policies support them to do so (McLeroy *et al.,* 1988). This is because healthy behavior is not only influenced by personal attributes but by the physical and social environments as well (Stokols *et al.,* 2013). This model has been used to study tobacco control, physical activity in children, mobility in old age, risk behavior related to Sexually Transmitted Infections and HIV/AIDS, condom use and in health promotion (Larios *et al.,* 2009; Mehtälä *et al.,* 2014; Yeom *et al.,* 2008). It has also been used in the study of neglected tropical diseases (Konan *et al.*, 2019). The main strength of this model is that it focuses on the multiple levels of influence on human behavior which in turn broadens the options for interventions. This is in contrast to, for instance, programs which address only the individuals who choose to participate in a program (McLeroy *et al.,* 1988). In this regard, when specific behavior is situated in the larger context of the multiple determinants of the behavior, a greater understanding is gained and better interventions could be developed. However, the limitations of this model are the lack of specificity as to the most important influence in the various levels as well as the lack of specific information about how the variables interact across the levels (McLeroy *et al.,* 1988).

2.7.2 Relevance of the theory to this study

This study was investigating the cultural drivers for brucellosis in livestock and humans as well as the treatment pathways for febrile illnesses. In particular this study addresses the awareness and knowledge related to brucellosis and the risk behavior that predisposes the agro pastoralists to brucellosis. It also seeks to understand their treatment seeking behavior during episodes of febrile illnesses. The main aspects of this model: Individual, cultural, environmental and policy/structural factors are used in this study. People's knowledge and awareness about disease can influence their willingness and ability to participate in disease control programs. It is well understood that the risk factors for brucellosis are related to individual behavior such as consumption practices and cohabitation with livestock (Kansiime *et al.,* 2014). However,

this behavior occurs in the context of cultural norms and values including animal husbandry practices and environmental considerations such as the close interaction with wildlife (Marcotty *et al.,* 2009). Thus, in the case of brucellosis, the risk factors are not only behavioral at the individual level but also cultural and environmental.

In this case therefore, some of the individual factors include knowledge and awareness of brucellosis, consumption practices and animal handling practices. Cultural factors include the norms, values and attitudes related to what is fit or not fit for consumption, how sick animals are handled and assisting in animal parturition as well as gender and occupational roles. Environmental factors relevant to this study are the close proximity to wildlife and livestock movement from one area to another. Lastly there are structural factors of important consideration such as land use management, policies on livestock movement and livestock-wildlife interactions. In terms of the treatment pathways for febrile illnesses, individual, cultural, environmental and policy factors all play a role in determining the kinds of care sought, by whom, where and when. Individual factors include age, financial income and personal history with febrile illnesses. The socio-cultural factors are lay perceptions on febrile illnesses, beliefs on disease etiology and attitudes on formal and informal treatment while the main environmental factors were the seasonality of livelihood activities and weather. Lastly, accessibility to health services was the main policy factor of influence.

In order to control and eliminate brucellosis in sub-Saharan Africa, there must be concerted efforts to address all the factors that influence and determine individual behavior. To promote suitable health seeking practices inclusivity of all the factors of influence is needed to ensure acceptability and accessibility of proper health care services. This model therefore is key in providing an enhanced awareness of the setting in which brucellosis occurs and treatment for febrile illnesses is sought by analyzing the multiple spheres of influence (Senior and Chenhall, 2013). This multi-level analysis is also beneficial as it helps to develop context specific control strategies that are likely to be accepted and adopted by the communities.

2.7.3 Conceptual framework

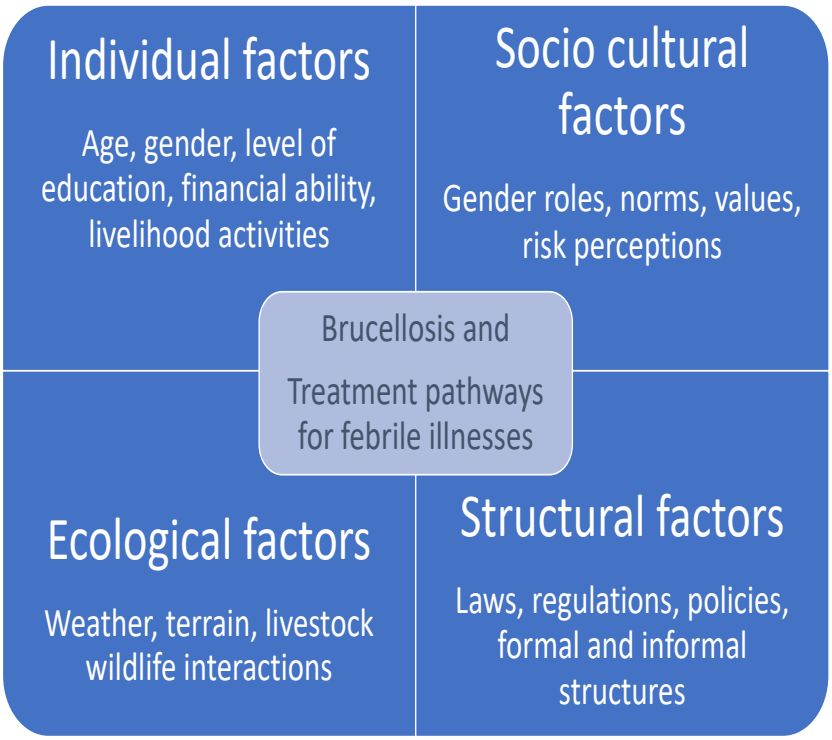


Figure 2.1: Socio ecological model as adapted from (M. A. Mehtälä *et al.*, 2014) demonstrating that different factors impact on brucellosis and treatment seeking behavior for febrile illnesses.

Chapter 3: Methodology

3.1 Introduction

This section consists of two parts, a description of the research site as well as the research methodology. The description of the site includes the population, geography, livelihood activities and the health system of Kilombero District of Tanzania. In addition, the research methods section covers the research design, the study population, sample population, the sampling procedures, data collection methods, data analysis and the ethical considerations.

3.2 Research site

3.2.1 Administrative boundaries and population

This study was conducted in Kilombero District of Tanzania as shown in Map 1. This district is situated in the Morogoro region in the South Eastern part of Tanzania between the Kilombero river and the Udzungwa mountains. It is located in a vast flood plain. It is situated at latitude 08^0 00'-16^0 south and 36^0 04'-36^0 41' east. This district borders Kilosa and Morogoro rural districts to the north, Lindi region to the east, Ulanga district to the south east and Iringa region to the south west. The district is divided into five divisions, 26 wards, 99 villages and 390 sub villages. This study was conducted in three villages; Sagamaganga and Signal both in Signal ward and Lungongole in Kibaoni ward. This district has a population of about 407, 880 people with males being 202,789 and females 205,091 (National Bureau of Statistics, Tanzania, 2012. The major ethnic groups in this district are the Wapogoro, Wandamba, Wabena and Wangoni while the minor ones are the Wahehe, Wasukuma and Wamaasai (Hetzel, 2008). Notably, the Wasukuma and Wamaasai have in the recent years relocated to this district in search of pasture for their livestock (Nindi *et al.,* 2014).

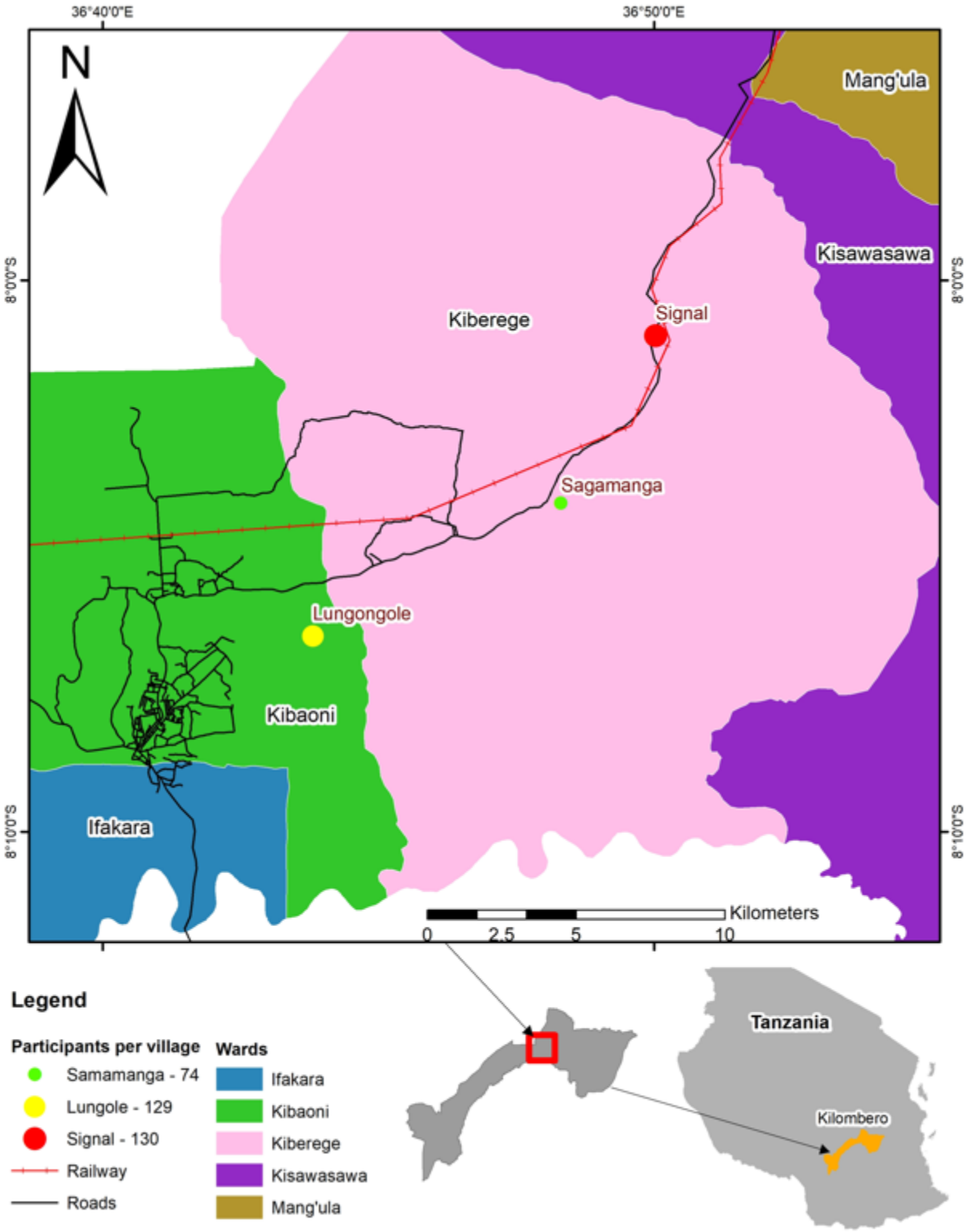


Figure 3.1: Map of study area

3.2.2 Climate and Topography

The district is one of the largest wetlands in East Africa and is bordered by the Udzungwa mountains to the north and Mahenge highlands to the south and Selous Game Reserve to the

east (Dinesen, 2016; Le Mare *et al.,* 2014). The Kilombero valley is the largest fresh water wetland in East Africa covering an area of over 6,000km^2 (Bamford *et al.,* 2014). There are forests in the mountains and woodlands and swampy grasslands in the lowlands (Kangalawe and Liwenga, 2005). The Kilombero floodplain covers a huge area approximately 260km long and in its widest place is 52 km wide and is fed by many rivers including Kilombero river (Dinesen, 2016; Kangalawe and Liwenga, 2005). The elevation of the district ranges from 262 – 550 meters above sea level (Hetzel, 2008). The mean annual temperatures vary with altitude from the valley bottom to the mountain top. The average annual temperature varies between 18C on the mountains to 32C in river valleys. In most parts of the district, the average temperatures are almost uniform at 26C (Kinimi *et al.,* 2018). The district receives an annual average rainfall of 1200 to 1800 mm (Hetzel, 2008). The rainy season is between November and April with flooding at its peak between Feb and April (Dinesen, 2016).

Pictures 3.1: Left: Flooded road

Picture 3.2 Farmland

3.2.3 Livelihood activities

Agriculture is the main livelihood activity in the region with large scale teak, sugar cane and rice plantations as well as subsistence farming of rice, cassava, millet and maize (Dinesen, 2016). In addition to agriculture, fishing is also a major economic activity (Nindi *et al.*, 2014). Numerous agricultural, pastoral and agro-pastoral tribes live in Morogoro due to the fertile land, water and climatic conditions which favor these activities. The population of this area has grown significantly in the past two decades due to the influx into the fertile land (Kangalawe and Liwenga, 2005). Agro-pastoralist tribes have settled on the outskirts of villages (Bamford

et al., 2014) and practice both farming and raising relatively large herds of livestock. They have settled in the fringes of the villages because these areas are relatively closer to both the farms and the communal grazing lands. These are the areas which are especially prone to flooding during the rainy season (Kangalawe and Liwenga, 2005). Agro pastoralists of the Wasukuma ethnic group have been noted as having immigrated to Kilombero district in huge numbers (Bamford *et al.,* 2014). Notably, since the wetland is suitable for both agriculture and livestock keeping there are conflicts between farmers and pastoralists related to the exploitation of the available resources (Kangalawe and Liwenga, 2005).

Picture 3.3: Agro pastoralist homestead

Picture 3.4: Top right; Rice paddy

Picture 3.5 Cattle market

Picture 3.6 Herders in the communal grazing area

3.2.4 Health Systems

Kilombero district has two major hospitals, 3 health centers and 35 dispensaries. The main health issues afflicting the people include malaria, pneumonia, diarrhea, cholera, brucellosis and Rift valley fever (Schellenberg *et al.,* 2003). While previously in the mid-nineties severe febrile illness cases were treated through traditional healers, one study found that ten years later most patients sought prompt medical attention in cases of both acute and severe febrile illness (Dillip *et al.,* 2009). This was attributed to intensive public campaigns in the area.

3.3 Research design

This study used a descriptive cross-sectional design which involved the collection of both quantitative and qualitative data in the three villages (Sagamaganga, Signal and Lungongole) of Kilombero district. The quantitative data were collected through structured interviews to access the awareness, knowledge and behavior related to brucellosis and treatment of febrile illnesses. The qualitative data were collected through in-depth interviews, focus group discussions, key informant interviews and observations. This study was conducted over a period of six months. The initial phase of this study entailed unstructured observations and informal interviews and interactions. This enabled the researcher to be familiar with the community and to build a rapport with the local people. This was followed by the structured interviews with both men and women as well as key informant interviews to identify broad issues and perspectives on the study objectives. Thereafter, focus group discussions and in-

depth interviews were conducted to gain deeper insights and clarify emerging issues related to this study. Observations were conducted throughout the study.

3.4 Study Population and Unit of Analysis

The study population consisted of residents who were agro pastoralists in Kilombero district. Specifically, the agro pastoralists who resided in the three study villages. Secondly, clinicians, veterinary officers, wildlife officials, community elders and traditional healers working in this area were also included in this study as key informants. The respondents were all aged 18 years and above. The unit of analysis was the individual agro pastoralist residing in any of the three villages.

3.5 Sample Population

The sample population was the men and women who were agro pastoralists and lived in any of the three villages. Included too were the animal health, public health, wildlife officers and community leaders who served the local people.

3.6 Sampling procedure and Sample Size

Kilombero district which was the site of this study was chosen purposively since a brucellosis prevalence study had recently been conducted in the area and this study was to complement the findings of that study (Kilonzo *et al.,* in preparation). A similar study conducted in Kilombero district found that livestock and especially cattle were infected with brucellosis with a prevalence of 14.3%, 0.5%, 0.6% and 13.6% for cattle, goats, sheep and buffalo respectively (Temba, 2012. p. 130). Another study found a prevalence for brucellosis of 14.6% in humans in the district (James, 2013 p. 25).Additionally there are agro pastoralists in the area who are isolated and live in the fringes of the village and it is known that livestock keepers are at an increased risk of contracting brucellosis due to their consumption and animal handling practices (Bamford *et al.,* 2014; McDermott and Arimi, 2002). This district also borders both the Selous game reserve and Mikumi national park and the community lifestyle allows for a close interaction between humans, livestock and wildlife which is a potential pathway for the transmission of brucellosis across species (Bardosh , 2014). The three villages themselves also bordered a wildlife management area called ILUMA and there were wild animals such as buffaloes, antelopes and elephants. The communal grazing area shared a border with the

wildlife management area and wildlife and livestock grazed freely together in the locality which is a risk factor for cross species brucellosis transmission.

For the structured interviews, all the 176 agro-pastoralist households in the three villages were visited and an adult male and an adult female interviewed in most of the consenting households. The aim of targeting all the livestock keepers' households was because they were not many since most were recent immigrants to the district. A total of 333 individuals were interviewed out of 352 possible interviewees. For the qualitative aspect of the research, participants were selected purposively. Seven focus group discussions with 74 participants were conducted while 39 in depth interviews were conducted. Participants for focus group discussions and in-depth interviews were selected out of the respondents of the structured interviews. These were follow up interviews to gain in-depth insights on the study objectives and to clarify the emerging issues from the structured interviews. The recruitment for qualitative interviews was done by the researcher assisted by the village leaders. By this time the researcher had already gained rapport with community members having lived in the locality for five months at the time. The inclusion criteria were being a livestock keeper, having lived in the area for at least five years and being knowledgeable on livestock keeping and treatment seeking behavior. Most of the participants belonged to the Wasukuma tribe since they were the major agro-pastoralist community in the area, with only a few participants from other communities. Interviews were held in a convenient location for participants such as in the participants homes, under a tree or in a primary school. The key informants included clinicians, veterinary officers, wildlife officials, forest officials, community elders and traditional healers in this area. The informants were selected on the basis of their knowledge on brucellosis in humans and animals, livestock and consumption practices, livestock/wildlife interaction and health seeking behavior for febrile illnesses.

3.7 Data Collection Methods

This study collected primary and secondary data. Primary data were collected through structured interviews, in depth interviews, focus group discussions and key informant interviews as shown in Table 3.1. In addition, secondary data from books and journal articles related to cultural drivers of brucellosis, environmental factors in the livestock/wildlife interface, and health seeking behavior related to febrile illnesses were included to provide

information on what had been done and the gaps that existed. This study was conducted between March and August 2019.

Table 3.1 Summary of the data collection methods and study respondents and participants

Data collection methods	Respondents
Structured Interviews N=333	333 livestock keepers both male and female (175 male and 158 female)
Focus group discussions N=7	FGDs conducted with 7-12 individuals per group (Male and Female groups were conducted separately) 2 groups in each village, one with males and one with females 1 group conducted with herders from one of the villages
In depth interviews N=39	39 with agro pastoralists (28 male and 11 female)
Key informant interviews N=18	Clinicians 6 (5 male and 1 female) Public health officer 1 (Male) Animal health officers 4 (2 Male and 2 female) Wildlife officer 1 (Male) Forest officers 2 (1 Male, 1 female) Livestock trader 1 (Male) Local elders 3 (2 Males. 1 female)

3.7.1 Primary Data Collection

Structured Interviews

Structured interviews were used to obtain information on the awareness and knowledge of the agro pastoralists on brucellosis as well as their attitudes on risk factors, perceptions on signs of brucellosis in livestock and treatment pathways on febrile illnesses (Appendix 9.3). A total of 333 individuals were interviewed and this included both men and women. This was a closed ended interview using a structured interview guide. It was divided into five sections. These were the demographic characteristics, awareness and knowledge on brucellosis and its symptoms in livestock and humans, attitudes and behavior related to brucellosis risk factors, the signs of brucellosis witnessed in livestock and the treatment seeking behavior during a suspected febrile illness. The interview guide was pretested with 20 local people in a neighboring village (Kikwawila) where residents shared similar characteristics with the study participants. Information obtained from the pretest site was not included in the main study. The

data were all collected in Kiswahili and in some cases the local languages (Kisukuma and Kimaasai) and later transcribed to English. The data were collected by research assistants from the area who could speak both Kiswahili and the local languages.

In depth interviews

A total of 39 in depth interviews were conducted with both men and women and these were follow up interviews with some of the participants from the survey. These interviews were conducted after the structured interviews over the course of two months and were stopped when saturation was achieved. The respondents were purposively selected and requested to participate in the study. Those who accepted to participate were guided through formal consent in either Kiswahili or the local language to ensure that informed consent was given. These were interviews to gain deeper insights on beliefs, practices and perceptions related to brucellosis regarding the symptoms, beliefs on causation and the perceived risk factors. In addition, they were also used to understand people's perceptions on the relationship between their animal husbandry practices and human brucellosis as well as their perceptions regarding the human-livestock-wildlife interface and its connection to zoonotic diseases in general and brucellosis in particular. Lastly, the treatment pathways were accessed especially the steps that local people took once they suspected they had a febrile illness. An in-depth interview guide (Appendix 9.6) was used to obtain this information. Each interview was conducted individually for 45 minutes to one hour, notes were taken and recording was done. This data was collected in Kiswahili or a local language and later transcribed and translated to English.

Key informant interviews

Eighteen key informants were interviewed and these were all people knowledgeable on the social cultural issues related to brucellosis and the treatment seeking behavior of people within the study area. These were face to face interviews with the purpose of getting detailed information on the brucellosis awareness and knowledge, local practices, perceptions and attitudes related to this disease and the treatment seeking behavior of the community during a febrile illness episode. These were conducted with local public health and animal health professionals, forest officers, livestock trader, wildlife experts, as well as both male and female local elders. Each of these individuals had the study explained to them and they were requested to participate. Formal consent was sought in Kiswahili or English before the questions were asked. Only those who consented to participate in this study were interviewed. A key informant

interview guide (Appendix 9.7) was used and the interviews were recorded where consent was given and notes also taken.

Focus Group Discussions

A total of 7 focus group discussions (FGDs) were conducted, 2 in each of the three study villages and 1 with herders from one of the villages. Adult males and females were interviewed separately to obtain data from both genders without undue interference or dominance from either gender. All the FGDs were conducted near the end of the study and all the participants had participated in the structured interviews. These allowed for consensus building on the knowledge, awareness on symptoms, perceptions on symptoms of brucellosis in livestock, consumption of animal sourced foods and handling animal products as well as the treatment behavior during a febrile illness. One FGD was conducted with herdsmen because they were even more isolated living for most of the year in the communal grazing grounds away from the village and it was important to gain their unique perspectives on livestock handling, consumption of raw milk and treatment seeking behavior. A focus group discussion guide was used to direct the discussion (Appendix 9.5). A community resource person in conjunction with the researcher facilitated the recruitment of the discussants. The discussants were selected purposively and were adults (over 18 years of age). FGDs were used because they provided a natural setting and therefore these issues could be discussed openly. A moderator guided the discussion with the help of a translator. Handwritten notes were taken in the course of the discussion. Additionally, tape recording was used to record the discussion. Each session lasted for about one to one and a half hours. These discussions took place in a quiet place within the community such as a school or under a tree and a small transport compensation was given to the study participants.

Observations

This method was used to identify the practices in the community related to animal handling, consumption of animal sourced foods like milk and meat and their treatment seeking behavior. An observation guide was used to collect this data (Appendix 9.8). The researcher conducted these observations in an ongoing manner because of living in close proximity to the village and would go to the village about five days a week and spend at least one night a week in the village and sometimes for several days at a time. This enabled the researcher to observe the behavior of the participants in their natural environment as they went along with their daily activities in an uninterrupted way as much as possible. These activities included milking, herding, assisting

livestock during calving, handling manure, animal slaughter, cooking, boiling of milk, consumption of milk and meat as well as activities in the local markets. These observations were made in the households, local markets, grazing lands and other surrounding areas. This was important as it provided the proper context and location within which certain activities happened, how and why they happened (Ameri *et al.,* 2009). As an observer the researcher not only observed the actions but also listened, questioning as well as recording the social setting, location and context within which those activities occurred. In this regard therefore, observations of people, their actions, interactions, body language, places and social settings were made. This provided a better understanding of the norms and values in those communities that enriched this study.

Secondary sources

Background information to the study was gathered from documents including journal articles, books and thesis from researchers who have been involved in brucellosis and zoonotic diseases research. This included relevant literature on the knowledge and practices of communities in regard to brucellosis, perceived risk factors for brucellosis as well as the treatment seeking practices for febrile illnesses. This allowed the researcher to understand what had already been done on this topic and what kinds of questions needed answering and clarifications related to lay beliefs and behavior.

3.8 Data processing and Analysis

The quantitative data was entered and cleaned in Ms excel and analyzed using the R software version 1.2.5019. Descriptive statistics were done as well as a general linear model to estimate the association between the level of knowledge and involvement in risky practices with socio demographic variables of sex, age, level of education, tribe and religious affiliation. All the qualitative data were transcribed into Swahili by one of the research assistants and then these were translated into English and organized and prepared for analysis. The field notes were also analyzed and the names of the informants were all replaced with pseudonyms on all the transcripts to ensure the anonymity of the study participants. Data entry was conducted in QSR NVIVO version 12.5.0 (NVivo qualitative data analysis software; QSR International Pty Ltd. Version 12, 2018). Through this software the data was ordered, organized and then analyzed. This process allowed for the identification of relevant themes according to the study objectives in an iterative process as elucidated in literature (Srivastava and Hopwood, 2009) and the

themes were modified and the relationships between them identified. Verbatim quotes have been used to support the thematic presentations identified.

3.9 Ethical Considerations

The ethical clearance for this study was issued by the National Institute of Medical Research (NIMR) in Tanzania via Ref No. NIMR/HQ/R.8a/Vol.1X/3102 (Appendix 9.9). The research permit was obtained from the National Council of Science and Technology in the Ministry of Higher Education, Science and Technology in Tanzania (Appendix 9.9). Approval to conduct this study was also given by the Kilombero District Council as well as the Village Executives in each of the three villages. The participants in this study were all above 18 years of age. A consent form (Appendix 9.1) was used to give information about the study and request for participation. All the participants in this study gave either a written consent or thumbprint for the interview to be conducted after the purpose of the study was explained to them including any benefits or risks involved through their participation in this study. The participants were also given an opportunity to ask any questions related to the study before any interview commenced. All the participants received information on brucellosis and how to prevent it in livestock and humans. Furthermore, no participant was coerced to participate and all the respondents were informed that they did have the right to opt out of the study at any point during the interview. Permission to record the interviews and to take photographs was sought before the interview began and all the interviews were conducted at a convenient time and place for the interviewee which was usually in their homes or at a public place like a public school or a quiet place within the shopping center. Additionally, to ensure anonymity and confidentiality of the participants, pseudonyms were used in the data collection tools and in the final report.

Chapter 4: Lay awareness, knowledge and perceptions on brucellosis

4.1 Introduction

This chapter discusses the results of objective 1 on the awareness, knowledge and perceptions of the agro pastoralists on brucellosis in livestock and humans. The demographic characteristics of the study respondents and participants are described as well as the socio cultural, historical and environmental context of the agro pastoralists. Findings on the awareness, knowledge and perceptions on brucellosis in livestock and in humans are also explained.

4.2 Demographic Characteristics of the Study respondents and participants

This study collected data through structured interviews (333), focus group discussions (7), in depth interviews (39) and key informant interviews (18) over a period of six months. This is shown in Table 4.1:

4.2.1 Sex

In this study, out of the 333 participants who participated in the structured interviews slightly over half 175 (53%) were male while 158 (47%) were female. On the other hand, 45 (61%) of the focus groups discussants were male and 29 (39%) were female. Only 6 (33%) of the key informants were female with the rest 12 (67%) being male. Majority 28 (72%) of the 39 individuals who participated in the in-depth interviews were male while women were 11 (28%).

4.2.2 Age and Marital Status

Majority of the structured interviews respondents were between 34-41 years (30%) while the minority were in the 18-25 years (7%) age bracket. Additionally, focus group discussants and in-depth interview participants were aged between 18-71 years. Key informant participants were adults aged between 25-50 years of age. Most (94%) of the respondents in the study were married.

4.2.3 Education and Religion

In this study over half of the respondents in the structured interviews had no formal education (197, 59%) while 129, 39% had primary level of education. Most of the respondents in the study (187, 56%) adhered to local religious beliefs with (105, 32%) and (41, 12%) being

Christians and Muslims respectively. Among those who participated in depth interviews, 23 followed local religious beliefs, 13 were Christians and 3 were Muslims.

4.2.4 Livelihood and ethnicity

Almost all the respondents in this study were agro pastoralists keeping livestock and also engaging in farming activities (332/333). The predominant ethnic group in this study were the Wasukuma (253, 76%) and (80, 24%) belonged to other ethnic groups primarily Wamaasai, Wanyamwezi, Wapogoro, Wamang'ati and Wanyakyusa.

Table 4.1 Summary of the socio demographic characteristics

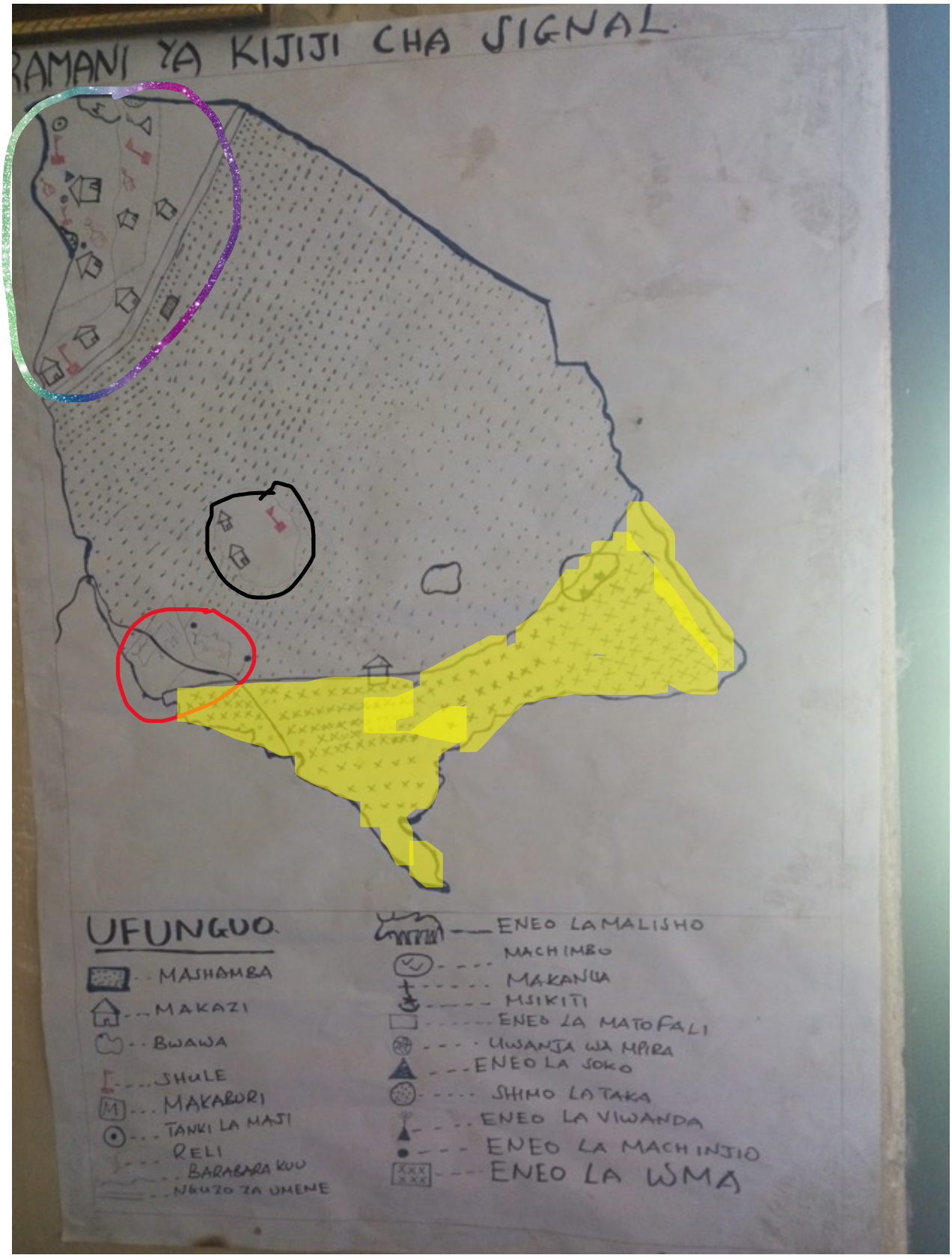
			Study respondents and participants			
	Demographic Characteristics		**Structured Interview respondents**	**Focus group discussion participants**	**In depth interview participants**	**Key informant interviews**
1.	**Sex**	Male	53%	61%	72%	67%
		Female	47%	39%	28%	33%
2.	**Age**	Range	18-65 years	18-71 years	18-71 years	-
3.	**Education**	None	59%	-	51%	12%
		Primary	39%	-	31%	-
		Secondary	2%	-	13%	-
		Tertiary	-	-	5%	88%
4.	**Religion**	Local religion	56%	-	59%	-
		Christian	32%	-	33%	-
		Muslim	12%	-	8%	-
5.	**Ethnicity**	Wasukuma	76%	-	92%	-
		Others	24%	-	8%	-

4.3 The social cultural, historical and environmental context of the agro pastoralists

This study uses the socio ecological model to situate the context within which brucellosis is understood and experienced by the agro pastoralists in the study area. This section addresses issues relevant to this study based on this model in order to lay a proper foundation for the

findings. The issues discussed relate to culture, history, livelihood activities and the physical environment in which the agro pastoralists live. Kilombero valley is mainly an agricultural zone where rice, sugarcane, maize and Teak trees are grown due to the fertile soils (Kangalawe and Liwenga, 2005) The original inhabitants of this district were the Wandamba and Wapogoro who are mainly small scale farmers and fishermen. The agro pastoralists began relocating to this district in the late 80s in search of pasture and water for their livestock from parts of Northern and South Western Tanzania most of whom were from the Wasukuma, Maasai and Wamang'ati tribes (Le Mare *et al.,* 2014). These livestock keeping communities traditionally keep large herds of cattle. The Wasukuma keep both large herds of livestock and also grow crops while the Maasai and Wamang'ati keep livestock and grow food on a much smaller scale. Due to the nature of their livelihoods, the agro pastoralists settled in the fringes of the village settlements where they cleared huge tracts of land for farming and for pasture. This allowed them to keep their livestock away from local farms and to access the communal grazing areas which were located further away closer to the wildlife conservation areas as shown in picture 4.1 below:

.



Picture 4.1: Village (Signal) map showing the land use plan. The area with a *red circle* is the communal grazing area approximately 8km from the homes *(circled in purple)* and it

bordered the Wildlife Management Area (WMA) *(shaded yellow)* where there were wildlife including buffalos, elephants, hippopotamus and warthogs. Herders lived in makeshift camps looking after livestock in the area *circled in black.*

Herders usually aged 12-30 years old (Picture 4.2) took the cattle to the communal grazing areas for up to nine months each year and only moved the animals back to the homesteads during the rainy season of March-May when the area was heavily flooded. While in the communal grazing areas the herders lived in makeshift camps in close proximity to cattle both for personal protection from wild animals and to protect their livestock (Picture 4.3).

Picture 4.2 Make shift shelter for herders

Picture 4.3 Teenage herder

The goats, sheep, calves and a few lactating cows were looked after closer to the homes by young boys (ages 4-11) who left home and got back each day (Picture 4.4). The other family members were mainly involved in farming activities, helped to look after the small ruminants and milked the cows. The Wasukuma who were the main study participants farmed huge tracts of land and lived together as a family in big households sometimes of up to 40 people. Therefore, during the farming season one woman remained home to look after the little children (3 months to five years old) who could be up to 12 in a household as well as cook for the

household (Picture 4.5). The woman was often assisted by girls aged 8-10 years old (Picture 4.6) to look after the babies and toddlers whose mothers had gone off to the farms usually from dawn to dusk with a few breaks to eat. The meal time breaks could be at home or at the farm in which case the woman at home would have to transport the food to the family members in the farm. Women took turns taking up this responsibility while the others went to the farm.

Picture 4.4 Young boy looking after livestock

Picture 4.5 Woman left home to look after babies

Picture 4.6 Young girl feeding a toddler raw milk

The agro pastoralists valued livestock as a source of livelihood and the animal sourced foods including raw milk. Livestock were also considered important for prestige and were not regarded as potential agents of disease so people interacted closely with them (Picture 4.7). They also treasured their way of life away from many modern conveniences and most of them did not have any formal education. They perceived themselves as capable of treating livestock diseases on their own using both traditional and conventional methods (Picture 4.8). This is related to their growing up in livestock keeping household and these skills being passed down from generation to generation. There had been evictions of livestock keepers from several major wetlands in Tanzania including Kilombero valley to reduce land degradation which left many livestock keepers feeling disenfranchised and bitter since they lost a lot of livestock which was their source of livelihood (Nindi *et al.,* 2014). Therefore, many moved some of their livestock to other regions in Tanzania while retaining some of their livestock in Kilombero district.

Picture 4.7 Common livestock drugs that were purchased by livestock keepers to self -treat their cattle

Picture 4.8 Young man touching a calf while eating

4.4 Agro pastoralists awareness, attitudes and knowledge on brucellosis in livestock

This section presents the results of the awareness, attitudes and knowledge on signs, causes, risk factors and transmission pathways for brucellosis in livestock among the agro pastoralists in Kilombero district. It is divided into two sections, one being community awareness and attitudes on brucellosis signs and causes in livestock and the second knowledge on brucellosis in livestock when associated with various demographic variables. According to the socio ecological model, a summary of the awareness and knowledge on brucellosis in livestock and humans is presented in Table 4.2 below:

Table 4.2 Socio ecological determinants of awareness and knowledge among agro pastoralists in Kilombero District, Tanzania

Socio ecological dimensions	Awareness and knowledge
Individual factors	• Older people had more awareness • Males had more knowledge • Higher level of education positively associated with increased knowledge
Socio cultural factors	• Low awareness due to geographical and cultural isolation. • Men had more access to education and sensitization due to their role as livestock caretakers and household heads. They interacted more with livestock officers and attended community sensitization meetings. • Women's cultural roles within the household limited their access to knowledge on livestock diseases because sensitization meetings were often only attended by men.
Physical environmental factors	• Young men spent most of the year in remote places looking after cattle so they had limited information since sensitization activities occurred in the central meeting areas such as the shopping center. • Presence of tse tse flies in the grazing areas enhanced the suspicion that reproductive health conditions in livestock were a result of trypanosomiasis.
Structural factors	• Other diseases were prioritized more than brucellosis in community education like foot and mouth disease and contagious bovine pleuropneumonia.

4.4.1 Community awareness and attitudes on brucellosis and its symptoms in livestock

The results of this study show that community awareness on brucellosis in livestock was very low with only 7.2% of the respondents having ever heard of the disease in livestock. Majority of the study participants had never heard of brucellosis which is known as *"ugonjwa wa kutupa mimba"* in Kiswahili in Tanzania. Although the study participants were unaware of brucellosis,

they identified Tuberculosis, Rift valley fever and anthrax as the zoonotic diseases that they were aware of. The quotes below demonstrate this:

"We have never heard of a disease called brucellosis".
Women FGD1, Kilombero

"There was a time when we heard about a disease called RVF that is transmitted to people from livestock. We don't know much about it because we only heard about it once and people here were not affected".
Male 50 years old, IDI Kilombero.

Proper understanding of the lay awareness regarding a disease is important in the development of suitable disease control strategies including community education and sensitization (Kangalawe and Liwenga 2005; Mutua *et al.,* 2016). For example, livestock keepers would not be able to report suspected cases of brucellosis to local authorities if they did not know the disease existed or were not familiar with its symptoms.

The three key informants working in the livestock sector in the area were all aware of brucellosis likely as a result of their training. Nevertheless, they noted that it was not prioritized for control due to the lack of proper diagnostic facilities. They also observed that the livestock keepers were largely unaware of the disease. The quotes below demonstrate this:

"We think that brucellosis is present in this locality but it is not prioritized for control due to lack of proper laboratory facilities. Therefore, the community also has very inadequate information on the disease".
KII Female, Veterinary Officer Kilombero.

"I have heard about brucellosis but it is not a common disease".
KII Male, Livestock Officer Kilombero

"I have never encountered any case of brucellosis in this area and I don't have a lot of information on the disease. The livestock keepers here are not familiar with the disease either".
KII Female, Livestock Officer Kilombero.

In Uganda similar findings were obtained among medical personnel and livestock workers who did not prioritize the disease (Nabirye *et al.,* 2017). In a another study conducted in Uganda, livestock keepers were well informed about brucellosis (Kansiime *et al.,* 2014) and this was because of the intense community sensitization done in the area by health personnel. This shows the need to ensure that livestock and public health workers especially those working in rural communities are well informed about brucellosis so that they can be at the forefront in the control of the disease. Pastoralists are known to be aware of livestock diseases in general (Mangesho *et al.,* 2017; Moritz *et al.,* 2013). They have lived with animals all their lives and often distinguish diseases based on the symptoms observed. Similarly, the participants of this study were aware of other livestock diseases such as foot and mouth disease, contagious bovine pleuropneumonia (CBPP), trypanosomiasis and infestation by worms. This is exemplified in the quotes below:

"Foot and mouth disease is very common in cattle here especially during the flooding season in March and April each year".
Men FGD 2, Kilombero.

"Other than foot and mouth disease which is common here, contagious bovine pleuropneumonia (CBPP) affects our cattle and then they cough and have difficulty breathing".
Men FGD 1, Kilombero.

Elsewhere, inadequate knowledge and misconceptions on brucellosis have been implicated in the unsuccessful control efforts of the disease such as the failure to report suspected cases of brucellosis to authorities (Assenga *et al.,* 2015; Franc *et al.,* 2018). Brucellosis still is a big health challenge in Sub Saharan Africa which continues to bear a considerable burden of brucellosis cases in livestock and yet those most at risk are largely unaware of the disease (Adesokan *et al.,* 2013: Assenga *et al.,* 2015, Njuguna *et al.,* 2017). Contrary to the findings of this study, other studies conducted in some parts of Africa demonstrated that agro pastoralists had heard about this disease in livestock and identified abortions as a major clinical sign (Cloete *et al.,* 2019; Hegazy *et al.,* 2015; Kansiime *et al.,* 2014). In West Africa particularly, livestock keepers even had a local name for brucellosis *"bakkale"* and identified it through symptoms

such as infertility, hygromas, abortions and swollen testicles (Healy Profitós *et al.,* 2013; Schelling *et al.,* 2003)

Knowledge of brucellosis signs and symptoms in livestock

Participants who had ever heard of brucellosis were asked what the major signs of the disease were. The major signs and symptoms that they identified were abortions, decreased milk yield and birth of weak calves as shown in Table 4.3 below:

Table 4.3: Major signs and symptoms of brucellosis in livestock

Major signs of brucellosis in livestock? (N=24)	**Number of participants responding**
Abortions	22
Reduced milk production	17
Birth of weak calves	17
Still births	13
Infertility	9
Weight loss	10
Lameness	6
Swollen joints (hygromas)	1

In spite of the low awareness on brucellosis, the results show that symptoms congruent with the disease had been observed by the participants in their livestock. These symptoms included abortions, retained placenta, still births and infertility as shown in Table 4.4 below.

Table 4.4: The awareness and experience of symptoms in livestock related to brucellosis among agro pastoralists in the Kilombero district, Tanzania

Question	Total count (N=333)	Frequency (%)
Awareness of brucellosis in livestock and humans		
Have you ever heard of brucellosis in livestock?	24	7.2
Have you ever heard of brucellosis in humans?	333	0
Experience of symptoms in livestock		
Did you witness any cases of abortions in your livestock in the past one year?	95	29
Did you witness any cases of retained placenta in your livestock in the past one year?	45	14
Did you witness any cases of still births in your livestock in the past one year?	28	8
Did you witness any cases of infertility in your livestock in the past one year?	9	3

Perceived sources of common brucellosis signs in livestock and its implications

Although brucellosis signs in livestock were routinely observed by the study participants, these were not attributed to brucellosis but to trypanosomiasis, unknown disease, difficulty in calving, emaciation and frequent breeding in the case of infertility as shown in Table 4.5 below:

Table 4.5: The perceived sources of common signs of brucellosis among agro-pastoralists in the Kilombero district, Tanzania

Symptom in livestock	Perceived causes	Frequency (%) N=333
Abortions	Do not know	56
	Trypanosomiasis	40
	Unidentified disease	3
	Supernatural causes	1
Retained placenta	Do not know	64
	Trypanosomiasis	16
	Calving complications	9
	Unidentified disease	7
	Supernatural causes	2
	Brucellosis	2
Still births	Don't know	50
	Trypanosomiasis	21
	Unidentified disease	21
	Calving complications	8
Infertility	Do not know	78
	Trypanosomiasis	11
	Supernatural causes	11

Brucellosis signs in livestock have already been identified and they include late term abortions, infertility, retained placenta, hygromas, still births and the birth of weak calves (Godfroid *et al.,* 2011). The characterization of a disease is very important in determining people's response to it and their willingness to be involved in any prevention or control activities. Community based studies of brucellosis have shown that there exists misconceptions on the signs and perceived severity of brucellosis and this has an impact on the adaptability of any control measures (Arif *et al.,* 2017; Healy Profitós *et al.*, 2013). In a study conducted in Cameroon, it was shown that pastoralists did not remove from their herds chronically sick animals from brucellosis since they would fetch low prices in the market (Healy Profitós, Moritz, and Garabed, 2013). This study therefore challenges the consideration of the impacts of brucellosis from a purely economic stand point and emphasizes the holistic nature of livestock keepers' attitudes towards their animals and their views about disease symptoms.

Abortions: The survey results show that 29% of the respondents had observed abortions especially in cattle in the previous year. Over half (56%) of the respondents noted that they did not know the cause of the abortions with some (40%) attributing them to untreated trypanosomiasis. The livestock keepers often treated their livestock with conventional drugs purchased from shops and trypanosomiasis was one of the diseases they felt confident to treat. When abortions were witnessed therefore in their herds, they were attributed to delayed or inadequate treatment for trypanosomiasis as the excerpts below demonstrate:

"Abortions happens when you do not treat livestock for trypanosomiasis. The abortions often occur when the cow is in the advanced stages of pregnancy from 7 months onwards".
Men FGD4, Kilombero.

"When a cow is pregnant, we must treat it for trypanosomiasis to prevent an abortion from occurring".
Male 52 years old, IDI Kilombero

Nevertheless, the participants also added that abortions still occurred even after treating their animals for trypanosomiasis which perplexed them because they did not know which disease the animals suffered from and how to treat them. The quotes below demonstrate the dilemma that livestock keepers are faced with related to abortions.

"We often treat our pregnant cattle when we suspect they have trypanosomiasis to prevent abortions but they still occur. So, we don't know what happens. This is another disease which we don't know. We just say that my cow has aborted".

Men FGD2, Kilombero

"The tsetse flies lay eggs on grass which cattle eat and then if pregnant they abort since they have contracted trypanosomiasis".

Male 45 years old, IDI Kilombero

Abortions are the main clinical sign of brucellosis in livestock but can be caused by other infections (Obonyo, 2015; Onono *et al.,* 2019).As observed earlier, the study participants had immigrated from other parts of Tanzania and reported that trypanosomiasis was very common in those areas. It was a disease with which they were very familiar. Abortions in livestock have many causes including trypanosomiasis (Shaapan, 2016). Other causes of abortion other than brucellosis in livestock include leptospirosis and bovine viral diarrhea (Dereje *et al.,* 2018). Inadequate knowledge and misconceptions therefore on the causes of abortions can be a barrier to the proper control of diseases including brucellosis.

Retained placenta: In this study, 14% of the respondents observed that they had observed cases of retained placenta especially in cattle but they did not know the cause. Participants of this study however did not consider retained placentas to be a major problem because they reported that they used both conventional and traditional methods to expel the placenta and these strategies often worked. These strategies included injections, herbs, salty water, soda ash and the use of a hot rod or stick applied to the birth canal. One or more of these strategies could be used in any case. This is explained through the following quotes:

"There is a drug we inject into the animal and often it works. However, if that fails then we wrap the protruding piece of placenta on a stick and gently pull the placenta over the course of a few hours and eventually it comes off".

Men FGD2, Kilombero

"I don't know why the placenta fails to come out naturally but we place a long stick across the back of the animal and roll it gently towards the back and drop the stick to the ground. If God wills then the placenta also comes off".

Female 71 years old, IDI Kilombero.

"We mix soda ash with other local herbs and apply on the animal's birth canal and usually it comes out".

Male 28 years old, IDI Kilombero.

Still births: In this study 8% of the respondents had noted cases of still births in their herds in the previous one year. Further, results show that still births were considered to be a result of trypanosomiasis or a long and difficult birth. Notably, female participants in the study associated these cases in livestock to human cases, because mothers did sometimes lose babies in utero. This made still births more accepted as part of life, a result of bad luck or supernatural causes as the quotes below demonstrate:

"Still births happen because the animal was sick or in labor for a long time and also God had planned for that to happen (calf to die) just like it happens in human beings".

Women FGD 2, Kilombero.

"Maybe the calf wasn't meant to live just the same way some babies die before they are born".

Female 36 years old, IDI Kilombero

Infertility: A small percentage (3%) of study respondents reported infertility in their livestock within the past one year prior to this study. Brucellosis was not mentioned as a possible cause of infertility in their animals. Data from the qualitative interviews shows that the cases of infertility in cattle were attributed to the size of the animal and frequent mating. They argued that body fat reduced the chances of conception as did repeat breeding. This however was not perceived as a big challenge or a sign of disease because the animal would be used for traction whereby it would lose weight and thereafter conceive. Other strategies that were used were removing the cow from the herd and keeping it with unfamiliar bulls and scalding the birth canal to prevent frequent mating. According to the participants, once these strategies were implemented then after a while the animal would conceive. However, if the animal failed to

conceive then it would be sold but, in some cases, it was retained in the herd to be sold later since it would often grow very big and thus fetch a good price or be slaughtered for a ceremony in the home.

Sometimes, it was retained because its huge size was appealing to the owner. In a male FGD ***(Male FGD2, Kilombero)*** they noted that, "*Usually, an infertile cow is attractive to look at and admirable because it grows very large and fat and will eventually be sold at a good price in the market because of its size. That is why we are often not in a hurry to sell them"*. Supernatural reasons also prevented such animals from being sold or culled because some opined that God had decided that the animal would be infertile and thus the animal was to be cherished. For example, in one FGD ***(Women FGD3, Kilombero)*** the participants said *"God gave me that animal to look after and he would be displeased if I sold it and such an action would cause my healthy cows to also die"*. On the other hand, since most of the participants owned many animals, they did not feel that having a few infertile animals in their herds threatened the overall productivity of their livestock. The participants in this study therefore did not perceive this animal as diseased and as a potential source of infection to other animals in the herd. These quotes demonstrate this:

"An infertile cow is made that way by God. And so, if I have many other cows that are reproducing, I retain the infertile cow just the same way people keep things in the house that they are not necessarily using".
Male 30 years old, IDI Kilombero.

"It is God who decides that some animals cannot conceive just like it is with some women. So, when we have such animals, we keep them and then slaughter them during a ceremony because they are big and their meat is very tasty".
Female 50 years old, IDI Kilombero.

Reduced milk production: Despite the participants noticing cases of reduced milk production in their herds they did not attribute this to brucellosis. The reasons suspected for these cases were insufficient feeding, calf maturity, age of the animal, pregnancy and illness. Nevertheless, brucellosis was not cited as a possible cause of low milk yield. Since the pastoralists kept large herds, they did not deem it necessary to cull low yielding cattle as they could milk other cows

in the herd. This is especially because the number of cattle in a herd was more important than the individual productivity of each animal. These quotes demonstrate these perspectives:

"When a cow is not feeding properly or when the calf is older the milk yield is low".
Male 25 years old, IDI Kilombero

"If a cow is pregnant, has been rained on or bitten by insects it cannot produce a lot of milk".
Female 35 years old, IDI Kilombero.

"The milk production reduces because a cow has gotten old. However as long as it is still calving, we don't sell it. We retain it in the herd but don't milk it, it only suckles its young. We can milk other cows in the herd".
Women FGD 3, Kilombero

However, participants in this study attributed these signs such as abortions, still births and infertility to trypanosomiasis, unknown disease, difficult birth process, size of the animal, frequent breeding and supernatural factors. When attributed to the supernatural they were related to similar occurrences in human beings especially in the case of still births and infertility and thus were accepted as part of life. In this regard therefore, the success or failure of the curative strategies utilized was attributed to divine determination. Majority of these cases were reported to occur in cattle. This shows that it is possible that brucellosis in livestock exists in the locality and indeed a recent epidemiological study estimated the prevalence of brucellosis in livestock in Kilombero district to be 14.3% in cattle, 0.5% in goats and 0.6% in sheep (Assenga *et al.,* 2015). In my study, diseased animals such as those with a history of abortions, still births or infertility were not culled because they were perceived to have other value such as being calm and attractive to look at, being used as traction animals or spared for eventual slaughter in a ceremony within the home. Infertile cows were admired for their large size and often retained in the herd to be sold at a later date. These animals were retained in the herd because the transmission dynamics of brucellosis were not known among the livestock keepers rendering disease control measures like culling impractical in such settings. This also shows that the value of livestock was not just monetary but sentimental and practical as well and thus culling on the basis of symptoms only might not be acceptable to the local people who valued potentially diseased animals. The study also shows that participants felt that since these

symptoms were witnessed occasionally and they owned large herds these conditions like infertility and reduced milk production did not threaten the overall productivity of their livestock and so they could still keep less productive and chronically sick animals. The study participants were more wary of other livestock diseases such as Contagious bovine pleuro pneumonia (CBPP) and foot and mouth diseases which were reported to be common in the area and perceived to be deadly. When livestock keepers do not prioritize a disease, then they are less likely to report the symptoms they observe to relevant authorities for proper mitigation measures (Bronner *et al.,* 2014). Strategies that have worked in Western countries for the control of brucellosis such as culling of diseased animals are much more difficult to implement in the African context because seemingly healthy animals such as those which have aborted once or are infertile may not be considered ill (Mai *et al.*, 2012).

In the case of brucellosis, it appears that symptoms seen in livestock were not viewed holistically by the community but addressed individually such that abortions were considered more severe than infertility and no connection between the two was made. In my study, these reproductive challenges in livestock were considered a normal part of raising livestock and associated to similar reproductive challenges that were known to exist in humans. Cases of retained placenta were regarded as minor issues that could be solved through the use of both conventional and traditional remedies while reduced milk production was attributed to poor feeding. Researchers elsewhere have made the same observation that brucellosis symptoms are not regarded as serious such as abortions being perceived merely as unfortunate incidences while hygromas are not considered a disease (Smits, 2013). This demonstrates that lay perceptions on disease causation and severity need to be well understood as they can impact disease control efforts.

4.4.2 Socio demographic characteristics associated with knowledge on brucellosis

The knowledge on brucellosis by the respondents is shown in Table 4.6. Two types of results are provided by the Zero Inflated Negative Binomial Regression (ZINB) model. The odds of having no knowledge are significantly decreased for males (OR=0.05; 95% CI: 0.007-0.43) as shown by the zero-inflation part and by level of education (OR=0.28; 95% CI: 0.13-0.63). The odds of having no knowledge of brucellosis (OR=0.71; 95% CI: 0.47-1.06) are decreased by being older, but not significantly. The relative risk of having better knowledge among knowledgeable group members is addressed by the count part of the ZINB model. Age significantly increases the "relative risk" to know more by 0.22 (95% CI: 1.05-1.43.

Corroborating the findings of this study, older livestock keepers were more knowledgeable about Rift valley fever (RVF) and brucellosis which was attributed to their having longer experience and more exposure on diseases (Alhaji *et al.,* 2018; Nabirye *et al.,* 2017). Being male increases the "relative risk" to have more knowledge by 0.07 (95% CI: 0.37-3.15), but this result is not significant. This might be because in this community men were the ones that played the biggest role in treating livestock when sick as well as attending any sensitization meetings on livestock diseases as similar studies demonstrate (Babo *et al.*, 2022). Access to knowledge is an engendered process especially in rural settings where traditional gender roles still apply. Similarly, in studies conducted in Kenya and India women had limited knowledge about brucellosis (Kolhe *et al.*, 2017; Lokamar *et al.,* 2020). The relative risk to know more is increased by level of education by 0.19 (95% CI: 0.84-1.68), but also not significantly. Formal education was significantly associated with enhanced knowledge on brucellosis in Kenya (Njuguna *et al.,* 2017), Ethiopia (Mandefero and Yeshibelay, 2018), Uganda (Nabirye *et al.,* 2017), Tibet (Zeng *et al.,* 2018) and Pakistan (Arif *et al.,* 2017a). Formal schooling provides individuals an increased opportunity for gaining relevant insights on zoonotic diseases as well as better knowledge on disease risk (Alhaji *et al.,* 2018; Zeng *et al.,* 2018).

Table 4.6: Predictors for agro-pastoralists in Tanzania to have knowledge of brucellosis and the relative risk for knowledge level

	Probability to have no knowledge, odds ratio (OR)	**95%CI**	**P-value**	**Level of knowledge, odds ratio (OR)**
Intercept	915	74-112	<0.0001	12.143
sex (female)	1	-	-	1
sex (male)	0.056	0.007-0.43	0.005	1.074
education	0.286	0.12-0.64	0.002	1.192
age group	0.71	0.47-1.06	0.09	1.228
Religion (Traditional)	1	-	-	1
Religion (Christianity)	1.94	0.62-6	0.15	0.62
Religion (Islam)	0.95	0.21-4.3	0.72	0.9
Ethnicity (Wamaasai)	1	-	-	1
Ethnicity (Other)	1.05	0.09-11.8	0.92	1.5
Ethnicity (Wasukuma)	0.79	0.07-8	0.44	0.95

4.5 Agro pastoralists awareness, attitudes and knowledge on brucellosis in humans

This section presents the results of the awareness, attitudes and knowledge on signs, causes, risk factors and transmission pathways for brucellosis in humans among the agro pastoralists in Kilombero district. It is divided into two sections, one being community awareness and attitudes on brucellosis signs and causes in humans and the second, knowledge on brucellosis in humans when associated with various demographic variables.

4.5.1 Community awareness and attitudes on brucellosis and its symptoms in humans

In this study, respondents in the structured interviews were asked whether they had ever heard of brucellosis in humans. None of them indicated to have ever heard of brucellosis in humans. In follow up interviews with focus group discussants they noted that they were unaware of brucellosis in humans. In the 39 in depth interviews conducted, only two respondents mentioned that they had ever heard of brucellosis in humans. One 48-year-old male had a better understanding as he noted that, *"Yes, I have ever heard of brucellosis in people and I think it is from milk or meat…. I think it is transmitted through milk"*. Concurring, a 40-year-old female said that, *"I have heard people talking about it. They say that this disease…I don't know it well enough. People mention it a little"*.

Various prevalence studies in different regions of Tanzania have demonstrated that brucellosis is common in Tanzania (Cash-Goldwasser *et al.*, 2018; Mujuni *et al.,* 2018; Sagamiko *et al.,* 2019; Stoddard *et al.,* 2012). Specifically, in the Morogoro region, studies have shown that while malaria is common other diseases with fever as a main symptom are present including brucellosis (Chipwaza *et al.,* 2015; Mchomvu *et al.,* 2019). In Kilombero district, a recent study found an estimated prevalence of 14.6% for brucellosis in humans (James, 2013). Other scientists have observed that livestock keepers are more likely to be infected with brucellosis in Tanzania due to their close proximity to livestock as well as consumption of raw milk and raw meat (Assenga *et al.,* 2015; John *et al.,* 2008).

Previous studies have shown that even among agro pastoralists who had heard about brucellosis in livestock, majority did not know that it was zoonotic (Adesokan *et al.,* 2013; Moritz *et al.,* 2013; Schelling *et al.,* 2003). This is attributed to the fact that the signs of brucellosis in livestock and humans do not occur at the same time which makes it hard for pastoralists to

make the connection that it is a zoonoses (Moritz *et al.,* 2013). Awareness on brucellosis in humans was also found to be very low in other parts of Africa (Kolhe *et al.,* 2017; Lokamar *et al.,* 2020; Mandefero and Yeshibelay, 2018; Nabirye *et al.,* 2017). Comparably, one recent major review of most of the knowledge, attitudes and practices studies on brucellosis in Africa and Asia concluded that about 50% of the participants did not know about brucellosis in humans (Zhang *et al.,* 2019). This shows that a major gap exists in knowledge especially in Sub Saharan Africa where brucellosis has been determined to be endemic (McDermott and Arimi, 2002). This research shows that febrile signs were often attributed to either malaria, typhoid or urinary tract infections (UTIs). The community's understanding of febrile illnesses is thus limited to only three diseases. Although these three diseases are very common in the area (Chipwaza *et al.,* 2014) and a source of febrile illness there are others too of zoonotic origin like dengue fever, brucellosis and Chikungunya (Chipwaza *et al.,* 2014b; Chipwaza *et al.,* 2015; Mchomvu *et al.,* 2019). In their study in Kenya, livestock keepers associated fever mainly with malaria (Mutua *et al.,* 2016). Some have noted that the low awareness on brucellosis is as a result of agro pastoral communities living in isolated areas where there is limited access to education and sensitization activities (Mandefero and Yeshibelay, 2018; Njenga *et al.,* 2020).

Nevertheless, the results of this study show that (78%, 259) of the respondents had experienced a fever in the previous three months in their household. This indicates that febrile illnesses are common in the area. It is worth noting that brucellosis does present as a febrile illness too although this is virtually unknown by the agro pastoralists interviewed in this study. Results from the FGDs corroborated this because participants indicated that they did not know about brucellosis in humans although fever causing illnesses were very common particularly malaria followed by typhoid and urinary tract infections (UTIs). This is demonstrated through the excepts below:

"Malaria is common here and though we use mosquito nets we still get malaria.".
Men FGD4, Kilombero

"Brucellosis is unheard of in this area. Whenever we present to the health facilities, we are told we are either suffering from malaria, UTI or typhoid. Clinicians never talk about it".
Women FGD3, Kilombero

Brucellosis in humans presents as a febrile illness with undulant fever, headaches, joint pains, stomachache and general malaise being some of the major symptoms and so it is often misdiagnosed as malaria or other common febrile diseases (Galińska and Zagórski, 2013; Majalija *et al.,* 2018). In this study, the major symptoms attributed to a febrile illness were fever (96%), headache (85%), abdominal pain (69%), vomiting (67%), joint pains (67%) and chills (63%) as shown in Fig. 4.2 below. Data from the qualitative interviews showed that fever, general malaise, headaches, stomach pains and chills were the main symptoms of a febrile illness.

Figure 4.2 Symptoms associated with a febrile illness by the agro pastoralists in Kilombero District

What other symptoms (s) did they exhibit? (n=259)

	RESPONSE	FREQUENCY ▼	
1	Fever	250	96.53
2	Headache	220	84.94
3	Abdominal pain	178	68.73
4	Vomiting	173	66.80
5	Joint Pains	172	66.41
6	Chills	163	62.93
7	Diarrhea	78	30.12
8	Sweating	30	11.58
9	Weight loss	18	6.95
10	Other (Specify)	15	5.79

Key informants working in the health sector in this locality corroborated these findings because although they were aware of brucellosis, they did not consider it to be a big priority in the area in their diagnosis of patients with febrile symptoms. This lack of prioritization was attributed to malaria being endemic in the area and the lack of proper diagnostic facilities for other febrile diseases. This is depicted in the following quotes:

"In this area you hardly hear anyone saying or thinking to check for brucellosis in a patient. And this is in spite of the fact that there are a lot of livestock keepers in this locality".
Male clinician 26 years old, KII Kilombero

"Brucellosis is not one of the diseases we think to look out for if someone has a fever because it does not occur commonly and we don't investigate to know if it is there or not".
Female clinician 26 years old, KII Kilombero

"You see, malaria is endemic in this area so when we have a patient with febrile signs, we first test for malaria then if it's not malaria we conduct other tests usually for typhoid. We also don't have the laboratory facilities to enable us to test for brucellosis unless the patient goes to the referral hospital. But I have never encountered a brucellosis patient myself".
Male clinician 50 years old, KII Kilombero.

When people do not know about a disease, they are not likely to seek treatment for it or they can use the wrong medicines for it. The clinicians in this study knew about brucellosis but did not investigate it because it was considered to be rarer than other febrile illnesses. These factors can lead to delayed treatment and a greater likelihood of the disease becoming chronic. Some quantitative studies call for community education to improve lay knowledge on the presence of zoonotic diseases but this is inadequate without the requisite policy improvements (Cash-Goldwasser *et al.,* 2018; Kunda *et al.,* 2007). Thus greater attention is needed to not only improve the awareness of communities on zoonotic diseases but also enhance the access and availability of health services in Africa (Adinan *et al.,* 2017; Kamat, 2006).

4.5.2 Knowledge on the risk factors of brucellosis in humans

In this study, respondents were asked 12 questions on their engaging in known risky practices associated with brucellosis in humans. Each individual categorical variable was thereafter scored on a binary scale of 0-1. Those with a lower score were considered to engage in fewer risky practices. A logistic regression model was used to test for the association between practices and socio demographic characteristics. Primary school attendance (p value 0.041), being Christian (p value 0.034) and being Muslim (p value <0.0001) were significantly associated with fewer risky practices as shown in Table 4.6 below. However, the number of Christians (32%) and Muslims (12%) in the study was low compared to those who ascribed to traditional religious beliefs (56%) so these results need to be interpreted cautiously. However, it is possible that religious prohibitions made it less likely for Muslims to engage in certain livestock related activities but this needs to be explored further since in this context culture played a bigger role in perpetuating risky behavior. Collaborating these finding though, a study

in Northern Tanzania found a negative correlation between Islam and brucellosis but the reasons for this were not immediately established (John *et al.,* 2010). Conversely, in their study in Uganda, Muslims were six times more likely to be infected with brucellosis as a result of their role in the slaughter of sheep, goats and cattle (Majalija *et al.,* 2018). In addition, the likelihood ratio test was conducted on the statistically significant variables to determine the influence of each variable on behavior. Fewer risky practices were highly associated with religion (x^2 = 25.03, df = 10, p value = <0.0001) and only moderately with education (x^2 = 0.17, df = 11, p value = <0.05). Lastly, a relationship between knowledge was accessed to determine whether more knowledge led to fewer risky practices and there was no significant relationship (p value 0.156). This is possibly related to the low literacy levels and the cultural value attached to close proximity to livestock and consumption of their products. Livestock and their products are perceived as beneficial and not linked to the risk for diseases.

Likewise, in other areas raw milk was consumed and risky animal handling practices done even when people knew about brucellosis (Arif *et al.,* 2017; Musallam *et al.,* 2015). In addition, pastoralists in Tanzania and Kenya valued raw milk to the extent that it was more important to them to maintain this cultural practice than to be safe from zoonotic disease (Mangesho *et al.,* 2017; Ng'ang'a *et al.,* 2016). Contrary to these findings, other studies found that those who had more knowledge on brucellosis engaged in less risky behavior (Adesokan *et al.,* 2013; Arif *et al.,* 2017). However, in a study conducted in South Africa, in spite of the high awareness on bovine Tuberculosis the transmission dynamics were poorly understood by the community and therefore risky behavior continued (Sichewo *et al.,* 2019). These differences in findings from different parts of Africa demonstrate the need for in depth studies that are holistic so that suitable information and messaging can be done and relevant control efforts deployed. Thus, even more importantly, a deeper understanding of the local dynamics and the structuring of prevention and control strategies to cater to context is central.

Table 4.7: Logistic regression on the association of behavior linked to brucellosis and socio demographic characteristics

Response variable	Explanatory variables	Co-efficient	p value	CI(+/-97.5%)
	Sex (Male)	0.32	0.87	-3.58-4.22
Practices (mp5)	Education (Primary)	-4.34	0.041	-8.48-0.19
	Education (Secondary)	-24.38	0.13	-24.38-3.11
	Religion (Christian)	-4.9	0.034	-9.42-0.39
	Religion (Muslim)	-17.88	<0.0001	-24.75-11
	Tribe1 (Wasukuma)	-3.49	0.175	-8.52-1.54

Chapter 5: Community perceptions of risk for brucellosis in humans

5.1 Introduction

This chapter discusses the results of Objectives 2 and 3 on community attitudes of risk related to the consumption of animal products and animal handling behavior as well as the interactions in the livestock-wildlife interface as risk factors for human brucellosis using the socio ecological model as shown in Table 5.1 below. The chapter is divided into three sections which are consumption practices, animal handling behavior and the interactions between humans, livestock and wildlife.

Table 5.1 Socio ecological determinants of behavior risking transmission with human brucellosis among agro pastoralists in Kilombero District, Tanzania

Socio ecological dimensions	Behavior risking transmission
Individual factors	• Young men more vulnerable due to their involvement in livestock related practices such as assisting in parturition. • Men participate more in risk behavior due to their role in tending livestock. • More education did not lead to safer behavior.
Socio cultural factors	• Women and girls' roles in tending to the home and looking after babies facilitates the feeding of raw milk to babies and children. • Cultural value attached to raw milk consumption and livestock handling. • Perceived benefits of raw animal products.
Physical environmental factors	• Grazing areas are away from home where herders live for months at a time subsisting largely on raw milk. • Comingling of herds in the communal grazing areas. • Livestock encounters with wild animals due to grazing in close proximity and in the same areas.
Structural factors	• The communal grazing areas are located next to the wildlife areas which facilitates interaction between livestock and wildlife.

5.2 Community attitudes of risk related to the consumption of raw animal products

This section discusses the community attitudes of risk around the consumption of raw animal products. It provides the cultural context, perceived benefits of raw animal products consumption and the attitudes on the usage of boiled milk.

5.2.1 Agro pastoralists attitudes and practices in relation to milk

In this section, the practice of raw milk consumption is elaborately discussed including the cultural context, perceived benefits of un boiled milk, perceived advantages and disadvantages of boiled milk and the pragmatic reasons that prevent the agro pastoralists from boiling of milk.

The cultural context of raw milk consumption

A recent study conducted in Kenya linked brucellosis in humans to the consumption of unpasteurized milk (Kiambi *et al.,* 2020). In order for behavior change to occur in relation to risky behavior, risk communication strategies must consider the social cultural background of the communities involved (Roesel, 2014). This is important because many agro and pastoral communities believe that milk is naturally safe and cannot be a source of disease (Roesel, 2014). When lay and professional risk perceptions differ then the avoidance of risky behavior by the community is hindered especially in food risk management (Jensen *et al.,* 2005). Professionals therefore must be willing to understand the local logics that govern consumption behavior if they are to adequately engage the communities. Sadly, lay risk perceptions are often dismissed as being irrational or not based on "evidence" and this leads to the poor uptake of control strategies by lay people and a lack of dialogue between lay people and professionals (Jensen *et al.,* 2005). Communities access risk based on a broad outlook on how lethal the disease is and the effects of the disease on their lives and that determines what they consider a priority and how willing they are to control the disease in light of their other present realities (Jensen *et al.,* 2005). Thus, in my study, the commonly repeated refrain was that the participants knew no one who had died or become seriously ill from drinking raw milk or other animal products. On the contrary what they reported was that they knew many people who did not consume raw animal products but still suffered from certain zoonotic diseases like tuberculosis. Some researchers have indeed noted that, similar to my study lay people base their risk perceptions on personal experience with the risk and experts base theirs on "scientific knowledge" (Jensen *et al.,* 2005). Meaning that risk awareness and perception for lay people and professionals is based on two differing planes and thus a common ground must be obtained for there to be a lasting behavior change in the community. Thus, to advocate for milk

pasteurization in communities which traditionally value raw milk we need to use creative methods (Caudell *et al.,* 2019). One way to improve adherence to risk communication messages is to use stories and narrations and coming up with low cost interventions and these are especially more effective in communities where literacy is low (Caudell *et al.,* 2019). This is more effective than using numbers to demonstrate risk.

Participants in this study were asked whether they consumed raw milk and over three quarters of the respondents (79%,333) reported that they did not boil milk before drinking it. Qualitative interviews and observations were conducted to obtain detailed information on the reasons why this practice was common. The first major reason cited for this practice was culture. The participants argued that they had grown up and continued to live in a context where this practice was normative as demonstrated in this statement, *"We prefer raw milk because it is our practice from a long time ago. We inherited this practice from our forefathers".* **Men FGD2, Kilombero.** Women agreed with this observation in a focus group saying that, *"Since we were born, we have never seen anyone boiling milk, we are used to drinking raw milk either fresh or fermented".* **Women FGD3, Kilombero**. Agro pastoralists therefore valued this practice as part of their cultural identity and for the perceived benefits including convenience, increased satiation and valued fat obtained from fermented raw milk. Another reason why raw milk was valued was the belief that if people boiled milk, then the newborn calf would fail to thrive. Among a group of pastoralists in Kenya raw milk was given to young children as it was perceived to boost their immunity (Onono *et al.,* 2019). Raw milk was also preferred in a recent study conducted in Kenya because it was perceived to taste better and have medicinal properties (Njenga *et al.,* 2020).

Convenience and accessibility of raw milk

Additionally, practical considerations including the lack of safe drinking water so that raw milk was used as an alternative and the notion that boiling milk was tedious and time consuming also prevented the community from boiling milk. As I collected data, I observed women left home with up to 8- 12 babies and toddlers alone or with a young girl of 7 or 8 years old as a helper. One woman would have to look after the babies and toddlers, cook for the family and do other chores like cleaning. This they did while the rest of the family members were in the farm. These women thus considered it an unnecessary extra chore to boil milk because they would have to temporary stop their other duties to watch the milk to prevent the little children from getting scalded by the boiling milk. Thus these women were overwhelmed with a lot of

chores and therefore were hesitant to boil milk which they felt was unnecessary. In my study, the babies and toddlers were fed raw milk several times a day as it was accessible and available and often their mothers would be in the fields all day. For mothers for example, being able to feed their young children raw milk right after milking was seen as beneficial in soothing the children and thus allowing mothers to focus on other responsibilities (Picture 5.2).

"Boiling milk is too much work. We milk a cow and feed it to the baby right away. If I was to boil milk it would take me time to light a fire, boil the milk and wait for it to cool down and yet the baby is hungry. That is too much work! We cannot boil".
Female 50 years old, IDI Kilombero

"In the morning little children will pick cups and head to the cattle shed and get milk as it is being milked. And the children become big and grow very well. So, we milk and immediately give it to the children while its warm from the cow's udder and they are very happy".
Female FGD3, Kilombero

On the other hand, herding of cattle was done by young men aged between 12-30 years old who lived in makeshift dwellings for up to 9 months each year in the communal grazing grounds away from the village. Raw milk therefore was convenient for them as a meal or accompanied by other easy to prepare foods such as rice (Picture 5.1). Milk was also used by the herdsmen in place of water. This is because they had no clean sources of water and they drank water from the same rivers and dams as they watered their cattle. During the drier months especially when it was very dry and drinking water unavailable the herders preferred to drink milk instead for rehydration. The local communities therefore used raw milk simply due to the fact that it was convenient as exemplified by the quotes below:

"For us herds men we take raw milk because we don't want to cook".
Male 30 years old, IDI Kilombero

"The herds boys and men take raw milk because they do not have clean sources of water. They drink water from the same dams where cows are watered or they dig shallow wells so milk is used as water to quench thirst especially in the dry months when the dam water is less and very dirty".

Male FGD2, Kilombero

Picture 5.1: A Herder outside a makeshift dwelling carrying raw milk

Picture 5.2 A baby being fed raw milk by his mother

Corroborating these findings other studies conducted among agro pastoralists in Kilombero valley observed that women had to work longer hours than men since they engaged in both farm work, household and kids management (Le Mare *et al.,* 2014; Ribera and Hausmann-Muela, 2011). Time constraints as a result of greater work load have been implicated in mothers inability to sufficiently care for their children and look after the welfare of the home (Hadley, 2005). In their study, Wasukuma households were found to have as many as 42 people and the mothers delayed the introduction of solid foods in their babies diet preferring breast milk and raw milk instead for convinience (Hadley, 2005). The Wasukuma also own a lot of cattle and farm huge tracts of land which is very labor intensive and both male and female labor is required (Hadley, 2005). This explains why most of the women would be reluctant to add another responsibility of boiling milk since they were already over worked. Pastoralists live and work in harsh, dusty and windy conditions and often lack access to clean drinking water

and ready food thus their preference for raw milk which is readily available (Greter *et al.,* 2014; Njenga *et al.,* 2020).

Desirable taste and increased satiation

Raw milk was also perceived to have a more desirable taste and smell and increased satiation compared to boiled milk. The respondents preferred the taste of raw milk and also felt that it kept them fuller for longer. This was cited in most of the interviews as a big hinderance to the boiling of milk. The people observed that when milk was boiled it lost taste and was more watery meaning that it was not as satisfying as demonstrated by the quotes below:

"Raw milk keeps you full for a long time…sometimes up to two days. That is why we do not boil milk because raw milk is nutritious and provides strength. But boiling destroys all that and makes it less valuable".

Male FGD3, Kilombero

"We don't boil because boiled milk loses taste so we prefer it raw. The taste is not the same".

Male 38 years old, IDI Kilombero

Valued fat obtained from raw fermented milk

The community valued raw fermented milk which they enjoyed as a drink and also the fat obtained from the process of fermentation with which they used to season their cooked vegetables. Key informants reported that they fermented the milk by storing it covered in a clean container or pot overnight and consuming it with the mid-morning meal the following day (Picture 5.3). This was not only an easy way to use up any leftover fresh milk but to obtain fat called *"samuli"* in Kiswahili from the milk which was used to fry food or used as an accompaniment to meals. Consequently, the participants noted that once milk was boiled, they needed to wait for the milk to cool down before fermenting it which was perceived as labor intensive and time consuming and they also could not obtain any fat as a result of the boiling as shown in these statements below:

"Every evening we put some of the milk in a clean container to ferment overnight. Once it has fermented the fat floats at the top and so we drink the milk and preserve the fat to use in cooking food or as a quick accompaniment for ugali (maize meal)".

Male 50 years old, IDI Kilombero

"Boiled milk does not ferment well and once boiled you cannot get the fat which we like to use to cook our food.

Female 40 years old, IDI Kilombero

Picture 5.3: A pot containing fermented raw milk in

Perceived benefits of raw milk

One of the biggest benefits attributed to raw milk was that it made the people healthy and strong. Participants in this study observed that their babies, children and herders gained weight and were fit and healthy as a result of consuming raw milk. They suggested this was due to the raw milk having all the essential nutrients necessary for growth which they opined were

eliminated when milk was boiled. The action of boiling milk was therefore seen as destructive and not beneficial. The following quote exemplifies this:

"Children who are fed raw milk become very big, they add weight fast and are healthy. So, it is good for the baby. And this milk has no harm for adults. We are told to boil milk by nurses in the hospital but we don't. We think that the raw milk is best (laughter). It is healthier and more nutritious because once you boil milk you kill the nutrients in it".

Female FGD3, Kilombero

Similarly, studies in Uganda (Kansiime *et al.,* 2014), Kenya (Muturi *et al.,* 2018; Njenga *et al.,* 2020), Cameroon (Shey-Njila *et al.,* 2005a) and Nigeria (Mai *et al.,* 2012) have found that risk perception related to raw animal products consumption is very low especially in agro pastoral and pastoral communities where these are valued not just as a source of food but for other cultural value.

Contrary to bio medical perspectives, raw milk was also perceived as medicinal and helpful in counteracting the effects of toxic substances in the body as well as curing stomach ulcers. This was especially noted by male participants and it is related to their greater exposure to harmful elements in the course of their daily and leisurely activities. This therefore was a big hinderance in their considering to boil milk. These quotes below explain the perceived curative properties of raw milk:

"Raw milk neutralizes poison, for example the harmful chemicals in soda (soft drink) cannot harm you if you take milk afterwards".

Male FGD4, Kilombero

"Raw milk destroys all the harmful germs and toxins in the body. Yes, indeed because when you consume any poison you quickly look for raw milk and consume because it destroys the poison. But when you boil the milk, you destroy the milks ability to neutralize the toxins".

Male FGD2, Kilombero

"As farmers and livestock keepers we are exposed to a lot of dust from the farms and also as we walk alongside huge herds of cattle. But this dust does not harm us because we consume

raw milk. Raw milk also cures stomach ulcers. Once you boil the milk, you remove the fat in the milk which is what kills the organisms that cause stomach ulcers".

Male FGD3, Kilombero

Perceived benefits of boiled milk

The communities in this study opined that boiled milk was useful either for babies below a year of age or as a leisurely drink by men before bed after raw milk had already been consumed alongside dinner. During focus group discussions, the participants indicated that they boiled milk for babies below a year mainly as a supplement to breast milk. The main reason cited for boiling milk for babies was to make it became easily digestible as it was less dense after the cream had been removed and also more hygienic. On the other hand, some of the male participants said that they consumed a cup of boiled milk at night as a matter of preference but that happened after they had already consumed raw milk as an accompaniment for dinner. Therefore, boiled milk was utilized mainly for babies and men on occasion.

"We boil milk before feeding it to little babies who are below a year because boiling milk destroys the germs and also because their tummies are weak and can't digest the raw milk.

Female FGD1, Kilombero

"We boil milk only for babies as they advise us in the health facilities because then it becomes as light as breast milk and in that case the baby cannot be constipated.

Male 25 years old, IDI Kilombero

"I like to take a cup of boiled milk before bed each night. However, I do this after I have already consumed several cups of raw milk with my dinner".

Male 57 years old, IDI Kilombero

The subject of cultural connotations of risk perception has gained prominence in the recent past especially in the wake of pandemics and endemic zoonotic diseases which continue to be a public health challenge (Goodwin *et al.,* 2012). The consumption of raw milk, raw blood and raw meat has been linked to human infections with brucellosis (Asiimwe *et al.,* 2015; McDermott and Arimi, 2002)**.** Social scientists have noted that the concept of risk is highly contested because risk perception differs among individuals and across populations and so risk is both as much a biological construction as it is a social one (Goodwin *et al.,* 2012). This

means that while risk can be understood as a biomedical concept whereby diseases have known risk factors it is also a social construct whereby individuals and communities have notions of what constitutes risky behavior or doesn't. This influences people's choices to engage or avoid certain behavior. Consequently, any proper understanding of the concept of risk must incorporate social as well as environmental and policy factors because these determine how people interact with their environment and how they perceive any disease risk emanating from this interaction (Goodwin *et al.,* 2012).

Perceived benefits of raw blood and meat

The survey results show that only a small minority at 11% and 10% respectively reported that they consumed raw meat and raw blood respectively. The results of the in-depth interviews and focus group discussions show that consumption of raw blood and raw meat was not practiced by any other ethnic group in the area other than the Maasai. Within the Maasai community in this area, once an animal was slaughtered, the fresh raw blood was consumed by adults while the liver was consumed raw immediately after the slaughter. In this community the safety of the raw blood and raw meat was determined by the men who performed a visual inspection and participants observed that they only consumed raw blood from what they considered to be healthy animals. Women on the other hand, consumed raw blood after childbirth and this was said to be beneficial in replenishing the lost blood during the delivery process. Anyone too with an injury that led to a loss of blood was given drink raw blood as it was believed it aided in recovery. Nevertheless, the Maasai key informants agreed that this practice was not as widely practiced as it was in the past.

"Of course, we drink blood (laughter). I personally drink it and I have never needed a blood transfusion ever, any time we feel that we don't have enough blood we obtain blood from a cow and drink it. We get blood from a big, fat and healthy cow. We also eat raw liver and God takes care of us".

Female 50 years old, IDI Kilombero

"We consume blood especially during ceremonies but from healthy cows. And before we slaughter the cow someone has to come and confirm that the cow is healthy and pray for it before the slaughter. We also eat raw liver but this is not as common as it used to be and most people nowadays cook it. There are too many diseases these days so people are hesitant to eat raw liver".

Male 47 years old, IDI Kilombero

"Yes, we drink blood, even feeding it to our babies and children when they are diagnosed with anemia. We do the same with adults too, it's a kind of first aid but if they don't recover, we take them to the referral hospital for a blood transfusion. But most people recover. We also eat raw liver but only from healthy not sickly and emaciated animals. The men examine the meat first to determine it is safe".

Female 28 years old, IDI Kilombero

"Raw blood is enjoyable to us Maasai and we consume it as part of our culture. Women take it when they give birth to replenish lost blood and it helps her to regain her energy speedily"..

Women FGD3, Kilombero

Other scholars have noted that although dietary patterns are changing among the Maasai due to influence from other communities, less milk and meat production, raw blood and raw meat are still a large part of their diet (Massoi and Saruni, 2020). Food is much a cultural object as it is for nourishment and thus the Maasai consider the consumption of raw blood and raw meat as a symbol of strength and cultural identity and thus a highly valued practice (Fontefrancesco and Lekanayia, 2018). The Maasai generally consume the meat and blood of younger and healthy animals although there us the risk of diseases including brucellosis from this practice (Chege *et al.,* 2015).

5.2.2 Local perceptions on risk for zoonotic diseases from raw milk consumption

The study findings show that raw milk was preferred and boiled milk was only marginally used. Participants in the study noted that while they had been told by health workers that boiling milk was protective against diseases such as diarrhea in children, Rift valley fever and TB they did not adopt the practice of boiling milk. One of the major reasons was that these diseases were also witnessed in people who did not take raw milk leading them to conclude that raw milk wasn't the problem. In addition, some observed that they had never come across anyone who got ill as a result of drinking un boiled milk. The community also adopted the attitude that God protected them from disease and thus they did not really need to change anything in their behavior. These reasons made them skeptical of the advice by health workers on the necessity of boiling milk as demonstrated through these quotes below:

"The experts claim that raw milk causes TB. However, there are those who boil milk but they still get TB so we don't understand. If raw milk was causing TB then how come that there are those who suffer from TB and yet they don't take raw milk?"

Male FGD1, Kilombero

"Diseases including TB affect all of us whether we take raw milk or not. When we go to the health facility, we find even those who traditionally boil milk in the queues suffering from TB. So, these diseases are from God not milk".

Male 65-year-old, IDI Kilombero

"It is God who takes care of us. If raw milk was making us ill, we would be dead by now. Even those who boil milk get sick".

Female 50 years old, IDI Kilombero

It is now well accepted that consumption of animal sourced foods is not just for nourishment but there is cultural attachment to this practice (Roesel, 2014). Lay attitudes about disease etiology have been identified to play a big role in determining whether people engage in behavior risking transmission with zoonotic diseases or not (Mutua *et al.,* 2017; Ng'ang'a *et al.,* 2016). Therefore, if the community does not attribute certain behavior to a disease, then they are less likely to change their behavior and vice versa. For the livestock keepers in this study, raw milk was consumed because it was part of their cultural identity and all they had known since childhood. Culture does influence human behavior significantly and though it is not static it is not very easy to change especially when people do not see the need to do so (Ng'ang'a *et al.,* 2016). Raw milk was also preferred because when fermented, fat would be obtained to use in cooking food. Participants said that once milk was boiled it did not ferment well and it took a long time to ferment. The fermentation of milk does make the nutrients more bioavailable (Chege *et al.,* 2015). However, brucella bacteria can survive in fermented milk especially in the milk fat thus exposing humans who consume raw fermented milk to the pathogen (Estrada, 2005.; Mai *et al.,* 2012).

Furthermore, during the in-depth interviews the local people agreed that they were often sensitized by public health workers about the necessity of boiling milk when there was a disease outbreak such as Rift valley fever (RVF) or cholera. They reported therefore that they would

boil milk for a while until when they suspected that the outbreak was over and then they would continue with raw milk consumption. Nevertheless, some participants said that some of the men still did not consume boiled milk even during such periods. There was therefore no lasting behavior change as the excerpts below show:

"Yes, there was a time they were telling us to boil during the RVF outbreak…we boiled and once the disease was over we went back to consuming raw milk".
Male 30 years old, IDI Kilombero

"I remember one time we were told to boil milk and not to eat meat from carcasses. But once we heard that particular disease was over, we stopped boiling. But some men still continued drinking raw milk, they did not heed".
Female 35 years old, IDI Kilombero

This low-risk awareness and wrong perceptions can be a barrier to the uptake of boiling milk in this community. The misconception that even those who boil milk suffer from diseases such as TB demonstrates that the transmission pathways for zoonotic diseases are poorly understood. In the case of TB, it is evident that the community does not differentiate between pulmonary TB and zoonotic TB. Policy makers therefore need to sensitize communities more specifically and relevantly to ensure that these misinformation and misconceptions are addressed.

5.3 Community attitudes of risk related to animal handling

In this section, community attitudes of risk related to animal handling behavior as a risk factor for brucellosis in humans are discussed, specifically addressing slaughtering and skinning, assisted parturition, residing with livestock, milking, handling manure and communal grazing of livestock. Majority of the cattle in this study were taken to the communal grazing lands for most of the year by the herders often young males ages 12->30 years old. Therefore as some have noted, exposure to risk is not uniform and is greatly impacted by people's daily interactions and responsibilities (Adesokan *et al.,* 2013; Schelling *et al.,* 2003). Indeed, prevalence studies conducted in Tanzania and Kenya reported that men had a higher seroprevalence for brucellosis than women (Njeru *et al.,* 2016; Sagamiko *et al.,* 2019). A recent study however noted that the seroprevalence of brucellosis was higher in females than males

although the reasons for this were not immediately established (Colman *et al.,* 2022). Some though have argued that age and gender play a key role in the transmission and infection with zoonotic diseases and this is attributed to the different roles in livestock keeping (Bukachi *et al.,* 2018; Mangesho *et al.,* 2017; Mutua *et al.,* 2017; Ng'ang'a *et al.,* 2016). Our study found that behavior might differ based on religion, but since in this context culture played a bigger role in perpetuating risk behavior than religion, these findings were inconclusive.

Perceptions related to the slaughtering and skinning of animals

In this study, economic reasons prevented people from slaughtering animals at will because animals were reserved to be sold at the market to cater for family needs. Therefore, when an animal died, the carcass was seen as a potential way to get meat. Therefore, it could not be discarded since that would be a double loss; not being able to sell the animal nor eat its meat. This therefore caused the livestock keepers to slaughter and skin carcasses for human consumption. Likewise, in their study the Maasai participants reported not to slaughter their animals in an effort to preserve the animals for family income (Chege *et al.,* 2015). The results of the in-depth interviews showed that slaughtering and skinning of animals was a common practice and carcasses were skinned and butchered too by the local communities. Key informants identified this practice as being done mainly by the men. In this study, 67% of the respondents reported that they skinned and butchered dead animals, while 53% slaughtered sick livestock. This was often done at home without any inspection by public health officials. Animals were slaughtered for meat consumption at home, during ceremonies and during market days for sale to the public. When an animal died, it was butchered and consumed especially if it appeared healthy. The criterion that was used to determine whether the carcass was fit for human consumption was if the animal had not been visibly sick for a long time, if it was not emaciated or had other unusual signs as described in the quote below:

"We skin carcasses and if the meat looks okay then we eat the meat although we make sure that we cook it very well. We pastoralists are experts at this even if we have not gone to school. We know what disease the animal has died from whether it is from East Coast Fever (ECF) or trypanosomiasis. But don't eat raw meat from a carcass".

Male 65 years old, IDI Kilombero

Nevertheless, even when the meat was deemed not fit for human consumption by the people the carcass would still be skinned and the meat fed to dogs. From observation, the agro

pastoralists keep a lot of dogs in their homesteads sometimes up to 10 dogs. The participants also added that in the event that they had any reason to suspect that the meat might not be entirely safe especially since most knew about Rift valley fever (RVF) then they would cook the meat for longer than usual or dry it first before cooking the meat. They believed that this would get rid of any potential infectious agents to humans. This entailed boiling the meat and discarding the water before frying it, they believed that by discarding the water with which the meat had been boiled that they had eliminated any potential disease-causing organisms. They also observed the inner organs especially the liver and lungs for any swellings or discoloration and if any of these were present then the inner organs would be discarded but the rest of the meat would be consumed. Focus group discussion participants suggested that they failed to involve animal or public health officials before the slaughter of animals at home because they did not want to potentially be advised or forced to discard the animal because they perceived it as food. In this community although meat was a source of food, livestock were treasured as a source of wealth and income and animals were not slaughtered frequently for food. Therefore, when an animal died, it was an opportunity for the family to consume some meat which was considered a great delicacy. In fact, most of the study participants were surprised at the prospect of "throwing away food" referring to discarding livestock carcasses. The community did not perceive animals as potential sources of diseases in general and believed that God would take care of them as these excerpts elucidate:

"We eat meat from carcasses (laughter). God takes care of us. We are not afraid. We cook it and then eat. You see, once you boil the meat then it is safe to eat. If a sick cow dies, we boil the meat well before consuming it".

Female 50 years old, IDI Kilombero

"(Laughter) Oh no we do not throw away any carcass. We skin it and eat unless the cow is very emaciated because the meat is not even pleasant. If the animal is emaciated, we skin it and cook it for the dogs, we don't bury the carcass. If the cow is not emaciated, we skin it and eat the meat. We don't often slaughter large animals like cows so when one dies, we cannot waste the meat. Cattle also are equal to money. You cannot bury money, that will be a big loss so you would rather eat the meat. We are not afraid of death because one day we all will die and you cannot die before your time. When your day to die comes you will die whether you eat meat or not and vice versa. We listen to the radio about not eating meat during an outbreak

but we don't take it too seriously. We cook the meat as usual or sometimes cook the meat for long so that the meat does not affect the people eating it. Cooking it long will kill the germs".
Male 45 years old, IDI Kilombero

"*We livestock keepers are able to tell usual from unusual diseases so we eat carcasses of animals that died from familiar diseases. When meat is from a carcass, we cook the meat in a different way though, the meat is dried first so that all the blood dries first. We dry it because most diseases are transmitted from the blood so once the blood dries off then the meat is safe to eat.*
Female 21 years old, IDI Kilombero

Attitudes on assisting in parturition with bare hands and handling of birth products

The results of this study showed that, majority (90%,333) of the respondents assisted in parturition with bare hands. According to the key informants, in most cases, this was done by herders whose role it was to look after livestock. Women in focus group discussions noted that they were called upon to assist in parturition in the absence of a male and often for goats and sheep. Key informants and interviewees agreed that this practice persisted because it was culturally acceptable, familiar and also due to the low-risk perception for human disease related to this behavior. Notably too, the lack of the use of gloves was done because gloves were not even available in the homes. These attitudes of practicality and low risk perception are demonstrated through these excerpts below:

"Gloves are actually available in the shops but it is not our habit to use them. This is because we grew up seeing our fathers and mothers use bare hands so we also don't use gloves".
Women FGD1, Kilombero

"We have never encountered any harm after assisting in parturition and even if there were risk associated with this practice, we wouldn't know the cause was this behavior. Only you experts can tell us if there are any dangers in doing that. We started doing this from childhood and we've never encountered any harm. So according to us there can be no harm because if there were, we would have experienced them by now".
Men FGD1, Kilombero

Interviewees also observed that they found it cumbersome to have to carry gloves around since they looked after livestock far away from home. As noted earlier, the work of looking after cattle belonged to boys and young men who lived in communal grazing areas in temporary camps for up to nine months each year and only occasionally went home to collect foodstuff. These camps had only basic amenities and storing gloves was thus not deemed a necessity. Most of the cattle were looked after in this area and thus most of the parturition happened here. The small ruminants and few cattle that remained within the homesteads were also taken daily to the grasslands for grazing. According to the participants, washing their hands with plain water after assisting in parturition was deemed sufficient to remove any dirt. Discussants in the FGD with herders reported that they did not wash their hands as there was no perceived danger from this behavior. In this regard therefore, this behavior was perpetuated by inadequate awareness, low risk perception as well as practical reasons.

"There is no harm in assisting animals during parturition without gloves. We do that all the time and sometimes we don't even wash our hands after we are done…. we cook and eat with those same unwashed hands (laughter)".

Men FGD4, Kilombero

"If you as a herdsman needs to assist your cow and you are in the wild, where do you find gloves?

Women FGD1, Kilombero

Similarly, study participants in other settings engaged in unprotected assisted parturition in spite of increased knowledge on brucellosis because they did not perceive there to be any risk to their health (Arif *et al.,* 2017; Musallam *et al.,* 2015). Among the survey respondents, (67.4%) reported that they fed aborted material to dogs while 28.4% and 4.2% respectively reported that they buried it or left it to rot on the ground. Results of the qualitative aspect of this study show that the participants generally fed aborted material to dogs often after cutting it up and in some cases cooking it first. Discussants considered the action of cutting up and cooking aborted material to be necessary because in that case then they were able to distribute the meat among all the dogs that they owned. Key informants noted that the cooking of aborted material was also perceived as a preventive measure to protect the dogs against any potential infections emanating from the consumption of the dead fetus. Also, the interviewees suggested

that feeding raw aborted material to dogs would cause the dogs to acquire the habit of consuming newly born calves. The preparation of these fetuses for dog consumption was conducted by herders especially the teenage boys who also reported that they often tasted the meat from the aborted fetus after cooking it. In the FGD with herdsmen ***(FGD4, Kilombero)*** they observed that, "*Most often we feed the aborted material to our dogs. A few other livestock keepers bury or burn it. We cut it so as to drain most of the blood and cook the fetus before feeding it to the dogs and so that we can also taste the meat. Additionally, the reason the cow has aborted might be because the cow was sick and so the fetus is infected too. So, if the fetus is not cooked the dog can get the same infection that was in the cow.*

Concurringly, women in an FGD observed that*, "If the fetus was older say 7 months, it's cut into pieces and fed to the dogs. Usually it's the boys (10-12 years old) who cut it into pieces. It's cut into pieces because we often have many dogs and you need to share out the meat otherwise some weaker dogs may not get a share. Sometimes they cook the aborted fetus to make it more palatable for the dogs. Also, if you give the aborted material to the dogs without cutting it into pieces then the dogs might form the habit of eating healthy calves.".*
Women FGD1, Kilombero

In this study, men engaged in most of the livestock related duties such as slaughtering, herding and assisting in parturition. According to participants in this study, boys and younger men (13-19 years old) were involved in preparation of aborted fetuses to feed to dogs. Consequently, this increased their exposure to brucellosis. One study conducted in Kenya found that aborted material was fed to dogs on a regular basis (Onono *et al.,* 2019). Some have actually concluded that dogs could spread brucella bacteria since the dogs dragged the aborted materials on the ground (Njuguna *et al.,* 2017). In other contexts, livestock keepers also threw aborted material into water canals further distributing the infectious agents into the water sources (Hegazy *et al.,* 2015). The handling of aborted material in this study was done in a manner which would potentially lead to livestock and human infections with brucellosis. The inadequate knowledge on the risks from this behavior and the limited risk perceptions are a big barrier to the implementation of safer livestock parturition in this area. Concerted efforts are required to not only sensitize the community on the risks involved but also improve support and access to protective materials such as gloves.

Lay attitudes on residing with animals

Only a small minority (3.3%, 333) reported that they resided with livestock. Most of the participants in the FGDs and in-depth interviews reported that this was not a common practice anymore and most livestock keepers built an enclosure for animals outside. Nevertheless, participants reported that calves and other young animals were brought in the houses especially during the rainy season to protect them from the heavy rain and cold as they were deemed immature to handle such harsh conditions (Picture 5.4). Observations however, revealed that the practice of residing with animals was still very common especially among the herders. In several Wasukuma households visited, the researcher noticed that boys had their sleeping quarters right next to the sheep and goats' shelter (Picture 5.5). According to the key informants, this was done as a precautionary measure because the boys would protect the livestock in case wild animals attacked the livestock. Herders too, who lived in the grazing areas reported to sleep close to livestock. Herders felt it was safer to be closer to the animals at night to protect themselves against attacks by wild animals. The alertness of the livestock in case a wild animal attacked would startle the herders and they would be able to take appropriate action. Discussants also agreed that they slept outside with livestock because it sometimes got too hot making it difficult for them to sleep inside their dwellings.

"We sleep close to our animals when it's too hot inside like in the month of September. We also sleep close to the cattle to avoid animal attacks; livestock will stir when there is a wild animal nearby and that will alert us to any potential danger.

Men FGD4, Kilombero

"Yes, when there are many new born calves and it is raining we take them to the house and after two weeks we remove them. We don't want them to be rained on when they are very young. We put the calves in the living room while people sleep in the bedroom. But sometimes the calves will come to the bedroom as there often is no door separating the two rooms and we don't drive them away. You don't chase away property, it is a common thing here and there is no harm".

Male 30 years old, IDI Kilombero

Picture 5.4: A calf sleeping inside the house right next to the bedroom where people slept in a Maasai household.

Picture 5.5: A bed in the background covered by a mosquito net where young boys slept inside the goats and sheep

Local attitudes on handling and disposal of manure

In depth interviews and observations revealed a glaring difference in how the two major agro pastoralist communities, the Wasukuma and the Maasai handled and disposed of livestock manure. While the former handled the manure with shovels and kept their immediate compound well swept the latter did not and livestock dung was often found within the compound where the daily activities took place. The Wasukuma shoveled out all the manure into a pile to be used in the farms while the Maasai left it for days in the compound and only occasionally swept and disposed it handling it with bare hands and this was done by women (Picture 5.6). In in-depth interviews with members of the Maasai community, they said that they did not perceive animal dung to be harmful at all. They considered it safe to handle with bare hands and even would let their toddlers play with the manure. Indeed, for them manure was actually medicinal to humans with them arguing that since cattle and sheep ate plants then their dung also contained medicinal properties when consumed. In this case therefore if a person was ill, they would consume fresh dung mixed with water. They did this for common ailments like flu or fever. On the other hand, when a sheep was slaughtered, the mothers would

go and collect the stomach contents to feed to their children because they believed this would protect against and cure malaria. However, goat dung was not used because goats were not discriminatory in the plants they fed on, which made their dung harmful in case the goats had fed on plants that would be poisonous to humans. One female in-depth participant observed that:

"According to us the Maasai, we do not consider cow dung dirty and that is why we do not clear up cow dung found in the courtyard every day. And we have no problem touching it with our hands either. We even use cow dung to treat febrile illnesses whereby when one is very ill cow dung is mixed with water, sieved and the sick person drinks it. Also, sheep dung is extracted directly from the stomach of a slaughtered sheep and drank directly. Goat dung is not used because goats eat all kinds of plants some of which are unsuitable to humans. But sheep and cows eat medicinal plants thus the reason why their dung is considered to have medicinal properties".

Female 28 years old, IDI Kilombero.

Picture 5.6 A Maasai woman collecting cow dung with bare hands

Scholars have observed that although brucellosis is one of the most investigated zoonotic disease in Africa, a lot of the studies focus on animal diagnostics with hardly any social science investigation of the risk perceptions related to how people coexist with livestock (Cavalerie *et al.,* 2021). Numerous studies have been conducted in Africa among livestock keepers and have identified various risky activities for human brucellosis ranging from milking (Aworh *et al.,* 2013), slaughtering and skinning (Alexander *et al.,* 2012), assisting in parturition with bare hands and handling newborns (Aworh *et al.,* 2013; Muturi *et al.,* 2018), mingling of herds in communal grazing areas (Cloete *et al.,* 2019; Schelling *et al.,* 2003), residing with livestock (Alexander *et al.*, 2012) and keeping goats, sheep and cattle together (Shey-Njila *et al.,* 2005). Livestock keepers regularly handle animals as they milk, slaughter, treat, assist with parturition and herd and all these practices have the potential to lead to infection with brucellosis in humans (Alexander *et al.*, 2012; McDermott and Arimi, 2002). In this regard therefore, policy makers and public health practitioners need to engage with lay people at a deeper level to co-develop solutions that are tailored to specific contexts. Gender roles also need to be understood in the wider framework of people's livelihoods because this determines who is most at risk for brucelllosis based on their gender. It has been argued that part of the reason why pastoralists are not able to understand the health risks from livestock and their products is because of the great value attached and all the uses they accrue from them (Hastings, 2017). Pastoralists livelihoods are centered on livestock and their products including cow dung. They even use cow dung as part of their building materials and therefore it is not perceived as a source of human illness but as a benefit to them (Henderson *et al.,* 2017).

Interaction of livestock in the animal markets and in grazing areas

The findings of this study show that livestock routinely interacted in open livestock markets throughout the district. In the area where this study was conducted, there was a livestock market located in one of the villages (Sagamaganga) where the sale and purchase of livestock especially cattle occurred approximately thrice a month. Most of the livestock came from the surrounding villages but also from other areas within the district. Although livestock was not allowed in from outside the district, livestock traders moved livestock freely within the district from one cattle market to another. Discussants reported that they also would go to other markets within the district to purchase cattle especially if the prices were lower. This continuous, unmonitored circulation of cattle within the district was a big risk factor for the spread of brucellosis from one area to another. These perspectives related to the sale and purchase of cattle are demonstrated in the excerpts below:

"We buy animals locally from each other or from the market. Some of the cattle we buy here come from other areas within the district such as Mahenge and Mlimba, all within Kilombero district".

Male 54 years old, IDI Kilombero

"There are business men who trade in cattle and they are the ones that bring cattle to the market here. Once the cattle get here then people buy them to keep or to use as traction animals. Some business men also come and get cattle here which they sell in other markets".

Male 25 years old, IDI Kilombero

Picture 5.7: Livestock market in Sagamaganga village in Kilombero

Participants in this study observed that their livestock grazed together in the communal grazing areas which were located in the outskirts of the villages (Picture 5.8). According to the village land use plan, a specific area had been set aside where herders were to look after their cattle. This ensured that cattle were not grazed in farms or close to homes to prevent farmer- livestock keepers' conflicts and land degradation. These communal grazing areas were found in each of the three villages. Herders took their cattle to this area for nine months each year relocating

only when there was flooding in the area usually between mid-February and early May. These herders lived in temporary shelters in the communal area to look after the cattle. From observation, the cattle grazed together and were watered in the same watering points. The interaction between cattle from different herds in search of water and pasture, was not limited to cattle from the Kilombero district but also from the neighboring districts such as Ulanga. A 30-year-old participant said that, *"When it floods here in Sagamaganga (Kilombero district), we cross over to Mahenge (Ulanga district) and take our cattle there. Herders from Mahenge also come to graze their animals in our pasture area during the dry season there.* This close contact between cattle was a big risk factor for the spread of brucellosis among the animals due to possible contaminated pasture and watering areas.

This regular interaction between different herds could lead to the spread of brucellosis as animals shared feeding and watering areas. In one study, the sharing of pasture and purchase of cattle within the locality were positively associated with brucellosis (Cowie *et al.,* 2014) It has already been established that when animals graze together then there is interaction between infected and uninfected animals which perpetuates the spread of the brucella bacteria (Makita *et al.,* 2011). Secondly, most of the pastoralists in Africa live in remote places and do not have access to veterinary services and their livestock mingle freely which makes it more difficult to control brucellosis (Boukary *et al.,* 2013; Smits 2013). The control of brucellosis is a big challenge in Africa due to the unique challenges such as the free movement of cattle, purchase of cattle in open livestock markets where diseased animals are sold and the cultural value of close proximity to animals (Hegazy *et al.,* 2015; Mai *et al.,* 2012).

Risk perception at the community level is determined by culture including values and norms and the characterizes of the risk itself which include how prevalent the risk is, severity of the risk and the effects of the risk to individuals and community (Decker *et al.,* 2010). Social scientists have already observed that how risk is perceived is often different between experts and communities and this has an impact on disease prevention and control (Decker *et al.,* 2010; Jensen *et al.,* 2005; MacGregor and Waldman, 2017; Paul, 2016). Others have observed that hazards do not always translate to risks and that this affects whether people take any preventive or control measures and their willingness to do so (Roesel, 2014). Some are calling for a more inclusive perspective that looks at human- animal interactions in a broader sense that caters to local realities (MacGregor and Waldman, 2017). Thus, behavior change is complicated and

social science efforts should not be limited to “blaming” local people for their risky behavior but in elucidating all the factors that contribute to risk perception and risky behavior (MacGregor and Waldman, 2017). Open dialogue is needed that respectfully addresses the risk perceptions of lay people cognizant of the fact that these perceptions are not irrational but based on certain deeply entrenched values and ecological contexts (Jensen *et al.,* 2005).

Picture 5.8: Communal grazing area in Sagamaganga village.

Therefore, risk communication strategies must consider the social cultural and ecological background of the communities involved in order to be successful (Decker *et al.,* 2010; Jensen *et al.,* 2005). This is because values, norms and the characteristics of the risk itself which include how prevalent the risk is, severity of the risk and the perceived effects of the risk to individuals and community, determine how risk is assessed and perceived (Decker *et al.,* 2010; Paul, 2016). While a number of studies (Aworh *et al.,* 2013; Mai *et al.,* 2012; Muturi *et al.,*

2018; Nabirye *et al.,* 2017; Njuguna *et al.,* 2017) record that pastoral and agro pastoral communities do engage in behavior risking transmission, most do not analyze the reasons and rationale for such behavior. This study elaborates on the reasons that lead to such behavior in an agro pastoralist community. Other studies have commented on the need to understand the reasons governing people's behavior through detailed qualitative studies such as this one (Cash-Goldwasser *et al.,* 2018; Launiala, 2009). It is suggested that this would help to develop better, contextually relevant health education and disease control plans. This is because the perceptions of livestock keepers on the risks associated with livestock handling practices play a big role in determining their behavior.

5.4 Community perceptions of risk at the livestock-humans-wildlife interface

This section presents the results of the nature of the interaction at the livestock-wildlife interface by the agro pastoralists in Kilombero district. It is divided into two sections. The first section addresses the close proximity between livestock and wildlife in the grazing areas. The second section looks at the interaction between wild and domestic animals during movement.

5.4.1 Community attitudes on the close proximity and interaction between livestock and wildlife

In this study, 42% of the respondents reported that they routinely grazed their livestock in close proximity to wildlife. In the study areas, a land use management plan is used to designate specific areas for specific livelihood activities such as grazing and farming and also wildlife conservation areas. The area allocated for grazing for livestock keepers in the study villages directly bordered the wildlife management area (Picture 5.9). The wildlife Management Area (WMA) was home to a variety of wild animals such as buffaloes, elephants, wild pigs as well as the puku antelope. According to the key informants, this land use plan was implemented to avoid land degradation, reduce farmer/livestock keepers' conflicts over animals destroying crops as well as to keep livestock away from wildlife management areas. These communal grazing areas are specifically set aside and their boundaries marked with large boulders so that cattle do not encroach into wildlife habitat.

However, discussants in this study said that in spite of the demarcation between the grazing and wildlife areas, livestock and wild animals grazed together routinely and used the same sources of water. Humans and livestock were not allowed into the game areas and they were heavily fined if they encroached but both key informants and participants noted that this

encroachment still occurred especially during the dry months when pasture was depleted. During the dry season humans moved livestock into the wildlife areas secretly to avoid being apprehended. These dynamics of interaction in the wildlife-livestock interface are elucidated in the quotes below:

"There are elephants, lions, buffaloes, hippopotamus, puku antelopes and many other animals in these Wildlife Management Areas (WMA). And yes, livestock and wild animals graze in the same areas. This is because during the dry season herders move their animals to the wildlife areas to look for pasture and water".
Wildlife Officer, KII Kilombero

"There is interaction between wild and domestic animals because there is no fence delineating the two areas only some big boulders. And they all consume water from the same dams and rivers". ***Men FGD2, Kilombero***

Picture 5.9: Village (Signal) map showing the land use management plan. The area circled in red is the communal grazing area while the area circled in black is the Wildlife Management Area.

These routine interactions between livestock especially cattle with wildlife such as buffaloes, antelopes, lions, elephants and wild pigs were common in the area. This association was not

considered as a potential route for transmission of disease by some of the FGD discussants. Among the respondents who had ever heard of brucellosis, majority (87.5%) noted that brucellosis could be transmitted from wildlife to livestock but through tse tse flies that had already bitten infected wild animals. Men in one FGD **(Men FGD3, Kilombero)** noted that, *"Buffaloes especially do not cause any harm to cattle because they belong to the same family. If you observe keenly, antelopes have the same kind of hooves as goats and buffaloes as cattle. These ones are not harmful to cattle or goats. But animals that have claws are constantly harming our cattle especially the lions. For buffaloes they feed on the grass in the grazing area and there really is no problem other than the grass being depleted".* Other participants, however, suspected that this interaction might be the cause of abortions in cattle, although they didn't know if it was through tse tse flies or other means.

"We think that this interaction could be harmful especially because sometimes we see very ill and unhealthy wild animals. If they are sick and grazing together with cattle, they can transmit these same infections to the cattle. We don't know if this interaction can cause disease spread but when cattle abort, we wonder if it is because of diseases transmitted from wildlife. We don't understand. But harm is there.

Men FGD2, Kilombero

The brucella species namely B. *melitensis*, B. *abortus* and B. *suis* have the potential to infect close to 91 species of wildlife including whales and seals (Bengis *et al.,* 2004). In North America, brucellosis has been found to infect wild animals such as elk, bison, reindeer and foxes (Franc *et al.,* 2018; Godfroid, 2017). In Africa, studies have shown that various species of wildlife can be infected with brucellosis ranging from impalas, wildebeest, oryx, buffaloes, giraffes and lions (Alexander *et al.,* 2012; Assenga *et al.,* 2015; Motsi *et al.,* 2013; Shirima and Kunda, 2016). Although many of these infections in wild animals don't cause any symptoms; abortions, infertility and lameness are witnessed in some cases (Bengis *et al.,* 2004). Wildlife therefore can be reservoirs for brucellosis but not get infected (Kayunze *et al.,* 2012; Smits, 2013). Previous studies have concluded that the close interaction between humans, livestock and wildlife results in the perpetual transmission of brucellosis across species (Assenga *et al.,* 2015; Kansiime *et al.,* 2014). Transmission from wildlife to livestock and vice versa occurs through contaminated material such as birth products in the grazing areas and watering points as well as aerosol transmission. Another risk factor for brucellosis infections to humans is the

slaughter of wild animals through the animal's bodily fluids and blood during the slaughtering and skinning process (Godfroid *et al.,* 2013). Thus, when wild and domestic animals move and graze in the same areas there is a greater likelihood of infections moving from infected animals to noninfected animals. Once livestock are infected then the chances of humans being infected are also high through consumption of raw animal products and close contact with livestock and handling animal products. As a result, there is a continuous chain of infections.

According to the key informants and discussants, another route of interaction between livestock and wildlife was during cattle movement within the district and without. The participants noted that although movement of livestock to Kilombero district from other districts was not allowed by the Government it still happened clandestinely. In an in-depth interview with a 38-year-old livestock keeper he said that, *"I have trekked many times with cattle within the districts of Ulanga and Kilombero. It can take us up to a week to trek from one area to another within the district. We often pass through the wild so we encounter many different wild animals but we are only afraid of the lions because they hunt our cattle. The rest like elephants, antelopes and buffaloes we avoid and they are generally not harmful".*

Thus, the discussants observed happened by passing through wildlife conservation areas to avoid being apprehended. In the course of this movement, the cattle grazed in these areas with wildlife. Movement also within the district happened when the livestock keepers bought livestock from other cattle markets within the district and transported them on foot to their villages. On the other hand, since the entire Kilombero valley is prone to flooding, the wildlife also moved to higher ground during this time and they passed through inhabited areas as one 21-year-old interviewee said, "*In the past there were a lot of wild animals in this area like buffaloes and antelopes. They have now reduced and we only see them near the village when this area floods as they migrate to the higher areas like the Udzungwa mountains".* This movement therefore of both wild animals and livestock across the district could potentially lead to transmission across species as animals grazed in pastures that were contaminated such as through aborted material left on the ground.

In one study in Kenya, seropositivity for brucellosis in livestock was higher in villages that were closer to the game reserve than those which were further away and this was attributed to the close contact with wildlife (Enström *et al.*, 2017). A similar study in Zimbabwe found that

more seropositive buffalo were found in a wildlife- livestock interface area indicating the possibility of cross infections between cattle and buffalo (Motsi *et al.,* 2013). People are regularly moving their livestock to wildlife conservation areas because those are the few remaining places with an abundance of grass and water as population increases and grazing areas reduce (Kayunze *et al.*, 2012; Mazet *et al.,* 2009). Pastoralists in particular are always on the move in search of pasture and water for their livestock and this movement exposes them to wildlife which in turn leads to cross infections between the different species (Alhaji, Babalobi, and Isola, 2018).

Contact between livestock and wildlife is common in Tanzania especially in the areas which border national parks and game reserves (Mbugi *et al.,* 2012). Brucellosis transmission between wildlife and livestock is poorly understood in the study community and was only associated with tsetse flies by the agro pastoralists. They opined that any disease that was transmitted from wild animals to livestock would be through bites from tse tse flies because they knew that tse tse flies are found in the wild. Kilombero district has a rich diversity of wildlife including elephants, buffalos, puku antelopes and movement of animals between Selous game reserve and Udzungwa National park is still happening and the wildlife especially buffaloes move along villages due to the encroachment by humans into the wildlife corridors (Bamford *et al.,* 2015). The study villages are located between Selous game reserve and Udzungwa National park and are thus some of the villages where wild animals move across as they migrate. This shows that there is a big risk for cross infections across species in the communities living in these villages in Kilombero district.

Although some (Mbugi *et al.,* 2012) have noted that community education and sensitization on the dangers involved in this wildlife-livestock-human interface is critical to prevent zoonotic diseases transmission, my study shows that educating the community is insufficient if structural factors are not addressed such as where to situate a communal grazing area. Scientists have already concluded that the sharing of ecological spaces between livestock and wildlife leads to inter species transmission of brucellosis (Ducrotoy *et al.,* 2017). Thus the eradication of brucellosis in livestock in these interface areas could lead to breaking the transmission chain (Ducrotoy *et al.,* 2017). This can only happen if all stakeholders are involved so that all aspects of this interaction are addressed including cultural, environmental and structural. In this regard therefore there is a big emphasis in the One Health movement to look for ways and strategies

to address the increasing close contact between animals and humans because this is a potential pathway for infectious diseases including brucellosis (Goodwin *et al.,* 2012; Godfroid *et al.,* 2014). For example the encroachment into previously wild habitats is bringing people into close proximity with wildlife thus leading to human infections with diseases such as brucellosis and nipah virus (Goodwin *et al.,* 2012; Kansiime *et al.,* 2014). As discussed above, this interaction is both a result of local factors but also larger macro level factors as this study demonstrates. Consequently, the interdisciplinary approach is crucial to understanding the wildlife-human-livestock interface because these interactions are influenced by both natural, structural and social cultural factors (Cunningham, Daszak, and Wood 2017; Goodwin *et al.,* 2012; Kruse, Kirkemo, and Handeland, 2004).

Chapter 6: Treatment pathways associated with febrile illnesses

6.1 Introduction

This chapter discusses the results of objective 4 on the perceptions related to fever inducing illness and the treatment pathways taken by agro pastoralists during a febrile illness episode. It explores the actions that the participants take when they suspect they are suffering from a febrile illness and why those actions are taken. This chapter is divided into three sections. The first addresses the awareness and attitudes regarding the symptoms and causes of febrile illnesses. The second section looks at the various actions taken in seeking a cure for the illness and what influences each of the actions taken using the socio ecological model. The last section concludes the chapter by showing the influence of perceived etiology for febrile illness and severity to determine the steps taken and the complex nature of the decision-making process.

6.1.1 Biomedical definition of a febrile illness

A febrile illness is defined as a fever with a high body temperature above 38 degrees when there is no sign of a localized infection (Nyaoke *et al.,* 2019). While fever is often indicative of a disease, it can also be part of the human body's way of fighting off an infection (Ogoina, 2011). Fevers are grouped into three categories according to duration (Ogoina, 2011). Acute fevers typically last for less than 7 days and are often seen in the cases of malaria and viral caused upper respiratory tract infections. Sub-acute fevers on the other hand last for up to two weeks and are associated with typhoid fever and other infections while chronic fevers are persistent lasting more than two weeks and can be due to HIV, brucellosis, tuberculosis, cancer and other chronic illnesses (Ogoina, 2011). In Sub Saharan Africa, febrile diseases of viral, parasitic and bacterial origin contribute significantly to both morbidity and mortality (Maze *et al.,* 2018). Febrile diseases therefore, manifest with fever which can be a result of malaria as well as a host of other infectious diseases such as typhoid fever, pneumonia, respiratory tract infections, meningitis, brucellosis, urinary tract infections and dengue fever (Chipwaza, Mugasa, Mayumana, *et al.,* 2014; Crump *et al.,* 2013; Ghai *et al.,* 2016). For example in East Africa the prevalence of brucellosis among febrile patients has been estimated to be between 2.6 and 22.4% and pastoral communities are at a high risk due to their practices of drinking raw milk and assisting in parturition with bare hands (Maze *et al.,* 2018). Other bacterial zoonoses that are implicated in causing fevers include leptospirosis, Q fever and Rickettsia infections (Maze *et al.,* 2018). Distinguishing these diseases clinically is difficult and usually

a laboratory test is required to confirm the etiology of the disease and therefore in countries with poor diagnostic capacity patients are often mismanaged leading to chronicity and suffering (Crump *et al.,* 2013). Some have observed that malaria is over diagnosed in many African contexts where malaria is endemic sometimes by 30-60% and other causes of fever not sufficiently explored (Ghai *et al.,* 2016; Hooft *et al.,* 2017).

6.1.2 Epidemiology of febrile illnesses in Tanzania

In Tanzania malaria control efforts have led to a reduction in the incidence of this disease but nevertheless many other causes of fever are not sufficiently explored in the management of febrile patients (Hercik *et al.,* 2018; Kinimi *et al.,* 2018). Other studies in Tanzania have noted that most of the fevers are caused by viral diseases and not malaria (D'Acremont *et al.,* 2014; Tarimo, 2016). In addition, the possibilities of co infections are not adequately considered when treating patients. This is mainly due to low diagnostic capacity for other febrile conditions including zoonotic diseases such as brucellosis which causes febrile symptoms (Chipwaza *et al.,* 2014; Kinimi *et al.,* 2018). Some have called for the training of health workers especially in the rural facilities to increase their ability to diagnose non malarial febrile diseases (Baltzell *et al.,* 2013). Malaria is endemic in Kilombero valley although there are other causes of febrile illnesses that are not adequately investigated including Chikungunya and dengue fever (Harchut *et al.,* 2013; Kinimi *et al.,* 2018; Reyburn *et al.,* 2004). In one study malaria was being over diagnosed by 64% in Kilombero district indicating that most of the febrile cases might be due to other causes (Harchut *et al.,* 2013). In Kilombero district there is inadequate data on other causes of febrile conditions although some studies have demonstrated the presence of viral and bacterial infections in patients presenting with fever and co morbidities are very common too (Chipwaza *et al.,* 2014.; Hercik *et al.,* 2018; Kinimi *et al.,* 2018; Mchomvu *et al.,* 2019). The ecological dynamics of Kilombero district make it a good thriving ground for the high malaria transmission and this disease continues to be a public health concern (Metta *et al.,* 2014).

6.2 Lay awareness and attitudes on febrile illnesses

This section discusses the awareness, perceptions and perceived severity of febrile illnesses among the agro pastoralists in Kilombero district of Tanzania.

6.2.1 Awareness and perceptions on febrile illnesses

The participants in this study were very familiar with febrile illnesses known as *"homa"* in Kiswahili and this was perceived as a common medical issue in the area. Majority, 259 (78%) of the respondent mentioned that they had witnessed a case of febrile illness in their household during the three months prior to this study. The table below shows the symptoms that they reported to have witnessed that characterized a febrile illness:

Table 6.1: Reported symptoms of febrile illness by the study participants

Symptom	**Frequency**	**Percentage (%)**
Fever	250	97
Headache	220	85
Abdominal pain	178	69
Vomiting	173	67
Joint pains	172	66
Chills	163	63
Diarrhea	78	30
Sweating	30	12
Weight loss	18	7
Other (backache, coughing and loss of appetite)	15	6

These findings were corroborated in all the focus group discussions where chills, headache, fever, fatigue, vomiting, weakness and joint pains were mentioned as the signs of a febrile illness. These symptoms such as fever, headache, abdominal pain, joint pains and chills are congruent with a febrile disease (Hercik *et al.,* 2018). However, participants in the in-depth interviews differed on what exactly was classified as a febrile illness with some including a broader range of symptoms. Participants explained the symptoms of febrile illness as feeling unusually cold, extreme fatigue, sadness and loss of taste. For others, it included these symptoms but they added that any kind of bodily pain and discomfort would be considered a febrile illness. During my observations too, I noticed that some individuals reported that they had a "*homa"* when they had leg pain for example with no other accompanying signs. In this case therefore this term was loosely used to mean "a disease". For example, a mother whose 11-year-old daughter was experiencing leg pain and weakness described it as "*homa"* to friends

and well-wishers. Febrile illnesses however, were mainly associated with malaria and to a lesser extent typhoid and urinary tract infections (UTI). There were no other causes of febrile disease mentioned by the participants. Malaria was the most suspected cause of febrile illness. These varied and broad perspectives on febrile illnesses are expressed through the excerpts below:

"The first sign of a febrile illness is tiredness, which is followed by feeling cold and having a headache"
Female 35 years old, IDI Kilombero

" When one says they are suffering from a "homa"(febrile illness) they have grouped a number of symptoms together meaning that one must explain exactly where they feel pain or discomfort" ***Male 30 years old, IDI Kilombero.***

"Here we use the term "homa" loosely to mean an illness. But for me when someone says they have "homa" I conclude that they are suffering from malaria.
Male 45 years old, IDI Kilombero

"Anytime I or someone else here has joint pains and general malaise I know that is a sign of malaria. That is a febrile illness".
Male 51 years old, IDI Kilombero

These results show that both lay and biomedical classifications of an illness can exist side by side in a community and used interchangeably. Anthropological studies such as this one are able to elucidate these categories and classifications which provides a proper context for understanding treatment seeking behavior and why people make the choices that they do. Notably the way that the biomedical professionals categorize febrile illnesses is very definitive while for the lay people this is a very fluid process which includes a broad range of symptoms and experiences. Social scientists, have already observed that the biomedical model of defining disease and illness is insufficient in catering for the broad spectrum of human experience with illness because it is limited and reductionistic (Wade and Halligan, 2004). It is limited because it attempts to fit signs and symptoms into clear silos to represent certain diseases. On the other hand, individuals and communities often look at illnesses through a broader lens that can

include many symptoms which can cut across various diseases and experiences. This means that how people identify illness and categorize disease can differ from how clinicians and public health officials do it. Lay and biomedical models therefore are often used interchangeably and do not fall into neat categories (Nsungwa-Sabiiti *et al.,* 2004). Others have observed that social cultural perspectives do influence how diseases are viewed, perceived and categorized and consequently the most effective ways to treat them (Brown *et al.,* 2017; Granado *et al.,* 2011). Since the community incorporates both their own lay perspectives as well as biomedical perspectives in their assessment of a febrile illness, they also utilize various options for treatment. Thus, there needs to be a broader understanding of how febrile illnesses are understood in different settings as part of local peoples cultural construct (Das *et al.,* 2013; Kanté *et al.,* 2015; Mchome *et al.*, 2019; Mwenesi *et al.*, 1995).

Concurringly, key informants also noted that other cases of febrile illness were not routinely investigated. Rather malaria, typhoid and UTIs were the commonly diagnosed diseases among febrile patients. This was attributed to a general lack of prioritization of other diseases including those of zoonotic origin as well as lack of diagnostic capacity. This might also be contributing to the low awareness of the community on other diseases. The excerpts below elaborate more on this:

"Malaria is very common here and causes headache, fever, general malaise, vomiting and in some cases diarrhea. So, when a febrile patient comes to the facility, we suspect malaria but also typhoid and UTIs. And if the patient continues to have fevers we still do not think of other diseases like brucellosis".

Male clinician in a dispensary, KII Kilombero

"I have never encountered any case of brucellosis in this area because obtaining a clear diagnosis is very difficult. This is because one would have to conduct special investigations and most of the symptoms of brucellosis are similar to those of other diseases. Usually when a febrile patient visits this health facility, we suspect either malaria or typhoid.

Male clinician, in a public hospital, KII Kilombero

Similar studies in Tanzania, Kenya and Ghana also found that febrile signs were associated with malaria (Ahorlu *et al.,* 2007; Chipwaza *et al.,* 2014; Muela *et al.,* 1998; Mutua *et al.,*

2016). In a similar study conducted in Tanzania, *"homa"* was regarded as synonymous with malaria and this was seen as a common illness in spite of the fact that malaria can be lethal (Mchome *et al.,* 2019). Malaria is often used as a local classification for a myriad of febrile illnesses and this is attributed to the advocacy given on malaria so many people know about it and its potential severity.

6.2.2 Perceived severity of febrile illnesses

Additionally, in my study a distinction was made between ordinary febrile illness and severe febrile illness known as *"homa ya kawaida"* and *"homa kali"* respectively in Swahili. The difference between the two was made based on the degree of incapacitation of the sick person. Consequently, if an individual was unwell but still able to continue with most of their daily chores and they were eating then that was considered an ordinary disease. If on the other hand, the person was bedridden, unable to eat or walk then that was considered a severe disease. The findings also show that other considerations were made in determining the severity of a febrile illness and this included the age of the individual with little children's illnesses being taken more seriously as they could result in death. In other cases, also, certain individuals were perceived as more vulnerable to severe disease and so even when they had an ordinary fever it was treated as a severe episode because of their previous experiences. Others also regarded febrile illnesses as a common thing that required them to rest or drink water and then they would be well again. As explained above therefore, these results show that a very broad range of experiences and perspectives existed and no clear-cut categories were found in relation to febrile illnesses. In Tanzania, studies have found that the term *"homa"* is used variably although in most cases it denotes a fever causing illness mostly malaria (Kamat, 2006; Mchome *et al.,* 2019; Winch *et al.,* 1996). These views are captured in the following quote:

"When one is ill and can't eat, is in pain and in bed all the time then we know they are suffering from a severe febrile illness. But one who is sick but still able to walk, sit and perform most of their daily duties is suffering from a common illness. In this case therefore for the common illness we know it is caused by malaria and so we buy over the counter drugs. But if one is severely ill, we take them to a health facility.

Male 43 years old, IDI Kilombero.

In his study in Tanzania, febrile illnesses were classified into ordinary or severe based on the symptoms and this partly determined the treatment actions that were taken (Kamat, 2006).

Similar to this study, (Winch *et al.,* 1996) also discovered that someone would be considered to have *"homa"* which did not really require medical attention until it was a "disease" with more severe symptoms. Meaning that at the onset of febrile symptoms most people waited to see how the disease would develop before deciding on a course of action. In my study, at the onset of febrile signs most people either took local herbs or paracetamol and waited to see if the disease would require further attention. This was done mainly with older children and adults while little children below three years of age and older people were promptly taken to a health facility for treatment. In their study in Abidjan, Cote d'voire (Granado *et al.,* 2011) found that the common term *"palu"* for malaria was objectified to include also fatigue and stress and also as another febrile illness such as typhoid fever. This means that the usage of this term was very fluid and could refer to a number of conditions. Consequently, while bio medical terms are used, they are culturally constructed and comprehended to include a wider range of experiences. Thus, similar to my study, the term *"palu"* as used in Cote d'voire just like *"homa"* in Tanzania becomes part of the daily discourse to represent not just a biomedical malady but a broad spectrum of everyday challenges (Granado *et al.,* 2011). In one study conducted in Tanzania, severe febrile illness was defined as high fever and weakness with fever being associated with malaria by more than half of that study's participants (Kaatano *et al.,* 2009). Witchcraft and supernatural forces were also associated with febrile illnesses in one community in Tanzania (Kaatano *et al.,* 2009). A clear comprehension of these perspectives is crucial because it determines the lens with which lay people categorize symptoms and take action to treat the illness. In some cases what is considered an ordinary fever is often treated with over the counter medication until when serious signs come up like convulsions and then medical attention is sought (Kamat, 2008). Other studies established that in spite of the fact that fever was identified, local classifications meant that some kinds of fever required a biomedical cure while other kinds of fever required a traditional cure (Nsungwa-Sabiiti *et al.,* 2004). Thus culturally appropriate solutions were sought depending on the lay classification of fever (Nsungwa-Sabiiti *et al.,* 2004).

6.3 Treatment seeking behavior during a suspected febrile illness episode

This section discusses the actions taken in seeking treatment for a febrile illness while the second part uses the socio ecological model to explain the decision-making process in seeking that treatment. According to the results of this study, the community's treatment seeking behavior was determined by perceived cause and perceived severity of the disease. As

elaborated above, when a febrile episode was regarded as ordinary many concluded it was malaria and if antimalarials were consumed to no avail then other options were explored. The febrile illnesses common in Kilombero district and its environs include urinary tract infections, malaria, respiratory tract infections, brucellosis, Q fever, dengue fever, typhoid and leptospirosis with possible co infections (Chipwaza *et al.,* 2014; Hercik *et al.,* 2018; Mchomvu *et al.,* 2019). Scientists agree that local illness classification does play a major role in the actions taken in seeking treatment especially determining whether traditional or conventional treatment will be sought (Ahorlu *et al.,* 2007; Majaj *et al.,* 2013; Mutua *et al.,* 2016a; Nsungwa-Sabiiti *et al.,* 2004, Mbonye *et al .,* 2006). For example, in cases where disease causation was attributed to supernatural forces the people were hesitant to take any preventive actions because they did not feel that they had a lot of control in whether they suffered from the illness or not (Majaj *et al.,* 2013). In another study, local classifications of febrile episodes meant that some kinds of fever required a biomedical cure while other kinds of fever required a traditional cure (Nsungwa-Sabiiti *et al.,* 2004). So culturally appropriate solutions were sought depending on the lay classification of the fever (Nsungwa-Sabiiti *et al.,* 2004).

6.3.1 Actions taken during a suspected febrile illness episode

In this study, 87% of the respondents reported that they visited a health facility when they had signs of a febrile illness. A much smaller number, 11% and 1.5% reported that they purchased over the counter drugs and took herbal remedies respectively. However, in FGDs with the participants and also from observations, visiting a health facility was not the first course of action but often the last. The initial courses of actions taken were the use of herbal remedies at home, purchase and consumption of over-the-counter medication and visiting traditional healers. The steps taken in seeking treatment for febrile illness were greatly dependent on what was perceived as the cause of the illness as well as the perceived severity of the disease. Non severe febrile illness was synonymous with malaria which they considered treatable using over the counter drugs while severe illness was marked by non-recovery after taking malaria medication. At this point a visit to a health facility was considered necessary to identify the cause of ill health.

Use of herbal remedies

Participants in this study observed that they used herbal remedies when they had febrile signs. These were especially used when there was accompanying stomach pain or discomfort as well as flu like symptoms. These herbs were used by children, women and men and were gathered

from the areas surrounding the homesteads (Picture 6.1 and 6.2). These were considered effective because they caused intense sneezing, vomiting and/or diarrhea which the participants believed led to the elimination of the illness. Furthermore, these were consumed immediately at the onset of the symptoms for quick relief before further action was decided upon. This could be either a visit to a health facility or purchase of over-the-counter drugs. These opinions are elaborated in the following interview excerpts:

Interviewer: *What is the first thing you do when you are suffering from a febrile illness?*
Participant: *(Maasai woman) First I obtain from the bush and prepare a plant called "ng'ochangoko" in Kisukuma or "okaboya" in Maasai. I boil the plant and drink the water which causes very intense vomiting. We believe that once the vomiting happens then the malaria is gone. Actually, if you tell a child that you are going to get this medicine when they are ill, they beg you and tell you that they are not ill anymore (laughter). They do not like it at all. This medicine "cleans" you completely after all the vomiting. You vomit for like 15 minutes and feel a lot better if it is not a severe illness. This one really helps as first aid. In most cases the sick person will get better and if they don't then we take them to a health facility.*
Women FGD3, Kilombero

"I take herbal medicine when I have febrile symptoms. I take some herbs because we know them from our forefathers. I take some herbs then sneeze until I recover. I take herbs mostly before going to the hospital. The herbs are like first aid just for a day or a night and then I go to the hospital".
Male 53 years old, IDI Kilombero

Picture 6.1: Men taking a homemade herbal concoction

Picture 6.2 Herbs that are consumed when one has a febrile illness and they induce severe vomiting.

Similarly in Uganda, herbal concoctions were given to induce diarrhea which was perceived to cure the individual (Nsungwa-Sabiiti *et al.,* 2004). Concurringly, in a study conducted in Tanzania, self-medication at home was very common especially through the use of herbal cures (Kaatano *et al.,* 2009). Actually, some of the herbs that are used in Tanzania to treat malaria have indeed been demonstrated to be effective against the malaria parasite and this might be encouraging their persistent use by the local people (Gessler *et al.,* 1995).

Use of traditional healers

Interview participants suggested that traditional healers were visited when someone had a febrile illness that was accompanied by what they considered unusual signs such as confusion or weakness of the limbs. Traditional healers used herbs to treat their patients as well as certain rituals. Secondly, traditional healers were consulted in the event of a long convalescence after several hospital visits or a recurring febrile illness because this kind of illness was considered

to be a result of witchcraft or supernatural influence. These quotes below show that traditional healers were valued in certain specific febrile illness episodes:

"There are times when someone is suffering from a febrile illness that is a little weird e.g., one is confused and appears mentally ill. Now that one is taken to traditional healers to calm him or her down and then after that we take them to the hospital.
Male 28 years old, IDI Kilombero

"If someone is severely ill we first take them to the hospital and they get treated. But if they keep getting sick then we begin to wonder "why the regular illness"? In that case we start seeking help elsewhere especially from the traditional healers".
Male 38 years old, IDI Kilombero

"Most times we seek the help of local healers when a febrile illness persists for a long time. This is because they have the ability to determine if the disease is from a supernatural cause or someone has been bewitched. Doctors cannot do that and, in that case, therefore only the traditional healer can prescribe the correct course of treatment.
Female 40 years old, IDI Kilombero

Healers were sought after a while, usually after several hospital visits, the reason was that at this stage the perception was that the illness was caused by witchcraft and the clinicians and other conventional drugs would not cure the illness. Only a traditional healer was said to be able to address these kinds of maladies. This finding is especially important in brucellosis treatment in humans because this disease often presents as a febrile illness but it can be chronic in many cases and affects any organ in the body (Ducrotoy *et al.,* 2017). Therefore, if the community is unaware of the disease, it is possible for them to seek the attention of healers and this could lead to severe disease. Notably, healers were said to use both herbs and chants to cure the ill person and this could take a long time, even months. The participants noted that they would move from one healer to another in different parts of the country and ultimately if they were not healed then they would reenter the hospital system. That shows that a lot of delay would have taken place by this time. Similarly a study in Cote d'voire, found that traditional healers were sought once there was a persistent fever after hospital treatment and many did not seek further immediate medical attention because at this point the disease was attributed to

supernatural causes (Essé *et al.,* 2008). In their study in India, they found that immediate medical treatment following febrile symptoms was not sought and home remedies such as bitter herbs were used and if they didn't feel better after a few days they sought help from a traditional healer (Das *et al.,* 2013). In Mali people visited a traditional healer when they had fever because it was cheaper than visiting a formal health care facility (Ellis *et al.,* 2012).(Metta et al., 2015)(Metta et al., 2015) Contrary to these findings though, (Kamat, 2008) found that local healers were not as popular or utilized much as people used over the counter pharmaceuticals which were deemed a lot more efficient in his study community in Tanzania. Seeking treatment from traditional healers reveals that there are a lot of opportunities for misdiagnosis and wrong treatment which can eventually lead to chronic disease for example in the case of brucellosis as discussed above. Indeed, studies have shown that patients with brucellosis do not often receive the right treatment. This could lead to the development of chronic disease which can be debilitating (Chipwaza *et al.,* 2014; Crump *et al.,* 2013). Critically, when chronic symptoms develop, they may be further attributed to witchcraft because of the length of time needed to treat them. Suspicions of witch craft are very common in rural Tanzania especially when a febrile illness is persistent (Ribera and Hausmann-Muela, 2011).

Use of over-the-counter medication

This study found that over the counter medication mainly antimalarials and paracetamol were very commonly used when a suspected case of febrile disease occurred. This was especially the case when one thought that they had the common form of febrile illness and which was generally assumed to be malaria. The community also commonly associated certain symptoms with either malaria, typhoid or urinary tract infections and purchased over the counter medication for whichever of the three diseases they perceived to be the cause of their illness. In most of the cases headaches, chills and general malaise were associated with malaria, stomachache with typhoid and severe headache with urinary tract infections. These quotes below show these perspectives on actions taken based on the perceived cause:

"Typhoid causes headache, leg pains and stomachache. When these symptoms come, I purchase the right drugs to treat typhoid".

Male 43 years old, IDI Kilombero

"I often take paracetamol for immediate relief whenever I am suffering from a headache and chills and thereafter buy malaria medication".

Female 50 years old, IDI Kilombero

"For me, whenever I have malaria, I suffer joint pains and chills while for a urinary tract infection I get a very bad headache, typhoid on the other hand causes constipation and stomach pain".

Male 28 years old, IDI Kilombero.

"Purchasing malaria drugs is my immediate course of action whenever the chills start because I know it is malaria that I am suffering from".

Male 44 years old, IDI Kilombero

The participants also reported that they purchased any medication that was recommended by the shop attendants or any medication that they had used in the past usually following a clinician's prescription. Nevertheless, malaria drugs and paracetamol were the most purchased because of the perception that most fevers were as a result of malaria. First this demonstrates that local perception on disease causation played a big role in treatment seeking behavior. In addition, there is a great chance of mis treatment and drug misuse in the community due to these cases of self-treatment. There is also a big need to sensitize the community on other febrile illnesses that present similarly to malaria including brucellosis and other zoonotic diseases. Home based treatment for fever is very common all over Africa especially in the rural areas due to both cultural reasons as well as poor access to proper medical care (Chipwaza *et al.,* 2014; Ellis *et al.,* 2012; Ghai *et al.,* 2016; Kamat 2006; Amuyunzu-Nyamongo and Nyamongo, 2006). In his study though, access to a health facility was a far bigger determinant of health seeking behavior than local disease perceptions on etiology (Kamat, 2008). Thus, all the stakeholders need to think broadly when assessing community behavior and not seem to attribute health seeking behavior to local cultural beliefs while structural issues are a much greater barrier. In a similar study in Tanzania, self-treatment was common and paracetamol and malaria medicines were purchased over the counter as the first course of action when someone had a fever (Metta *et al.,* 2014). Likewise, febrile patients in Ethiopia sought over the counter malarial drugs because of the assumption that every fever was caused by malaria (Animut *et al.,* 2009). In Kenya too, mothers of febrile ill children attempted to treat their sick children at home using malaria drugs before taking them to a health facility (Amuyunzu-Nyamongo and Nyamongo, 2006). While some (Chipwaza *et al.,* 2014; Ghai *et al.,* 2016) have

concluded that rural communities purchase drugs due to poor physical access to health facilities, my study found that indeed physical access was a big barrier but so were the long queues in public health facilities. Comparably, the shops were a lot more accessible and there was no time wastage like in the public facility where participants reported that sometimes they would have to make several hospital visits before receiving treatment. Therefore, not only do lay perspectives need to be addressed in educating communities but also issues of timely access to health care. Many studies conducted in Africa have highlighted the different reasons that cause communities to prefer over the counter medications. One major factor for the self-treatment of febrile conditions in Tanzania was a result of the ease of access to medicine shops much more than formal health facilities (Metta *et al.,* 2014). Again in Tanzania, people preferred going to shops to buy medicine because they could purchase them on credit and the payment arrangement was much more friendly compared to health facilities where one had to pay before receiving any treatment (Kamat, 2008). In Mali people purchased modern drugs from shops because it was cheaper than visiting a formal health care facility (Ellis *et al.,* 2012).(Metta et al., 2015)(Metta et al., 2015) In Kenya, over the counter drugs were preferred because of ease of access and the low cost involved (Amuyunzu-Nyamongo & Nyamongo, 2006b).

Use of a formal healthcare facility

Study participants in the FGDs and in-depth interviews reported that they visited a health facility when the febrile illness was severe in which case the patient was visibly ill, could not eat or walk or perform their regular daily duties. On the other hand, children below three years of age and older people were also promptly taken to a health facility because of the fear of complications in their case. Visiting a health facility was considered in most cases, as a last resort after other options had been explored and used such as herbs and over the counter medications as the excerpts below demonstrate:

"First we take paracetamol and if not feeling better then we go to the health facility where they conduct tests like those for malaria and UTI and then we receive treatment".

Women FGD1, Kilombero

"We go to the hospital when critically sick and that is after trying other options like herbs, antimalarials and other over the counter medication"

Men FGD3, Kilombero

Key informants in the health sector, noted that they lacked diagnostic facilities for febrile illnesses and so when a febrile patient visited a health facility they first tested for malaria and used clinical signs to diagnose typhoid or urinary tract infections. In this regard a 26-year-old female clinician said that, *"We always test for malaria. But for typhoid and UTIs we take a proper history and diagnose clinically. This is because in the case of typhoid the patient will have not only malaria signs but also stomach pain, diarrhea and vomiting and lower abdominal pain in the case of UTIs. In addition, in the case of typhoid a patient will have a low-grade undulating fever. But with other infections like malaria and UTI the fever is consistent".*

This study shows that there was a significant delay in participants seeking medical care and this could lead to exacerbation of the symptoms making the conditions more difficult to treat. A study conducted in Palestine and Uganda found that there was a cultural expectation that women should only seek hospital care after first attempting home based cures like herbs and over the counter drugs (Majaj *et al.,* 2013). Similarly, in another study people visited a health care facility when their symptoms worsened (Metta *et al.,* 2014). Delay in seeking medical care is common in Tanzania and other parts of the world especially in rural communities (Amuyunzu-Nyamongo and Nyamongo, 2006; Ahorlu *et al.,* 2007; Kamat, 2006).

The lack of prioritization for non-malaria febrile illnesses and inadequate diagnostic services for a vast array of febrile illness in the area is a big hinderance too to the proper and timely management of these illnesses thus perpetuating the harmful cycle of seeking help from unskilled people (Chipwaza *et al.,* 2014; Chipwaza *et al.,* 2015). Thus, in many African settings pluralism is utilized in treatment seeking behavior for febrile illnesses as seen in the case of Tanzania (Kamat 2006), Mali (Ellis *et al.,* 2012), Kenya (Nyamongo, 2002), Uganda (Mbonye et al 2006) and Cote d Voire (Essé *et al.,* 2008). Also, the complexity of health care access and health seeking behavior has already been underscored and criticism made for the reductionistic approach of many analysis which delineates individual actions from larger cultural and policy issues (Kamat, 2006; Ribera and Hausmann-Muela, 2011). In this regard therefore, some social scientists have called for a "syndemic" perspective which incorporates biological, social, economic and ecological factors for a holistic understanding of treatment seeking behavior and for developing a broad action plan (Ellis *et al.,* 2012; Ribera and Hausmann-Muela, 2011;

Singer, Bulled, and Ostrach, 2012). This approach appreciates that disease does not occur in a vacuum but is influenced by the occurrence of other diseases, social and cultural conditions as well as structural inequalities that promote different vulnerabilities in populations (Dzingirai *et al.,* 2017). For example the SARS (severe acute respiratory syndrome) was much more severe in cases where comorbidities existed (Singer *et al.,* 2012). Such a critical assessment would help policy makers and practitioners to come up with strategies that are both culturally and contextually relevant. Meaning that community engagement and education is not sufficient if the larger issues such as access and proximity to health facilities are not addressed.

6.3.2 Decision making process on treatment options using the socio ecological model

This section examines the determinants which were found to influence treatment seeking behavior when self- reported febrile illness episodes occurred. Using the socio ecological model, the different levels of influence were found to be instrumental in the actions taken as presented in Table 6.2 below. These levels of influence are discussed in more detail below.

Table 6.2: Determinants of agro pastoralists treatment seeking behavior during a suspected febrile illness episode using the socio ecological model

Level of influence	Determinants	Illustration
Individual	Age	Children below the age of three taken to a health facility at the onset of symptoms for fear of severe illness.
	Economic status	Poorer households unable to afford cost of treatment in health facilities.
	Personal history	People take note of drugs they have used in the past and buy them anytime they have similar symptoms
Socio cultural	Lay attitudes on fever inducing illnesses	Febrile illnesses were generally regarded as malaria so malaria drugs bought for treatment
		The perceived severity of the symptoms was used to distinguish between common and severe disease.
		Most cases of febrile illness were attributed to malaria, Urinary tract infections and typhoid.
		Malaria associated with fever, chills and joint pains
		Urinary tract infection perceived to manifest through severe headache and backache
		Stomach pain and constipation were the main typhoid symptoms.
	Attitudes on formal and informal treatment	Traditional healers were sought when febrile illness persisted because these were attributed to witchcraft.
		Individuals who sold medicine were regarded as competent on disease causes and therefore able to administer the right treatment.
		When self-treatment failed clinicians were sought after due to their ability to perform the required tests to determine the cause of illness.
Environmental	Seasonal livelihood activities	Purchase of over-the-counter drugs was routinely done because people were unwilling to stop their daily activities related to farming and livestock keeping.
		Herders delayed in seeking medical attention as they were alone in remote areas looking after livestock.
	Weather	Access to health facilities was impeded by flooding which occurred each year for a period of time.
Structural	Accessibility to health services	Health facilities were inaccessible compared to shops that sold medicine.
		Medical tests were available only in major facilities which were situated in major towns and not in close proximity to most people.
		Tests for malaria, typhoid and urinary tract infections were conducted in private facilities which were closer to villages than public health facilities.

Individual level of influence

The individual factors that influenced treatment seeking behavior in this study were age, economic status and personal history of the patient with febrile illness. These are discussed in further detail below.

Age of the patient

In this study the age of the patient determined the actions taken when ill with a febrile illness. Participants in the in-depth interviews and FGDs noted that children below the age of three and older people were considered to be very vulnerable to serious and life-threatening febrile illness and thus were always taken to the hospital at the onset of symptoms. Younger children were also deemed unable to fully express the extent of their discomfort and thus their symptoms had to be taken seriously. In the case of older children and adults' other strategies were utilized as mentioned above ranging from herbs and antimalarials before a hospital visit but this was not done with toddlers and older people as the excerpts below show:

"Adults prefer using over the counter medications unless critically ill. Children below three years of age and older people are taken to the health facility immediately due to the risk for severe disease in their case".

Male 28 years old, IDI Kilombero.

"We take little children to the hospital because they cannot express how they feel so they might be severely ill and you may not know as the caregiver.

Women FGD1, Kilombero

Similarly in one study, children below five were prioritized for medical attention in a health facility which was related to the sensitization to parents on the severity of illnesses in under-five year old children (Kamat, 2006).

Economic status

Participants in this study opined those available resources at the time of the illness determined what mode of treatment was chosen. This was also dependent on how severe the illness was perceived to be. Seeking formal health care was considered expensive and thus when resources were limited and the illness considered to be a common one then over the counter medication

was sought to avoid spending money on tests and transportation to a health facility. If a subsequent action was needed and money was sufficient, they sought care in the more expensive private facilities to avoid the long queues in public facilities. However, when severely ill then all efforts were made to raise the money needed for treatment which included borrowing from neighbors and friends. Concurringly, key informants added that traditional healers were paid using goods such as farm produce which endeared patients to them as they did not need to have cash in hand. This shows that financial ability and affordability played a big role in determining what was done when one was ill. This was also based on the patient's previous experiences with a febrile illness too. This meant that some people were promptly taken to a health facility if they had a history of severe disease. The excerpts below elucidate on these perspectives:

"I prefer to buy over the counter medication when I do not have enough money. Visiting a health facility is costly because I have to cater for both transport and treatment costs"
Male 52 years old, IDI Kilombero.

"We buy over the counter medicine to avoid the long queues which comes with a significant expense because often you will not receive treatment in one day. It's so much trouble going to the health facility and also costly because you may have to go for two consecutive days and that costs money. Money for transportation, for lunch as well as for the medication.
Women FGD1, Kilombero

"We sell livestock or borrow money from neighbors if we have a severely ill person to be able to take them to hospital. This is especially if we know the individual gets severe febrile illness episodes".
Male 43 years old, IDI Kilombero.

Low financial capacity has been implicated in causing a delay in prompt medical seeking in other studies (Nyamongo, 2002; Das *et al.,* 2013; Metta *et al.,* 2014; Rashid *et al.,* 2001; Kanté *et al.,* 2015). Others have identified the preference for the purchase of drugs because of the low cost (Rashid *et al.,* 2001; Kanté *et al.,* 2015). In Mali people purchased modern drugs from shops or visited a traditional healer because it was cheaper than visiting a formal health care facility (Ellis *et al.,* 2012).

Previous experience with febrile illness episode

An individual's personal history with febrile illnesses was used to determine what options would be utilized when they had a similar episode in future. Discussants reported that they utilized several options such as storing previously used medicine packets so that they would buy the same medication when ill in the future and avoid visiting a health facility. On the other hand, certain individuals who were known to get severely ill were taken to a health facility without utilizing home remedies first. Furthermore, since certain febrile illness signs were associated with a certain disease, the community felt capable of self-treatment using herbs or over the counter medication based on the signs they were experiencing.

"I don't go to the hospital when I have familiar symptoms that I have had before. If I had headache, malaise and chills and went to hospital and each time am told its malaria then the third time I get those similar symptoms I know it is malaria and so I just go and buy malaria drugs".

Male 30 years old, IDI Kilombero

"When symptoms of a disease recur after treatment we go and purchase the treatment that we have used previously". ***Female 50 years old, IDI Kilombero***

"Many times, we familiarize ourselves with the common symptoms we encounter and the subsequent treatment administered. In this case, we store the drug packaging material and when we encounter similar symptoms we purchase that same medicine".

Male 52 years old, IDI Kilombero

In a study in Tanzania caregivers administered antimalarials to their feverish children because they believed that these same medicines would be provided in the health facility anyway based on their previous experience (Kamat, 2006).

Socio cultural level factors

The socio-cultural level factors that influenced people's treatment seeking behavior were community perceptions on febrile illnesses as well as attitudes on formal and informal treatment options as discussed elaborately below.

Community perceptions on febrile illnesses

The in-depth interviewees perceived malaria to be the cause of febrile symptoms and this disease was regarded as straightforward to treat using over-the-counter medication. A febrile illness (*homa* in Kiswahili) was considered one which caused chills, general aches, malaise, headaches and pain in the joints. A 45-year-old male participant defined a febrile illness as, *"General body pains, extreme fatigue, headache and joint pains.* A 21-year-old female respondent observed that, *"a febrile illness is defined as one that causes headaches, tummy ache, diarrhea and body aches".* When an individual had these signs, they perceived that they were either suffering from malaria, typhoid or a urinary tract infection (UTIs). Malaria however was the most common perceived cause of a febrile illness and thus over the counter medication mainly paracetamol and antimalarials were the primary course of action as demonstrated in the quotes below:

"Whenever I have chills, I definitely know that I am suffering from malaria and thus purchase malaria drugs".

Male 44 years old, IDI Kilombero

"I purchase paracetamol and malaria medication when I have symptoms such as a recurring headache".

Female 50 years old, IDI Kilombero

Studies in Tanzania and other parts of Africa had corresponding findings whereby febrile symptoms were attributed to malaria (Kamat, 2006; Winch *et al.,* 1996). In Ethiopia, over the counter malarial drugs were used because of the assumption that every fever was caused by malaria (Animut *et al.,* 2009). In Kenya, mothers of febrile ill children attempted to treat their sick children at home using malaria drugs before taking them to a health facility due to a similar attitude (Amuyunzu-Nyamongo and Nyamongo, 2006).

This is because there is a broad spectrum of febrile illnesses many of which are difficult to distinguish clinically. In Kilombero district, the common fever causing illnesses which have already been identified include urinary tract infections, malaria, respiratory tract infections, brucellosis, Q fever, dengue fever, typhoid and leptospirosis with possible co infection (Mchomvu *et al.,* 2019). Malaria, typhoid fever, pneumonia and urinary tract infections were

diagnosed in febrile patients in one study in Tanzania while no cases of brucellosis, leptospirosis and typhoid were clinically diagnosed (Chipwaza *et al.,* 2015).

As discussed earlier, the lay people differentiated between what they considered an ordinary/common febrile illness *(homa ya kawaida in Kiswahili)* and a severe one *(homa kali in Kiswahili).* An ordinary febrile illness was synonymous with malaria which they considered treatable using over the counter drugs while severe illness was marked by non-recovery after taking malaria medication. At this point a visit to a health facility was considered necessary to identify the cause of ill health. The statement below exemplifies this:

"We know someone has a regular illness (homa ya kawaida) if they have chills and joint pains but are still able to conduct their daily activities and so we buy them malaria drugs. Nevertheless, we identify severe illness (homa kali) as the time when the individual is too ill to eat, walk, talk and is in bed all the time and so we quickly take then to the hospital)".
Male 43yrs, IDI Kilombero

Additionally, the community differentiated symptoms of febrile illnesses (malaria, typhoid and urinary tract infections) symptomatically. In most of the cases, different set of symptoms were attributed to a different disease. For example, malaria signs were perceived to be severe headache, the major sign of a UTI was seen as backache and in the case of typhoid constipation and stomachache. Specific medication therefore was purchased depending on what the disease was perceived to be without a prescription. The statement below demonstrates this:

"Malaria ni homa na homa ni malaria" which means: Malaria is febrile illness and febrile illness is malaria. Headache, stomachache, bodily pains and vomiting are all signs of malaria"
Women FGD1, Kilombero

"I can tell what I am suffering from. For malaria I get chills and joint pains while for a urinary tract infection I have a very bad headache and for typhoid I get a stomachache and constipation and I will often go and purchase over the counter medication for the particular ailment I think I am suffering from.
Male 28 years old, IDI Kilombero.

Whenever a febrile illness persisted in spite of the use of pharmaceutical drugs, a traditional healer was sought as the illness was considered to be as a result of witchcraft. However, if the traditional methods failed then the patient went back to the formal health care system for treatment. These quotes below demonstrate this:

"We seek the attention of local healers when a febrile illness persists because most times this happens because of witchcraft or if the disease if from God. These healers are able to cure such illnesses because doctors cannot".

Female 40 years old, IDI Kilombero

Although some diseases causing fever can be severe and progress dangerously fast such as malaria some can be chronic and not cause serious illness at first such as brucellosis. Lay attitudes that determine what kinds of illnesses are regarded as common or severe can misguide and cause delayed treatment. The biomedical model of defining disease and illness including severity is also inadequate because it is limited and reductionistic (Nsungwa-Sabiiti *et al.,* 2004; Granado *et al.,* 2011; Wade and Halligan, 2004). All people experience ill health in a variety of ways and how disease is categorized thus influences if traditional or conventional treatment will be sought (Nsungwa-Sabiiti *et al.,* 2004; Granado *et al.,* 2011). Specifically, studies on health seeking behavior show that the perceived severity of a disease influenced the actions taken with delay in treatment by people of low socio economic means (Mutua 2016; Nyamongo, 2002; Kamat, 2006) In one study in Uganda, care seeking for a child who had a fever was dependent on perceived severity of the illness whereby some illnesses were seen as requiring traditional therapy (Nsungwa-Sabiiti *et al.,* 2004). Another study demonstrated that preventive action for disease were not taken when people thought that the disease occurred due to supernatural forces which were considered to be beyond their control (Majaj *et al.,* 2013).

Attitudes on formal and informal treatment

The community regarded both formal and informal providers highly albeit with different expertise. Clinicians were highly regarded since they could conduct tests and determine the exact cause of illness. Drug sellers were also considered experts in the administration of the right medication and so the medicine they recommended was seen as appropriate. Traditional healers were seen as able to deal with febrile illnesses caused by witchcraft which could not be

addressed using conventional drugs. Therefore, the formal and informal sources of treatment were valued for different reasons as these quotes below demonstrate:

"Those selling medicines are experts too and so we trust them when they recommend treatment. However, if we don't feel better then we go to a hospital where they can conduct tests. Sometimes you might be taking malaria medication and yet you are suffering from typhoid and so fail to recover".

Female 42 years old, IDI Kilombero

"We regard clinicians highly but sometimes they also fail to cure diseases and, in that case, we change strategy. We visit a traditional healer without telling the clinician because they do not like it when we do so. In some cases, we get better and can even tell the clinician that the traditional healer cured the illness but if not then we revert back to the clinicians and lie that we were looking for money for health care or we were using over the counter medication".

Male 45 years old, IDI Kilombero

In this study, health care personnel in the formal sector and providers in the informal sector were regarded as experts in addressing a fever causing illness. Their ability to conduct tests and determine the cause of disease made clinicians to be valued highly while those who sold drugs were seen as experts in recommending the right treatment. Local healers who used herbs and charms on the other hand were preferred when a febrile illness kept recurring and often several of them would be consulted. If traditional cures failed the patients would reenter the hospital system. The community determined which approach to utilize and which mode of treatment to pursue, whether formal or informal based on their attitude on the cause of the illness. A study in Tanzania noted that local people sought the attention of local healers after clinical care whenever they had a long running fever and further medical attention was often not sought after (Muela *et al.,* 1998). However, a study conducted in Tanzania found that local healers were not used as much with over the counter pharmaceuticals utilized more because these were deemed to be more effective (Kamat, 2008). The utilization of different modes of care has the potential to lead to the development of chronic disease which can be debilitating (McDermott and Arimi, 2002). Critically, when chronic symptoms develop, they may be further attributed to witchcraft because of the length of time needed to treat them.

Environmental factors

The environmental factors which determined treatment seeking behavior were seasonal livelihood activities as well as the weather.

Seasonal livelihood activities

In the study area, people were seasonally engaged in farm work between Feb-July of each year planting, weeding and harvesting their crops. Between Aug-Nov, the community was less busy before they started to prepare their farms again for the next planting season. During the busy season therefore, many reported that they preferred to buy medicines from local shops because visiting a health facility would take too much time but they were willing to visit a health facility during the less busy times. On the other hand, the grazing area was located *about* 8-12 km away from the homes and it is here that the herders camped for up to 9 months each year between June and February of the following year. As a result of their living far from home and from health facilities the herders often carried over the counter medicine such as antimalarials and paracetamol to use in case they had a febrile disease. The excerpts below elucidate this:

"For us herdsmen since we live away from the village and health facilities, we purchase the paracetamol and antimalarials and store them well and if one is sick then they take. We preserve them well and then we use them on ourselves or someone else who is sick. It is hard to walk all the way back to the village from the grazing area when sick.

Male 30 years old, IDI Kilombero.

"When ill I straight away go and buy medicine. It depends on how busy I am. If it is during the planting season, I buy over the counter medicine and take but like now when I am not very busy then I will go to the hospital. When I go to purchase the medicine, I specify the ones I want whether it is for malaria or UTI. Most of us do that, for those who don't know the specific names of the drugs they buy the ones recommended by the attendant".

Male 28 years old, IDI Kilombero

Weather

Discussants agreed that weather was also a big influencer of treatment seeking behavior. This is because this area was prone to flooding for about three to four months each year (Feb-May). When it flooded, movement was impaired since most people used bicycles or motorbikes for transportation and it became very difficult to move around especially for women (Pictures 6.3

and 6.4). This caused most of the people to purchase drugs, use herbs or visit traditional healers who were often located within the villages. The quotes below elucidate this:

"It is an immense challenge for many of us when it rains. The roads get flooded and our homes become inaccessible to motorbikes which are often our mode of transportation. It is even harder for us women and many times we prefer to use herbs or to send a man to buy us medicine when ill".

Female 50 years old, IDI Kilombero

"During the rainy season we have a big challenge because the roads are impassable. So, one keeps falling in the murky water if walking to a health facility and its really tough. We therefore opt to use herbs. But when it's not flooded it is not too hard because the motorbikes come all the way to our homes and thus it is easier to go to a health facility".

Women FGD3, Kilombero

Picture 6.3: Flooded road

Picture 6.4: The researcher trying to access Signal village.

Corroborating these findings, similar studies in Kilombero district demonstrated that during the rainy season (Jan to April) individuals faced greater challenges due to food shortage and flooding making it harder for people to access correct treatment due to limited household finances (Le Mare, Makungu, and Dunn, 2014; Ribera and Hausmann-Muela, 2011; Hadley, 2005; Spangler 2011). Therefore, the livelihood strategies that people engage in influence how people address illness and their treatment seeking practices (Le Mare *et al.,* 2014). Strategies to improve livelihood income such as through profitable animal rearing and farming practices would lead to more utilization of formal health care services (Le Mare *et al.,* 2014). In a study in Uganda, care seeking for children was negatively affected because mothers were busy tending to household duties (Hildenwall *et al.,* 2008). Similarly, in a study conducted in Palestine, women's treatment seeking behavior was negatively affected by their role in child care and household duties (Majaj *et al.,* 2013).

Structural factors

The major structural factor that influenced treatment seeking behavior for the agro pastoralists was accessibility and proximity to health services as discussed below.

Accessibility and proximity to health services

In this study participants said that accessibility and proximity to health services influenced their choice of treatment. These factors included long distances to health facilities, flooded roads, poor road network and long queues which all served as deterrents for the participants in opting to make a hospital visit their first cause of action except in cases of severe disease. Notably too, the agro pastoral communities lived in the fringes of the settlements where there was poor road access especially when it flooded making accessibility to public health facilities seriously impaired. Consequently, sick people opted to send their family members or friends for drugs in the shops instead of making the long trek to a health facility and queue all day or sometimes for several days. Traditional healers were also utilized because they were more accessible since they lived among the people in the villages. The following statement demonstrates these perspectives:

"Hey! It is tough for us here. If one goes to Kibaoni health center (Main facility in the area) you'll be there all day and you'll leave without medication and have to go back the following day to get the results of your tests and to see the clinician for medication. That is why we prefer

over the counter medication or visiting traditional healers because you get your treatment without delay".

Women FGD2, Kilombero

Long queues in public facilities also deterred many from visiting them and thus choosing to purchase over the counter medication. Public health facilities that are affordable might dissuade patients from seeking the help of unqualified persons when they suspected that they were suffering from a febrile illness. In one study, self-treatment was associated with the availability of medicine shops and privately owned laboratory facilities much more than formal health facilities causing people to visit a public health facility when the symptoms worsened (Metta *et al.,* 2014). Concurringly, in his study, access to a health facility was a far bigger determinant of health seeking behavior than local disease perceptions on etiology in rural Tanzania (Kamat, 2008). Lay people have been reported to use herbs and over the counter medication more due to their ease of access (Majaj, Nassar, and De Allegri, 2013). The registration of private health facilities therefore needs to be closely monitored and regulated to ensure the provision of appropriate and correct diagnosis and treatment and this would contribute to better health outcomes for the local people.

Chapter 7: Conclusion and Recommendations

7.1 Introduction

This chapter highlights the key findings of this study and proposes specific recommendations including further research areas.

7.2 Conclusion

The purpose of this study was to provide anthropological insights regarding the cultural and ecological context within which brucellosis occurs among agro pastoralists in Kilombero District in Tanzania. This study aimed at enriching the scope of work that has been conducted by epidemiologists, clinicians, veterinarians and biomedical scientists on brucellosis. This was done by providing in depth insights on the awareness, knowledge, risk perceptions and practices of the livestock keepers related to brucellosis. The treatment pathways followed by the agro pastoralists during a febrile illness have also been elaborated and discussed at length.

First in seeking to explore the awareness and knowledge of the agro pastoralists on brucellosis, this study found that they had very low awareness on brucellosis in livestock and no awareness at all on brucellosis in humans. Knowledge on brucellosis was also very low and the community had very minimal knowledge on the signs, causes and transmission pathways for brucellosis in both livestock and people. Men, those over 50 and with formal education were found to have more knowledge on brucellosis. However, increased knowledge on the disease did not lead to less risky practices by the participants. Nevertheless, brucellosis signs in livestock such as abortions, retained placenta, infertility, still births, weak calves and reduced milk production were seen regularly. These signs however were attributed to trypanosomiasis, unknown disease, difficult birth process, size of the animal and supernatural causes. These symptoms too, other than abortions were not considered very serious and more often than not diseased animals were retained for other purposes. These included sentimental value, use as traction animals and for economic value where they would be sold at a later date.

Secondly, the risk factors for brucellosis in humans included the consumption of raw animal products, handling aborted material and other animal products with bare hands and close proximity with livestock. The community did not consider any of these to be risk factors for any zoonotic disease, brucellosis included. On the other hand, they engaged in this behavior as part of their livestock rearing responsibilities and for cultural reasons. Raw milk was consumed

in the community as long-standing tradition as well as for practical reasons. These included rehydration in the absence of drinking water and because boiling milk was perceived as an unnecessary extra chore by the women who had a lot of other responsibilities in their homes and farms. Raw blood and raw meat were only consumed by members of the Maasai ethnic group and they believed that raw blood helped to replenish lost blood during child birth or during an injury or illness. Men in this communities engaged in most of the livestock management duties including milking, slaughtering, skinning and assisting in parturition. Young men were involved in handling aborted material by cutting up the fetuses and cooking these for consumption by dogs. The young boys and men also slept in close proximity to sheep, goats and sheep. Animals were routinely slaughtered for food in the homes and market places and carcasses were skinned for consumption by humans or to feed to the dogs if deemed unfit for human consumption.

Thirdly, livestock- wildlife interaction was very common in this area in the grazing areas and as livestock moved from one area to another within the district. The livestock in this community especially cattle grazed in communal grazing areas which were located about 10km from the villages. Young men (12-30 years old) lived in the communal grazing areas for up to nine months each year looking after cattle. Sheep, goats, calves and a few cows remained within the home and these grazed in pastures close to the homesteads or in the farms after crops had been harvested. The communal grazing areas directly bordered the Wildlife management Area (WMA) where a lot of wild animals existed such as elephants, buffaloes, antelopes, wild pigs, hippos and lions. There wasn't a fence separating the two areas and so wild animals and livestock mingled in the communal pastures. While herders and livestock were not allowed into the wildlife management areas they still secretly encroached especially during the dry months for pasture and water. On the other hand, wild animals and livestock used the same water holes in the area. Interaction between wild animals and domestic animals also happened during movement of cattle from one area to another within the district. Cattle were regularly moved from one area to another within the district and this was done by trekking. The herders and the cattle moved along areas with wildlife. Although these interactions could propagate brucellosis disease across species, the livestock keepers were not aware of this and did not perceive it as a risky activitiy. This area is also prone to flooding in late February to May each year. The communal grazing area was flooded during this time and so cattle were moved back

to the homes. Wild animals also moved to higher ground and they passed along the villages because the wildlife migration routes had been blocked by human activity.

Febrile illnesses were very common in the area with malaria being endemic in this lowland area. The signs that the community associated with febrile illnesses included fever, headache, stomachache, joint pains, vomiting and chills. These were often attributed to malaria and occasionally to typhoid fever and Urinary Tract Infections (UTIs). Secondly, the community distinguished between ordinary and severe febrile disease based on the extent of incapacitation of the sick individual. Most cases of ordinary febrile illness were associated with malaria unless there was non-recovery after the use of antimalarials. When a febrile illness was perceived as severe the patient was promptly taken to a health facility. Due to these perceptions' herbs and over the counter paracetamol and antimalarials were the first course of action taken in the case of a suspected febrile episode. Hospital treatment was sought after these strategies had been used and failed. Traditional healers were sought in cases where hospital treatment was deemed ineffective or when an illness took a long time to treat. This is because at this stage the illness was attributed to supernatural factors and the community perception was that only healers could address it and not clinicians. Both formal and informal treatment options therefore were valued and highly regarded depending on the course of the illness.

The factors that determined treatment seeking behavior were individual, socio cultural, environmental and structural. Individual factors were age, economic status and personal history with a febrile illness. Children below three and older people were taken to hospital promptly during a febrile illness episode as they were perceived to be at risk of severe illness. Socio cultural factors were community perceptions on the cause and severity of the illness as well as attitudes towards formal and informal health care. When a disease was perceived as ordinary then over the counter medication was the first cause of action. In the event that someone had made several hospital visits and used conventional treatment in vain then the disease was attributed to witchcraft and traditional medicine was sought after. Environmental factors were weather and seasonal livelihood activities. As noted, before, this area is prone to flooding which made the roads impassable and during that time herbs and over the counter medication were used as these were more accessible. In addition, during the busy planting, weeding and harvesting seasons the community preferred over the counter drugs to avoid spending time in health facilities where queues were often very long. Structural factors were accessibility and

proximity to health services. This related to both physical access as well as the time it took to receive treatment. The long queues in the public health facilities were a big impediment to prompt medical treatment for the community and also created resistance in using these facilities.

7.3 Recommendations

In light of the findings from this study, the following recommendations are made:

1. Continuous community education and engagement should be offered to address the low awareness and this should be done to children, herders, women and men in separate groups within the community. This would facilitate wide coverage and discussions to clarify misconceptions and increase their knowledge of brucellosis and its risk factors, transmission routes, control as well as treatment in both humas and livestock.
2. The veterinary and livestock department in Kilombero district should be strengthened so that they have the capacity to educate the livestock keepers as well as to diagnose brucellosis. This would be through trained and sufficient staff, motorbikes and fuel so that they can access the agro pastoralists as well as a diagnostic equipment and a laboratory. Livestock officers should also conduct demonstration exercises for best behavior in livestock handling during slaughter, skinning and parturition. This would enable the community to understand what is required to prevent disease transmission.
3. Collaboration between public health, livestock officials, wildlife experts and other stakeholders would be crucial so that they can continually educate the community on zoonotic diseases in general. This would allow them also to develop land use policies that are both supportive for the livestock keepers but also that do not expose them and their livestock to zoonotic diseases. They should also conduct participatory exercises to understand how the community prioritizes livestock and human diseases which would help them develop relevant and acceptable control measures.
4. The government of Tanzania should adequately staff and stock dispensaries and health facilities which are the first point of care for the community. This would ensure that sick people are treated adequately and promptly. Many diseases present as a febrile illness including brucellosis. However, these are not routinely suspected and malaria is over diagnosed in many malaria endemic regions like Kilombero district. Clinicians at

all levels should be sensitized to prioritize their examination for zoonotic diseases including brucellosis. This would ensure the timely management of patients and avoid the development of chronic symptoms which leads the community to seek help from non-professionals.

5. Interdisciplinary studies need to be conducted by natural and social scientists that are holistic in nature and close collaboration done with communities and policy makers so that relevant and suitable disease control measures are implemented.

REFERENCES

Addo, K. K., Mensah, G. I., Nartey, N., Nipah, G. K., Mensah, D., Aning, K. G., & Smits, H. L. (2011a). *Knowledge, Attitudes and Practices (KAP) of Herdsmen in Ghana with respect to Milk-Borne Zoonotic Diseases and the Safe Handling of Milk*. 7.

Addo, K. K., Mensah, G. I., Nartey, N., Nipah, G. K., Mensah, D., Aning, K. G., & Smits, H. L. (2011b). *Knowledge, Attitudes and Practices (KAP) of Herdsmen in Ghana with respect to Milk-Borne Zoonotic Diseases and the Safe Handling of Milk*. 7.

Adesokan, H. K., Akinseye, V. O., & Sulaimon, M. A. (2018). Knowledge and practices about zoonotic tuberculosis prevention and associated determinants amongst livestock workers in Nigeria; 2015. *PLOS ONE*, *13*(6), e0198810. https://doi.org/10.1371/journal.pone.0198810

Adesokan, H. K., Alabi, P. I., Stack, J. A., & Cadmus, S. I. B. (2013a). Knowledge and practices related to bovine brucellosis transmission amongst livestock workers in Yewa, south-western Nigeria. *Journal of the South African Veterinary Association*, *84*(1), 5 pages. https://doi.org/10.4102/jsava.v84i1.121

Adesokan, H. K., Alabi, P. I., Stack, J. A., & Cadmus, S. I. B. (2013b). Knowledge and practices related to bovine brucellosis transmission amongst livestock workers in Yewa, south-western Nigeria. *Journal of the South African Veterinary Association*, *84*(1). https://doi.org/10.4102/jsava.v84i1.121

Adesokan, H. K., Alabi, P. I., Stack, J. A., & Cadmus, S. I. B. (2013c). Knowledge and practices related to bovine brucellosis transmission amongst livestock workers in Yewa, south-western Nigeria. *Journal of the South African Veterinary Association*, *84*(1). https://doi.org/10.4102/jsava.v84i1.121

Adhikari, B., Phommasone, K., Pongvongsa, T., Koummarasy, P., Soundala, X., Henriques, G., Sirithiranont, P., Parker, D. M., von Seidlein, L., White, N. J., Day, N. P. J., Dondorp, A. M., Newton, P. N., Cheah, P. Y., Pell, C., & Mayxay, M. (2019). Treatment-seeking behaviour for febrile illnesses and its implications for malaria control and elimination in Savannakhet

Province, Lao PDR (Laos): A mixed method study. *BMC Health Services Research*, *19*(1), 252. https://doi.org/10.1186/s12913-019-4070-9

Adinan, J., Damian, D. J., Mosha, N. R., Mboya, I. B., Mamseri, R., & Msuya, S. E. (n.d.). *Individual and contextual factors associated with appropriate healthcare seeking behavior among febrile children in Tanzania*. 15.

Adinan, J., Damian, D. J., Mosha, N. R., Mboya, I. B., Mamseri, R., & Msuya, S. E. (2017). Individual and contextual factors associated with appropriate healthcare seeking behavior among febrile children in Tanzania. *PLOS ONE*, *12*(4), e0175446. https://doi.org/10.1371/journal.pone.0175446

Affognon, H., Mburu, P., Hassan, O. A., Kingori, S., Ahlm, C., Sang, R., & Evander, M. (2017). Ethnic groups' knowledge, attitude and practices and Rift Valley fever exposure in Isiolo County of Kenya. *PLOS Neglected Tropical Diseases*, *11*(3), e0005405. https://doi.org/10.1371/journal.pntd.0005405

Ahorlu, C. K., Koram, K. A., & Weiss, M. G. (2007). Children, Pregnant Women and the Culture of Malaria in Two Rural Communities of Ghana. *Anthropology & Medicine*, *14*(2), 167–181. https://doi.org/10.1080/13648470701381473

Albert, M., & Laberge, S. (2017). Confined to a tokenistic status: Social scientists in leadership roles in a national health research funding agency. *Social Science & Medicine*, *185*, 137–146. https://doi.org/10.1016/j.socscimed.2017.05.018

Alexander, K. A., Blackburn, J. K., Vandewalle, M. E., Pesapane, R., Baipoledi, E. K., & Elzer, P. H. (2012a). Buffalo, Bush Meat, and the Zoonotic Threat of Brucellosis in Botswana. *PLoS ONE*, *7*(3), e32842. https://doi.org/10.1371/journal.pone.0032842

Alexander, K. A., Blackburn, J. K., Vandewalle, M. E., Pesapane, R., Baipoledi, E. K., & Elzer, P. H. (2012b). Buffalo, Bush Meat, and the Zoonotic Threat of Brucellosis in Botswana. *PLoS ONE*, *7*(3), e32842. https://doi.org/10.1371/journal.pone.0032842

Alexander, K. A., Blackburn, J. K., Vandewalle, M. E., Pesapane, R., Baipoledi, E. K., & Elzer, P. H. (2012c). Buffalo, Bush Meat, and the Zoonotic Threat of Brucellosis in Botswana. *PLoS ONE*, *7*(3), e32842. https://doi.org/10.1371/journal.pone.0032842

Alhaji, N. B., Babalobi, O. O., & Isola, T. O. (2018a). A quantitative exploration of nomadic pastoralists' knowledge and practices towards Rift Valley fever in Niger State, North-central Nigeria: The associated socio-cultural drivers. *One Health*, *6*, 16–22. https://doi.org/10.1016/j.onehlt.2018.09.001

Alhaji, N. B., Babalobi, O. O., & Isola, T. O. (2018b). A quantitative exploration of nomadic pastoralists' knowledge and practices towards Rift Valley fever in Niger State, North-central Nigeria: The associated socio-cultural drivers. *One Health*, *6*, 16–22. https://doi.org/10.1016/j.onehlt.2018.09.001

Ali, S., Akhter, S., Neubauer, H., Melzer, F., Khan, I., Abatih, E. N., El-Adawy, H., Irfan, M., Muhammad, A., Akbar, M. W., Umar, S., Ali, Q., Iqbal, M. N., Mahmood, A., & Ahmed, H. (2017). Seroprevalence and risk factors associated with bovine brucellosis in the Potohar Plateau, Pakistan. *BMC Research Notes*, *10*(1). https://doi.org/10.1186/s13104-017-2394-2

Allen, T., & Parker, M. (2011). The 'Other Diseases' of the Millennium Development Goals: Rhetoric and reality of free drug distribution to cure the poor's parasites. *Third World Quarterly*, *32*(1), 91–117. https://doi.org/10.1080/01436597.2011.543816

Alonso, S., Dohoo, I., Lindahl, J., Verdugo, C., Akuku, I., & Grace, D. (2016). Prevalence of tuberculosis, brucellosis and trypanosomiasis in cattle in Tanzania: A systematic review and meta-analysis. *Animal Health Research Reviews*, *17*(1), 16–27. https://doi.org/10.1017/S146625231600013X

Ameri, A. A., Hendrickx, S. C. J., Jones, B., Mariner, J. C., Mehta, P., & Pissang, C. (2009). *Introduction to participatory epidemiology and its application to highly pathogenic avian influenza participatory disease surveillance: A manual for participatory disease surveillance practitioners*.

Amuyunzu-Nyamongo, M., & Nyamongo, I. K. (2006a). Health Seeking Behaviour of Mothers of Under-Five-Year-Old Children in the Slum Communities of Nairobi, Kenya. *Anthropology & Medicine*, *13*(1), 25–40. https://doi.org/10.1080/13648470500516261

Amuyunzu-Nyamongo, M., & Nyamongo, I. K. (2006b). Health Seeking Behaviour of Mothers of Under-Five-Year-Old Children in the Slum Communities of Nairobi, Kenya. *Anthropology & Medicine*, *13*(1), 25–40. https://doi.org/10.1080/13648470500516261

Animut, A., Mekonnen, Y., Shimelis, D., & Ephraim, E. (n.d.-a). *Febrile Illnesses of Different Etiology among Outpatients in Four Health Centers in Northwestern Ethiopia*. 4.

Animut, A., Mekonnen, Y., Shimelis, D., & Ephraim, E. (n.d.-b). *Febrile Illnesses of Different Etiology among Outpatients in Four Health Centers in Northwestern Ethiopia*. 4.

Arif, S., Thomson, P. C., Hernandez-Jover, M., McGill, D. M., Warriach, H. M., & Heller, J. (2017a). Knowledge, attitudes and practices (KAP) relating to brucellosis in smallholder dairy farmers in two provinces in Pakistan. *PLOS ONE*, *12*(3), e0173365. https://doi.org/10.1371/journal.pone.0173365

Arif, S., Thomson, P. C., Hernandez-Jover, M., McGill, D. M., Warriach, H. M., & Heller, J. (2017b). Knowledge, attitudes and practices (KAP) relating to brucellosis in smallholder dairy farmers in two provinces in Pakistan. *PLOS ONE*, *12*(3), e0173365. https://doi.org/10.1371/journal.pone.0173365

Asakura, S., Makingi, G., John, K., Kazwala, R., & Makita, K. (2019). Seroprevalence and risk factors for human brucellosis in agro-pastoral areas in Tanzania. *Tanzania Journal of Health Research*, *21*(1), 10.

Asiimwe, B. B., Kansiime, C., & Rwego, I. B. (2015a). Risk factors for human brucellosis in agro-pastoralist communities of south western Uganda: A case–control study. *BMC Research Notes*, *8*(1), 405. https://doi.org/10.1186/s13104-015-1361-z

Asiimwe, B. B., Kansiime, C., & Rwego, I. B. (2015b). Risk factors for human brucellosis in agro-pastoralist communities of south western Uganda: A case–control study. *BMC Research Notes*, *8*(1), 405. https://doi.org/10.1186/s13104-015-1361-z

Assenga, J. A. (2015). *Epidemiology of Brucella infection in the human, livestock and wildlife interface in the Katavi-Rukwa ecosystem, Tanzania*. 11.

Assenga, J. A., Matemba, L. E., Malakalinga, J. J., Muller, S. K., & Kazwala, R. R. (2016). Quantitative analysis of risk factors associated with brucellosis in livestock in the Katavi-Rukwa ecosystem, Tanzania. *Tropical Animal Health and Production*, *48*(2), 303–309. https://doi.org/10.1007/s11250-015-0951-z

Assenga, J. A., Matemba, L. E., Muller, S. K., Malakalinga, J. J., & Kazwala, R. R. (2015a). Epidemiology of Brucella infection in the human, livestock and wildlife interface in the Katavi-Rukwa ecosystem, Tanzania. *BMC Veterinary Research*, *11*(1). https://doi.org/10.1186/s12917-015-0504-8

Assenga, J. A., Matemba, L. E., Muller, S. K., Malakalinga, J. J., & Kazwala, R. R. (2015b). Epidemiology of Brucella infection in the human, livestock and wildlife interface in the Katavi-Rukwa ecosystem, Tanzania. *BMC Veterinary Research*, *11*(1). https://doi.org/10.1186/s12917-015-0504-8

Assenga, J. A., Matemba, L. E., Muller, S. K., Malakalinga, J. J., & Kazwala, R. R. (2015c). Epidemiology of Brucella infection in the human, livestock and wildlife interface in the Katavi-Rukwa ecosystem, Tanzania. *BMC Veterinary Research*, *11*(1). https://doi.org/10.1186/s12917-015-0504-8

Aworh, M. K., Okolocha, E., Kwaga, J., Fasina, F., Lazarus, D., Suleman, I., Poggensee, G., Nguku, P., & Nsubuga, P. (2013a). Human brucellosis: Seroprevalence and associated exposure factors among abattoir workers in Abuja, Nigeria - 2011. *Pan African Medical Journal*, *16*. https://doi.org/10.11604/pamj.2013.16.103.2143

Aworh, M. K., Okolocha, E., Kwaga, J., Fasina, F., Lazarus, D., Suleman, I., Poggensee, G., Nguku, P., & Nsubuga, P. (2013b). Human brucellosis: Seroprevalence and associated exposure factors among abattoir workers in Abuja, Nigeria - 2011. *Pan African Medical Journal*, *16*. https://doi.org/10.11604/pamj.2013.16.103.2143

Babo, S. A. Y., Fokou, G., Yapi, R. B., Mathew, C., Dayoro, A. K., Kazwala, R. R., & Bonfoh, B. (2022). Gendered asymmetry of access to knowledge for brucellosis control among pastoral communities in north-west Côte d'Ivoire. *Pastoralism*, *12*(1), 28. https://doi.org/10.1186/s13570-022-00241-9

Baltzell, K., Elfving, K., Shakely, D., Ali, A. S., Msellem, M., Gulati, S., & Mårtensson, A. (2013). Febrile illness management in children under five years of age: A qualitative pilot study on primary health care workers' practices in Zanzibar. *Malaria Journal*, *12*(1), 37. https://doi.org/10.1186/1475-2875-12-37

Bamaiyi, P. H. (2016). Prevalence and risk factors of brucellosis in man and domestic animals: A review. *International Journal of One Health*, *2*, 29–34. https://doi.org/10.14202/IJOH.2016.29-34

Bamford, A., Ferrol-Schulte, D., & Smith, H. (2014). *The status of the Ruipa corridor between the Selous game reserve and the Udzungwa mountains*. Fauna and Flora International, Oryx, 48(4), 504-513.

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

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

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

Bardosh, K. L., Berbri, I. E., Ducrotoy, M., Bouslikhane, M., Ouafaa, F. F., & Welburn, S. C. (2016). Zoonotic encounters at the slaughterhouse: pathways and possibilities for the control of Cystic Echinococcosis in Northern Morocco. *Journal of Biosocial Science*, *48*(S1), S92–S115. https://doi.org/10.1017/S0021932015000486

Bardosh, K. L., Murray, M., Khaemba, A. M., Smillie, K., & Lester, R. (2017). Operationalizing mHealth to improve patient care: A qualitative implementation science evaluation of the WelTel texting intervention in Canada and Kenya. *Globalization and Health*, *13*(1), 87. https://doi.org/10.1186/s12992-017-0311-z

Bardosh, K. L., Scoones, J. C., Grace, D., Kalema-Zikusoka, G., Jones, K. E., de Balogh, K., Waltner-Toews, D., Bett, B., Welburn, S. C., Mumford, E., & Dzingirai, V. (2017a). Engaging research with policy and action: What are the challenges of responding to zoonotic disease in Africa? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1725), 20160172. https://doi.org/10.1098/rstb.2016.0172

Bardosh, K. L., Scoones, J. C., Grace, D., Kalema-Zikusoka, G., Jones, K. E., de Balogh, K., Waltner-Toews, D., Bett, B., Welburn, S. C., Mumford, E., & Dzingirai, V. (2017b). Engaging research with policy and action: What are the challenges of responding to zoonotic disease in Africa? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1725), 20160172. https://doi.org/10.1098/rstb.2016.0172

Bengis, R. G., Leighton, F. A., Fischer, J. R., Artois, M., Mörner, T., & Tate, C. M. (n.d.-a). *The role of wildlife in emerging and re-emerging zoonoses*. 16.

Bengis, R. G., Leighton, F. A., Fischer, J. R., Artois, M., Mörner, T., & Tate, C. M. (n.d.-b). *The role of wildlife in emerging and re-emerging zoonoses*. 16.

Bonfoh, B., Kasymbekov, J., Dürr, S., Toktobaev, N., Doherr, M. G., Schueth, T., Zinsstag, J., & Schelling, E. (2012). Representative Seroprevalences of Brucellosis in Humans and Livestock in Kyrgyzstan. *EcoHealth*, *9*(2), 132–138. https://doi.org/10.1007/s10393-011-0722-x

Boukary, A. R., Saegerman, C., Abatih, E., Fretin, D., Alambédji Bada, R., De Deken, R., Harouna, H. A., Yenikoye, A., & Thys, E. (2013). Seroprevalence and Potential Risk Factors for Brucella Spp. Infection in Traditional Cattle, Sheep and Goats Reared in Urban, Periurban and Rural Areas of Niger. *PLoS ONE*, *8*(12), e83175. https://doi.org/10.1371/journal.pone.0083175

Bouley, A. J., Biggs, H. M., Stoddard, R. A., Morrissey, A. B., Bartlett, J. A., Afwamba, I. A., Maro, V. P., Kinabo, G. D., Saganda, W., Cleaveland, S., & Crump, J. A. (n.d.). *Brucellosis among Hospitalized Febrile Patients in Northern Tanzania*. 7.

Bouley, A. J., Biggs, H. M., Stoddard, R. A., Morrissey, A. B., Bartlett, J. A., Afwamba, I. A., Maro, V. P., Kinabo, G. D., Saganda, W., Cleaveland, S., & Crump, J. A. (2012). Brucellosis among Hospitalized Febrile Patients in Northern Tanzania. *American Journal of Tropical Medicine and Hygiene*, *87*(6), 1105–1111. https://doi.org/10.4269/ajtmh.2012.12-0327

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist*, *32*(7), 513.

Bronner, A., Hénaux, V., Fortané, N., Hendrikx, P., & Calavas, D. (2014). Why do farmers and veterinarians not report all bovine abortions, as requested by the clinical brucellosis surveillance system in France? *BMC Veterinary Research*, *10*(1), 93. https://doi.org/10.1186/1746-6148-10-93

Brown, H., Kelly, A. H., Marí Sáez, A., Fichet-Calvet, E., Ansumana, R., Bonwitt, J., Magassouba, N., Sahr, F., & Borchert, M. (2015). Extending the "Social": Anthropological Contributions to the Study of Viral Haemorrhagic Fevers. *PLOS Neglected Tropical Diseases*, *9*(4), e0003651. https://doi.org/10.1371/journal.pntd.0003651

Brown, N., González, L. T. de, McIlwraith, T. F., American Anthropological Association, BC Open Textbook Project, & BCcampus. (2017). *Perspectives: An open invitation to cultural anthropology*. https://open.bccampus.ca/find-open-textbooks/?uuid=af6a3eed-243a-4eeb-8903-65df924a1201&contributor=&keyword=&subject=

Buhari, H. U. (2015a). Knowledge, Attitude and Practices of Pastoralists on Bovine Brucellosis in the North Senatorial District of Kaduna state, Nigeria. *Journal of Animal Health and Production*, *3*(2), 28–34. https://doi.org/10.14737/journal.jahp/2015/3.2.28.34

Buhari, H. U. (2015b). Knowledge, Attitude and Practices of Pastoralists on Bovine Brucellosis in the North Senatorial District of Kaduna state, Nigeria. *Journal of Animal Health and Production*, *3*(2), 28–34. https://doi.org/10.14737/journal.jahp/2015/3.2.28.34

Bukachi, S. A., Mumbo, A. A., Alak, A. C. D., Sebit, W., Rumunu, J., Biéler, S., & Ndung'u, J. M. (2018). Knowledge, attitudes and practices about human African trypanosomiasis and their implications in designing intervention strategies for Yei county, South Sudan. *PLOS Neglected Tropical Diseases*, *12*(10), e0006826. https://doi.org/10.1371/journal.pntd.0006826

Burton, D. C., Flannery, B., Onyango, B., Larson, C., Alaii, J., Zhang, X., Hamel, M. J., Breiman, R. F., & Feikin, D. R. (2011). Healthcare-seeking Behaviour for Common Infectious Disease-related Illnesses in Rural Kenya: A Community-based House-to-house Survey. *Journal of Health, Population, and Nutrition*, *29*(1), 61–70. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3075057/

Campbell, D. (2020). Anthropology's Contribution to Public Health Policy development. *McGill Journal of Medicine*, *13*(1). https://doi.org/10.26443/mjm.v13i1.239

Carugati, M., Biggs, H. M., Maze, M. J., Stoddard, R. A., Cash-Goldwasser, S., Hertz, J. T., Halliday, J. E. B., Saganda, W., Lwezaula, B. F., Kazwala, R. R., Cleaveland, S., Maro, V. P., Rubach, M. P., & Crump, J. A. (2018). Incidence of human brucellosis in the Kilimanjaro Region of Tanzania in the periods 2007–2008 and 2012–2014. *Transactions of The Royal Society of Tropical Medicine and Hygiene*, *112*(3), 136–143. https://doi.org/10.1093/trstmh/try033

Cash-Goldwasser, S., Maze, M. J., Rubach, M. P., Biggs, H. M., Stoddard, R. A., Sharples, K. J., Halliday, J. E. B., Cleaveland, S., Shand, M. C., Mmbaga, B. T., Muiruri, C., Saganda, W., Lwezaula, B. F., Kazwala, R. R., Maro, V. P., & Crump, J. A. (n.d.). *Risk Factors for Human Brucellosis in Northern Tanzania*. 9.

Cash-Goldwasser, S., Maze, M. J., Rubach, M. P., Biggs, H. M., Stoddard, R. A., Sharples, K. J., Halliday, J. E. B., Cleaveland, S., Shand, M. C., Mmbaga, B. T., Muiruri, C., Saganda, W., Lwezaula, B. F., Kazwala, R. R., Maro, V. P., & Crump, J. A. (2018). Risk Factors for Human Brucellosis in Northern Tanzania. *The American Journal of Tropical Medicine and Hygiene*, *98*(2), 598–606. https://doi.org/10.4269/ajtmh.17-0125

Castro, M., Sánchez, L., Pérez, D., Sebrango, C., Shkedy, Z., & Van der Stuyft, P. (2013). The Relationship between Economic Status, Knowledge on Dengue, Risk Perceptions and Practices. *PLoS ONE*, *8*(12), e81875. https://doi.org/10.1371/journal.pone.0081875

Caudell, M. A., Charoonsophonsak, P. V., Miller, A., Lyimo, B., Subbiah, M., Buza, J., & Call, D. R. (2019). Narrative risk messages increase uptake and sharing of health interventions in a hard-to-reach population: A pilot study to promote milk safety among Maasai pastoralists in Tanzania. *Pastoralism*, *9*(1), 7. https://doi.org/10.1186/s13570-019-0142-z

Cavalerie, L., Wardeh, M., Lebrasseur, O., Nanyingi, M., McIntyre, K. M., Kaba, M., Asrat, D., Christley, R., Pinchbeck, G., Baylis, M., & Mor, S. M. (2021). One hundred years of zoonoses research in the Horn of Africa: A scoping review. *PLOS Neglected Tropical Diseases*, *15*(7), e0009607. https://doi.org/10.1371/journal.pntd.0009607

Chege, P. M., Kimiywe, J. O., & Ndungu, Z. W. (2015a). Influence of culture on dietary practices of children under five years among Maasai pastoralists in Kajiado, Kenya. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 131. https://doi.org/10.1186/s12966-015-0284-3

Chege, P. M., Kimiywe, J. O., & Ndungu, Z. W. (2015b). Influence of culture on dietary practices of children under five years among Maasai pastoralists in Kajiado, Kenya. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 131. https://doi.org/10.1186/s12966-015-0284-3

Chipwaza, B., Mhamphi, G. G., Ngatunga, S. D., Selemani, M., Amuri, M., Mugasa, J. P., & Gwakisa, P. S. (2015b). Prevalence of Bacterial Febrile Illnesses in Children in Kilosa District, Tanzania.

PLOS Neglected Tropical Diseases, *9*(5), e0003750. https://doi.org/10.1371/journal.pntd.0003750

Chipwaza, B., Mugasa, J. P., Mayumana, I., Amuri, M., Makungu, C., & Gwakisa, P. S. (2014b). Community Knowledge and Attitudes and Health Workers' Practices regarding Non-malaria Febrile Illnesses in Eastern Tanzania. *PLoS Neglected Tropical Diseases*, *8*(5), e2896. https://doi.org/10.1371/journal.pntd.0002896

Chipwaza, B., Mugasa, J. P., Mayumana, I., Amuri, M., Makungu, C., & Gwakisa, P. S. (2014d). Self-medication with anti-malarials is a common practice in rural communities of Kilosa district in Tanzania despite the reported decline of malaria. *Malaria Journal*, *13*(1). https://doi.org/10.1186/1475-2875-13-252

Chipwaza, B., Mugasa, J. P., Selemani, M., Amuri, M., Mosha, F., Ngatunga, S. D., & Gwakisa, P. S. (2014). Dengue and Chikungunya Fever among Viral Diseases in Outpatient Febrile Children in Kilosa District Hospital, Tanzania. *PLoS Neglected Tropical Diseases*, *8*(11), e3335. https://doi.org/10.1371/journal.pntd.0003335

Cloete, A., Gerstenberg, C., Mayet, N., & Tempia, S. (2019). Brucellosis knowledge, attitudes and practices of a South African communal cattle keeper group. *Onderstepoort Journal of Veterinary Research*, *86*(1). https://doi.org/10.4102/ojvr.v86i1.1671

Colman, H., Komba, E., Kazwala, R., & Mathew, C. (2022). Prevalence of Brucella infection and associated risk factors among children in livestock keeping communities of Morogoro, Tanzania. *East African Journal of Science, Technology and Innovation*, *3*(2). https://doi.org/10.37425/eajsti.v3i2.419

Cowie, C. E., Marreos, N., Gortázar, C., Jaroso, R., White, P. C. L., & Balseiro, A. (2014). Shared risk factors for multiple livestock diseases: A case study of bovine tuberculosis and brucellosis. *Research in Veterinary Science*, *97*(3), 491–497. https://doi.org/10.1016/j.rvsc.2014.09.002

Crump, J. A., Morrissey, A. B., Nicholson, W. L., Massung, R. F., Stoddard, R. A., Galloway, R. L., Ooi, E. E., Maro, V. P., Saganda, W., Kinabo, G. D., Muiruri, C., & Bartlett, J. A. (2013). Etiology of

Severe Non-malaria Febrile Illness in Northern Tanzania: A Prospective Cohort Study. *PLoS Neglected Tropical Diseases*, *7*(7), e2324. https://doi.org/10.1371/journal.pntd.0002324

Cunningham, A. A., Daszak, P., & Wood, J. L. N. (2017). One Health, emerging infectious diseases and wildlife: Two decades of progress? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1725), 20160167. https://doi.org/10.1098/rstb.2016.0167

Cunningham, A. A., Scoones, I., & Wood, J. L. N. (2017). One Health for a changing world: New perspectives from Africa. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1725), 20160162. https://doi.org/10.1098/rstb.2016.0162

D'Acremont, V., Kilowoko, M., Kyungu, E., Philipina, S., Sangu, W., Kahama-Maro, J., Lengeler, C., Cherpillod, P., Kaiser, L., & Genton, B. (2014). Beyond Malaria—Causes of Fever in Outpatient Tanzanian Children. *New England Journal of Medicine*, *370*(9), 809–817. https://doi.org/10.1056/NEJMoa1214482

Das, A., Gupta, R. D., Friedman, J., Pradhan, M. M., Mohapatra, C. C., & Sandhibigraha, D. (2013). Community perceptions on malaria and care-seeking practices in endemic Indian settings: Policy implications for the malaria control programme. *Malaria Journal*, *12*(1), 39. https://doi.org/10.1186/1475-2875-12-39

Decker, D. J., Evensen, D. T. N., Siemer, W. F., Leong, K. M., Riley, S. J., Wild, M. A., Castle, K. T., & Higgins, C. L. (2010a). Understanding Risk Perceptions to Enhance Communication about Human-Wildlife Interactions and the Impacts of Zoonotic Disease. *ILAR Journal*, *51*(3), 255–261. https://doi.org/10.1093/ilar.51.3.255

Dereje, T., Benti, D., Feyisa, B., & Abiy, G. (2018). Review of common causes of abortion in dairy cattlein Ethiopia. *Journal of Veterinary Medicine and Animal Health*, *10*(1), 1–13. https://doi.org/10.5897/JVMAH2017.0639

Dillip, A., Hetzel, M. W., Gosoniu, D., Kessy, F., Lengeler, C., Mayumana, I., Mshana, C., Mshinda, H., Schulze, A., Makemba, A., Pfeiffer, C., Weiss, M. G., & Obrist, B. (2009). Socio-cultural factors

explaining timely and appropriate use of health facilities for degedege in south-eastern Tanzania. *Malaria Journal*, *8*(1), 144. https://doi.org/10.1186/1475-2875-8-144

Dinesen, L. (2016). Kilombero Valley Floodplain (Tanzania). In C. M. Finlayson, G. R. Milton, R. C. Prentice, & N. C. Davidson (Eds.), *The Wetland Book* (pp. 1–8). Springer Netherlands. https://doi.org/10.1007/978-94-007-6173-5_224-1

Djangwani, J., Ooko Abong', G., Gicuku Njue, L., & Kaindi, D. W. M. (2021). Brucellosis: Prevalence with reference to East African community countries – A rapid review. *Veterinary Medicine and Science*, *7*(3), 851–867. https://doi.org/10.1002/vms3.425

Ducrotoy, M., Bertu, W. J., Matope, G., Cadmus, S., Conde-Álvarez, R., Gusi, A. M., Welburn, S., Ocholi, R., Blasco, J. M., & Moriyón, I. (2017a). Brucellosis in Sub-Saharan Africa: Current challenges for management, diagnosis and control. *Acta Tropica*, *165*, 179–193. https://doi.org/10.1016/j.actatropica.2015.10.023

Dunn, C. E., Le Mare, A., & Makungu, C. (2011). Malaria risk behaviours, socio-cultural practices and rural livelihoods in southern Tanzania: Implications for bednet usage. *Social Science & Medicine*, *72*(3), 408–417. https://doi.org/10.1016/j.socscimed.2010.11.009

Dzingirai, V., Bett, B., Bukachi, S., Lawson, E., Mangwanya, L., Scoones, I., Waldman, L., Wilkinson, A., Leach, M., & Winnebah, T. (2017a). Zoonotic diseases: Who gets sick, and why? Explorations from Africa. *Critical Public Health*, *27*(1), 97–110. https://doi.org/10.1080/09581596.2016.1187260

Dzingirai, V., Bett, B., Bukachi, S., Lawson, E., Mangwanya, L., Scoones, I., Waldman, L., Wilkinson, A., Leach, M., & Winnebah, T. (2017b). Zoonotic diseases: Who gets sick, and why? Explorations from Africa. *Critical Public Health*, *27*(1), 97–110. https://doi.org/10.1080/09581596.2016.1187260

Dzingirai, V., Bukachi, S., Leach, M., Mangwanya, L., Scoones, I., & Wilkinson, A. (2017). Structural drivers of vulnerability to zoonotic disease in Africa. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1725), 20160169. https://doi.org/10.1098/rstb.2016.0169

Ellis, A. A., Traore, S., Doumbia, S., Dalglish, S. L., & Winch, P. J. (2012). Treatment actions and treatment failure: Case studies in the response to severe childhood febrile illness in Mali. *BMC Public Health*, *12*(1), 946. https://doi.org/10.1186/1471-2458-12-946

Enström, S., Nthiwa, D., Bett, B., Karlsson, A., Alonso, S., & Lindahl, J. F. (2017b). Brucella seroprevalence in cattle near a wildlife reserve in Kenya. *BMC Research Notes*, *10*(1), 615. https://doi.org/10.1186/s13104-017-2941-x

Essé, C., Utzinger, J., Tschannen, A. B., Raso, G., Pfeiffer, C., Granado, S., Koudou, B. G., N'Goran, E. K., Cissé, G., Girardin, O., Tanner, M., & Obrist, B. (2008). Social and cultural aspects of "malaria" and its control in central Côte d'Ivoire. *Malaria Journal*, *7*(1), 224. https://doi.org/10.1186/1475-2875-7-224

Estrada, A. Z. (2005). Survival of Brucella abortus in milk fermented with a yoghurt starter culture. *Rev Latinoam Microbiol*, 47 (3-4); 82-85

Farmer, P. (1996). Social Inequalities and Emerging Infectious Diseases. *Emerging Infectious Diseases*, *2*(4), 259–269. https://doi.org/10.3201/eid0204.960402

Fontefrancesco, M. F., & Lekanayia, L. (2018). *Meanings and taboos in traditional gastronomy of Maasai communities in Kajiado County, Kenya*. *14*(1), 9.

Franc, K. A., Krecek, R. C., Häsler, B. N., & Arenas-Gamboa, A. M. (2018a). Brucellosis remains a neglected disease in the developing world: A call for interdisciplinary action. *BMC Public Health*, *18*(1). https://doi.org/10.1186/s12889-017-5016-y

Galińska, E. M., & Zagórski, J. (2013). Brucellosis in humans – etiology, diagnostics, clinical forms. *Annals of Agricultural and Environmental Medicine*, *20*(2), 6.

Gessler, M. C., Msuya, D. E., Nkunya, M. H. H., Mwasumbi, L. B., Schär, A., Heinrich, M., & Tanner, M. (1995). Traditional healers in Tanzania: The treatment of malaria with plant remedies. *Journal of Ethnopharmacology*, *48*(3), 131–144. https://doi.org/10.1016/0378-8741(95)01293-M

Ghai, R. R., Thurber, M. I., El Bakry, A., Chapman, C. A., & Goldberg, T. L. (2016). Multi-method assessment of patients with febrile illness reveals over-diagnosis of malaria in rural Uganda. *Malaria Journal*, *15*(1), 460. https://doi.org/10.1186/s12936-016-1502-4

Glanz, K., Rimer, B. K., & Viswanath, K. (Eds.). (2008a). *Health behavior and health education: Theory, research, and practice* (4th ed). Jossey-Bass.

Godfroid J, Garin-Bastuji, B, Saegerman, C and Blasco, J.M. 2013. Brucellosis in terrestrial wildlife. *Rev. sci. tech. Off int. Epiz,* 32 (1) 27-42.

Godfroid, J. (2002). Brucellosis in wildlife: *Revue Scientifique et Technique de l'OIE*, *21*(2), 277–286. https://doi.org/10.20506/rst.21.2.1333

Godfroid, J. (2017a). Brucellosis in livestock and wildlife: Zoonotic diseases without pandemic potential in need of innovative one health approaches. *Archives of Public Health*, *75*(1), 34. https://doi.org/10.1186/s13690-017-0207-7

Godfroid, J., Debolle, X., Roop, R. M., O'Callaghan, D., Tsolis, R. M., Baldwin, C. J., Santos, R. L., Mcgiven, J. A., Olsen, S. C., Nymo, I. H., Larsen, A., Al Dahouk, S., & Letesson, J. J. (2014). The quest for a true One Health perspective of brucellosis: - *Revue Scientifique et Technique de l'OIE*, *33*(2), 521–538. https://doi.org/10.20506/rst.33.2.2290

Godfroid, J., Scholz, H. C., Barbier, T., Nicolas, C., Wattiau, P., Fretin, D., Whatmore, A. M., Cloeckaert, A., Blasco, J. M., Moriyon, I., Saegerman, C., Muma, J. B., Al Dahouk, S., Neubauer, H., & Letesson, J.-J. (2011a). Brucellosis at the animal/ecosystem/human interface at the beginning of the 21st century. *Preventive Veterinary Medicine*, *102*(2), 118–131. https://doi.org/10.1016/j.prevetmed.2011.04.007

Goodwin, R., Schley, D., Lai, K.-M., Ceddia, G. M., Barnett, J., & Cook, Ni. (2012). Interdisciplinary approaches to zoonotic disease. *Infectious Disease Reports*, *4*(1), 37. https://doi.org/10.4081/idr.2012.e37

Granado, S., Manderson, L., Obrist, B., & Tanner, M. (2011). Appropriating “Malaria”: Local Responses to Malaria Treatment and Prevention in Abidjan, Côte d’Ivoire. *Medical Anthropology*, *30*(1), 102–121. https://doi.org/10.1080/01459740.2010.488664

Greter, H., Jean-Richard, V., Crump, L., Béchir, M., Alfaroukh, I. O., Schelling, E., Bonfoh, B., & Zinsstag, J. (2014). The benefits of ‘One Health’ for pastoralists in Africa. *Onderstepoort J Vet Res*, *81*(2), 3 pages. https://doi.org/10.4102/ojvr.v81i2.726

Hadley, C. (2005). Ethnic expansions and between-group differences in children’s health: A case study from the Rukwa Valley, Tanzania. *American Journal of Physical Anthropology*, *128*(3), 682–692. https://doi.org/10.1002/ajpa.20056

Hammerl, J. A., Ulrich, R. G., Imholt, C., Scholz, H. C., Jacob, J., Kratzmann, N., Nöckler, K., & Al Dahouk, S. (2017). Molecular Survey on Brucellosis in Rodents and Shrews—Natural Reservoirs of Novel *Brucella* Species in Germany? *Transboundary and Emerging Diseases*, *64*(2), 663–671. https://doi.org/10.1111/tbed.12425

Harchut, K., Standley, C., Dobson, A., Klaassen, B., Rambaud-Althaus, C., Althaus, F., & Nowak, K. (2013). Over-diagnosis of malaria by microscopy in the Kilombero Valley, Southern Tanzania: An evaluation of the utility and cost-effectiveness of rapid diagnostic tests. *Malaria Journal*, *12*(1), 159. https://doi.org/10.1186/1475-2875-12-159

Hastings, J. (2016a). RUMOURS, RIOTS AND THE REJECTION OF MASS DRUG ADMINISTRATION FOR THE TREATMENT OF SCHISTOSOMIASIS IN MOROGORO, TANZANIA. *Journal of Biosocial Science*, *48*(S1), S16–S39. https://doi.org/10.1017/S0021932016000018

Healy Profitós, J. M., Moritz, M., & Garabed, R. B. (2013b). What to do with chronically sick animals? Pastoralists’ management strategies in the far north region of Cameroon. *Pastoralism: Research, Policy and Practice*, *3*(1), 8. https://doi.org/10.1186/2041-7136-3-8

Healy-Profitós, J, Piperata, B.A, Moritz, M, Lee J, Garabed, R, Grundich, M, Mouhaman, A, Ahmadou, M and Lee, S. 2016. One health Research in Cameroon; A critical role for anthropologists. *Practising Anthropology; 38 (4).*

Hegazy, Y., Elmonir, W., Abdel-Hamid, N. H., & Elbauomy, E. M. (2015a). Seroprevalence and "Knowledge, Attitudes and Practices" (KAPs) survey of endemic ovine brucellosis in Egypt. *Acta Veterinaria Scandinavica*, *58*(1). https://doi.org/10.1186/s13028-015-0183-2

Henderson, R. I., Hatfield, J., Kutz, S., Olemshumba, S., Manyama, M., & Bastien, S. (2016). 'We can't get worms from cow dung': reported knowledge of parasitism among pastoralist youth attending secondary school in the Ngorongoro Conservation area, Tanzania. *J. Biosoc. Sci, 1-20.*

Hercik, C., Cosmas, L., Mogeni, O. D., Kohi, W., Mfinanga, S., Loffredo, C., & Montgomery, J. M. (2019). Health Beliefs and Patient Perspectives of Febrile Illness in Kilombero, Tanzania. *The American Journal of Tropical Medicine and Hygiene*, *101*(1), 263–270. https://doi.org/10.4269/ajtmh.17-0862

Hercik, C., Cosmas, L., Mogeni, O. D., Wamola, N., Kohi, W., Houpt, E., Liu, J., Ochieng, C., Onyango, C., Fields, B., Mfinanga, S., & Montgomery, J. M. (2018). A Combined Syndromic Approach to Examine Viral, Bacterial, and Parasitic Agents among Febrile Patients: A Pilot Study in Kilombero, Tanzania. *The American Journal of Tropical Medicine and Hygiene*, *98*(2), 625–632. https://doi.org/10.4269/ajtmh.17-0421

Hercik, C., Cosmas, L., Mogeni, O. D., Wamola, N., Kohi, W., Omballa, V., Ochieng, M., Lidechi, S., Bonventure, J., Ochieng, C., Onyango, C., Fields, B. S., Mfinanga, S., & Montgomery, J. M. (2017). *A diagnostic and epidemiologic investigation of acute febrile illness (AFI) in Kilombero, Tanzania*. PLOS ONE 12(1-20).

Hildenwall, H., Tomson, G., Kaija, J., Pariyo, G., & Peterson, S. (2008). "I never had the money for blood testing" – Caretakers' experiences of care-seeking for fatal childhood fevers in rural Uganda – a mixed methods study. *BMC International Health and Human Rights*, *8*(1), 12. https://doi.org/10.1186/1472-698X-8-12

Holt, H. R., Eltholth, M. M., Hegazy, Y. M., El-Tras, W. F., Tayel, A. A., & Guitian, J. (2011). Brucella spp. infection in large ruminants in an endemic area of Egypt: Cross-sectional study investigating

seroprevalence, risk factors and livestock owner's knowledge, attitudes and practices (KAPs). *BMC Public Health*, *11*(1), 341.

Hooft, A. M., Ripp, K., Ndenga, B., Mutuku, F., Vu, D., Baltzell, K., Masese, L. N., Vulule, J., Mukoko, D., & LaBeaud, A. D. (2017). Principles, practices and knowledge of clinicians when assessing febrile children: A qualitative study in Kenya. *Malaria Journal*, *16*(1), 381. https://doi.org/10.1186/s12936-017-2021-7

James, L. W. (2013). Studies on human brucellosis in the Mikumi Selous ecosystem, Morogoro, Tanzania. *Sokoine university of Agriculture.*

Jensen, K. K., Lassen, J., Robinson, P., & Sandøe, P. (2005). Lay and expert perceptions of zoonotic risks: Understanding conflicting perspectives in the light of moral theory. *International Journal of Food Microbiology*, *99*(3), 245–255. https://doi.org/10.1016/j.ijfoodmicro.2004.09.004

John, K., Fitzpatrick, J., French, N., Kazwala, R., Kambarage, D., Mfinanga, G. S., MacMillan, A., & Cleaveland, S. (2010). Quantifying Risk Factors for Human Brucellosis in Rural Northern Tanzania. *PLoS ONE*, *5*(4), e9968. https://doi.org/10.1371/journal.pone.0009968

John, K., Kazwala, R., & Mfinanga, G. S. (2008b). Knowledge of causes, clinical features and diagnosis of common zoonoses among medical practitioners in Tanzania. *BMC Infectious Diseases*, *8*(1). https://doi.org/10.1186/1471-2334-8-162

Joly, D. O., & Messier, F. (2005). The Effect of Bovine Tuberculosis and Brucellosis on Reproduction and Survival of Wood Bison in Wood Buffalo National Park. *Journal of Animal Ecology*, *74*(3), 543–551. http://www.jstor.org/stable/3505431

Kaatano, G., Muro, A., & Medard, M. (2009). Caretaker's perceptions, attitudes and practices regarding childhood febrile illness and diarrhoeal diseases among riparian communities of Lake Victoria, Tanzania. *Tanzania Journal of Health Research*, *8*(3). https://doi.org/10.4314/thrb.v8i3.45113

Kamat, V. R. (2006a). “I thought it was only ordinary fever!” cultural knowledge and the micropolitics of therapy seeking for childhood febrile illness in Tanzania. *Social Science & Medicine*, *62*(12), 2945–2959. https://doi.org/10.1016/j.socscimed.2005.11.042

Kamat, V. R. (2008a). Dying under the Bird’s Shadow: Narrative Representations of Degedege and Child Survival among the Zaramo of Tanzania. *Medical Anthropology Quarterly*, *22*(1), 67–93. https://doi.org/10.1111/j.1548-1387.2008.00004.x

Kamat, V. R. (2008b). Reconsidering the Allure of the Culturally Distant in Therapy Seeking: A Case Study from Coastal Tanzania. *Medical Anthropology*, *27*(2), 106–135. https://doi.org/10.1080/01459740802017314

Kangalawe, R. Y. M., & Liwenga, E. T. (2005). Livelihoods in the wetlands of Kilombero Valley in Tanzania: Opportunities and challenges to integrated water resource management. *Physics and Chemistry of the Earth, Parts A/B/C*, *30*(11–16), 968–975. https://doi.org/10.1016/j.pce.2005.08.044

Kansiime, C., Mugisha, A., Makumbi, F., Mugisha, S., Rwego, I. B., Sempa, J., Kiwanuka, S. N., Asiimwe, B. B., & Rutebemberwa, E. (2014c). Knowledge and perceptions of brucellosis in the pastoral communities adjacent to Lake Mburo National Park, Uganda. *BMC Public Health*, *14*(1), 242. https://doi.org/10.1186/1471-2458-14-242

Kanté, A. M., Gutierrez, H. R., Larsen, A. M., Jackson, E. F., Helleringer, S., Exavery, A., Tani, K., & Phillips, J. F. (2015). Childhood Illness Prevalence and Health Seeking Behavior Patterns in Rural Tanzania. *BMC Public Health*, *15*(1), 951. https://doi.org/10.1186/s12889-015-2264-6

Kayunze, K. A., Kiwara, A. D., Lyamuya, E., Kambarage, D. M., Rushton, J., Coker, R., Kock, R., & Rweyemamu, M. M. (2012). A socio-economic approach to One Health policy research in southern Africa. *Onderstepoort J Vet Res*, *79*(2), 8 pages. https://doi.org/10.4102/ojvr.v79i2.460

Keck, F., & Lynteris, C. (2018). Zoonosis. *Medicine Anthropology Theory*, *5*(3). https://doi.org/10.17157/mat.5.3.372

Kiambi, S. G., Fèvre, E. M., Omolo, J., Oundo, J., & de Glanville, W. A. (2020). Risk factors for acute human brucellosis in Ijara, north-eastern Kenya. *PLOS Neglected Tropical Diseases*, *14*(4), e0008108. https://doi.org/10.1371/journal.pntd.0008108

Kinimi, E., Shayo, M. J., Patrick, B. N., Angwenyi, S. O., Kasanga, C. J., Weyer, J., Jansen van Vuren, P., Paweska, J. T., Mboera, L. E. G., & Misinzo, G. (2018). Evidence of chikungunya virus infection among febrile patients seeking healthcare in selected districts of Tanzania. *Infection Ecology & Epidemiology*, *8*(1), 1553460. https://doi.org/10.1080/20008686.2018.1553460

Kisoka, W. J., Tersbøl, B. P., Meyrowitsch, D. W., Simonsen, P. E., & Mushi, D. L. (2016). COMMUNITY MEMBERS' PERCEPTIONS OF MASS DRUG ADMINISTRATION FOR CONTROL OF LYMPHATIC FILARIASIS IN RURAL AND URBAN TANZANIA. *Journal of Biosocial Science*, *48*(1), 94–112. https://doi.org/10.1017/S0021932015000024

Kolhe, S. R., Kolhe, R. P., Jagtap, U. V., & Sulakhe, V. V. (2017). *Assessment of Knowledge Level of Women Towards Major Zoonotic Diseases*. 5.

Konan, D. O., Mosi, L., Fokou, G., Dassi, C., Narh, C. A., Quaye, C., Saric, J., Abe, N. N., & Bonfoh, B. (2019a). Buruli ulcer in southern Côte D'ivoire: Dynamic schemes of perception and interpretation of modes of transmission. *Journal of Biosocial Science*, *51*(4), 520–533. https://doi.org/10.1017/S0021932018000317

Konan, D. O., Mosi, L., Fokou, G., Dassi, C., Narh, C. A., Quaye, C., Saric, J., Abe, N. N., & Bonfoh, B. (2019b). Buruli ulcer in southern Côte D'ivoire: Dynamic schemes of perception and interpretation of modes of transmission. *Journal of Biosocial Science*, *51*(4), 520–533. https://doi.org/10.1017/S0021932018000317

Kriger, D. (2021). What is Risk? Four Approaches to the Embodiment of Health Risk in Public Health. *Health, Risk & Society*, *23*(3–4), 143–161. https://doi.org/10.1080/13698575.2021.1929864

Kruse, H., Kirkemo, A.-M., & Handeland, K. (2004). Wildlife as Source of Zoonotic Infections. *Emerging Infectious Diseases*, *10*(12), 2067–2072. https://doi.org/10.3201/eid1012.040707

Kunda, J., Fitzpatrick, J., Kazwala, R., French, N. P., Shirima, G., MacMillan, A., Kambarage, D., Bronsvoort, M., & Cleaveland, S. (2007b). Health-seeking behaviour of human brucellosis cases in rural Tanzania. *BMC Public Health*, *7*(1). https://doi.org/10.1186/1471-2458-7-315

Larios, S. E., Lozada, R., Strathdee, S. A., Semple, S. J., Roesch, S., Staines, H., Orozovich, P., Fraga, M., Amaro, H., de la Torre, A., Magis-Rodríguez, C., & Patterson, T. L. (2009). An exploration of contextual factors that influence HIV risk in female sex workers in Mexico: The Social Ecological Model applied to HIV risk behaviors. *AIDS Care*, *21*(10), 1335–1342. https://doi.org/10.1080/09540120902803190

Launiala, A. (2009a). *How much can a KAP survey tell us about people's knowledge, attitudes and practices? Some observations from medical anthropology research on malaria in pregnancy in Malawi*. *11*, 13.

Launiala, A. (2009b). How much can a KAP survey tell us about people's knowledge, attitudes and practices? Some observations from medical anthropology research on malaria in pregnancy in Malawi. *Anthropology Matters*, *11*(1). http://anthropologymatters.com/index.php/anth_matters/article/view/31

Le Mare, A., Makungu, C., & Dunn, C. (2014). *"Yes we are here, living, but malaria is surrounding us"*: Sustainable livelihoods and malaria in Tanzania. *Development in Practice*, *24*(2), 216–233. https://doi.org/10.1080/09614524.2014.892571

Leach, M., Bett, B., Said, M., Bukachi, S., Sang, R., Anderson, N., Machila, N., Kuleszo, J., Schaten, K., Dzingirai, V., Mangwanya, L., Ntiamoa-Baidu, Y., Lawson, E., Amponsah-Mensah, K., Moses, L. M., Wilkinson, A., Grant, D. S., & Koninga, J. (2017a). Local disease–ecosystem–livelihood dynamics: Reflections from comparative case studies in Africa. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1725), 20160163. https://doi.org/10.1098/rstb.2016.0163

Leach, M., Bett, B., Said, M., Bukachi, S., Sang, R., Anderson, N., Machila, N., Kuleszo, J., Schaten, K., Dzingirai, V., Mangwanya, L., Ntiamoa-Baidu, Y., Lawson, E., Amponsah-Mensah, K., Moses, L.

M., Wilkinson, A., Grant, D. S., & Koninga, J. (2017b). Local disease–ecosystem–livelihood dynamics: Reflections from comparative case studies in Africa. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1725), 20160163. https://doi.org/10.1098/rstb.2016.0163

Leach, M., & Scoones, I. (2013a). The social and political lives of zoonotic disease models: Narratives, science and policy. *Social Science & Medicine*, *88*, 10–17. https://doi.org/10.1016/j.socscimed.2013.03.017

Lokamar, P. N., Kutwah, M. A., Atieli, H., Gumo, S., & Ouma, C. (2020). Socio-economic impacts of brucellosis on livestock production and reproduction performance in Koibatek and Marigat regions, Baringo County, Kenya. *BMC Veterinary Research*, *16*(1), 61. https://doi.org/10.1186/s12917-020-02283-w

Lupton, D., & Tulloch, J. (2002). `Risk is Part of Your Life': Risk Epistemologies Among a Group of Australians. *Sociology*, *36*(2), 317–334. https://doi.org/10.1177/0038038502036002005

MacGregor, H., & Waldman, L. (2017). Views from many worlds: Unsettling categories in interdisciplinary research on endemic zoonotic diseases. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1725), 20160170. https://doi.org/10.1098/rstb.2016.0170

Mackian, S. (2004c). Up the garden path and over the edge: Where might health-seeking behaviour take us? *Health Policy and Planning*, *19*(3), 137–146. https://doi.org/10.1093/heapol/czh017

Mai, H. M., Irons, P. C., Kabir, J., & Thompson, P. N. (2012a). A large seroprevalence survey of brucellosis in cattle herds under diverse production systems in northern Nigeria. *BMC Veterinary Research*, *8*(1), 144. https://doi.org/10.1186/1746-6148-8-144

Majaj, L., Nassar, M., & De Allegri, M. (2013). "It's not easy to acknowledge that I'm ill": A qualitative investigation into the health seeking behavior of rural Palestinian women. *BMC Women's Health*, *13*(1), 26. https://doi.org/10.1186/1472-6874-13-26

Majalija, S., Luyombo, P., & Tumwine, G. (2018). Sero-prevalence and associated risk factors of Brucellosis among Malaria negative febrile out-patients in Wakiso district, Central Uganda. *BMC Research Notes*, *11*(1), 803. https://doi.org/10.1186/s13104-018-3907-3

Makita, K., Fèvre, E. M., Waiswa, C., Eisler, M. C., Thrusfield, M., & Welburn, S. C. (2011). Herd prevalence of bovine brucellosis and analysis of risk factors in cattle in urban and peri-urban areas of the Kampala economic zone, Uganda. *BMC Veterinary Research*, *7*(1), 60. https://doi.org/10.1186/1746-6148-7-60

Mandefero, D., & Yeshibelay, G. (2018). Assessment of community knowledge, attitude and practice on milk borne zoonoses disease in Debre- Birhan town, north Shewa, Ethiopia. *Journal of Public Health and Epidemiology*, *10*(4), 123–131. https://doi.org/10.5897/JPHE2017.0983

Mangen, M. J., Otte, J., Pfeiffer, D., & Chilonda, P. (2002). Bovine brucellosis in sub-Saharan Africa: Estimation of sero-prevalence and impact on meat and milk offtake potential. *Food and Agriculture Organisation of the United Nations, Rome*. http://www.fao.org/ag/againfo/resources/es/publications/sector_discuss/pp8.pdf

Mangesho, P. E., Neselle, M. O., Karimuribo, E. D., Mlangwa, J. E., Queenan, K., Mboera, L. E. G., Rushton, J., Kock, R., Häsler, B., Kiwara, A., & Rweyemamu, M. (2017a). Exploring local knowledge and perceptions on zoonoses among pastoralists in northern and eastern Tanzania. *PLOS Neglected Tropical Diseases*, *11*(2), e0005345. https://doi.org/10.1371/journal.pntd.0005345

Marcotty, T., Matthys, F., Godfroid, J., Rigouts, L., Ameni, G., Gey van Pittius, N., Kazwala, R., Muma, J., van Helden, P., Walravens, K., de Klerk, L. M., Geoghegan, C., Mbotha, D., Otte, M., Amenu, K., Abu Samra, N., Botha, C., Ekron, M., Jenkins, A., … van den Bossche, P. (2009a). Zoonotic tuberculosis and brucellosis in Africa: Neglected zoonoses or minor public-health issues? The outcomes of a multi-disciplinary workshop. *Annals of Tropical Medicine & Parasitology*, *103*(5), 401–411. https://doi.org/10.1179/136485909X451771

Massoi, L., & Saruni, P. (2020). *Changing Dietary Practices: The New Food Insecurity among The Pastoralists in Mabwegere Village Kilosa District*. *4*, 21.

Maze, M. J., Bassat, Q., Feasey, N. A., Mandomando, I., Musicha, P., & Crump, J. A. (2018). The epidemiology of febrile illness in sub-Saharan Africa: Implications for diagnosis and management. *Clinical Microbiology and Infection*, *24*(8), 808–814. https://doi.org/10.1016/j.cmi.2018.02.011

Mazet, J. A. K., Clifford, D. L., Coppolillo, P. B., Deolalikar, A. B., Erickson, J. D., & Kazwala, R. R. (2009). A "One Health" Approach to Address Emerging Zoonoses: The HALI Project in Tanzania. *PLoS Medicine*, *6*(12), e1000190. https://doi.org/10.1371/journal.pmed.1000190

Mbugi, E. V., Katale, B. Z., Kendall, S., Good, L., Kibiki, G. S., Keyyu, J. D., Godfrey-Faussett, P., Van Helden, P., & Matee, M. I. (2012). Tuberculosis cross-species transmission in Tanzania: Towards a One-Health concept. *Onderstepoort J Vet Res*, *79*(2), 6 pages. https://doi.org/10.4102/ojvr.v79i2.501

McDermott, J. J., & Arimi, S. M. (2002b). Brucellosis in sub-Saharan Africa: Epidemiology, control and impact. *Veterinary Microbiology*, *90*(1–4), 111–134. https://doi.org/10.1016/S0378-1135(02)00249-3

Mcdermott, J. J., Grace, D., & Zinsstag, J. (2013). Economics of brucellosis impact and control in low-income countries: -EN- -FR- -ES-. *Revue Scientifique et Technique de l'OIE*, *32*(1), 249–261. https://doi.org/10.20506/rst.32.1.2197

Mchome, Z., Bailey, A., Darak, S., Kessy, F., & Haisma, H. (2019). 'He usually has what we call normal fevers': Cultural perspectives on healthy child growth in rural Southeastern Tanzania: An ethnographic enquiry. *PLOS ONE*, *14*(9), e0222231. https://doi.org/10.1371/journal.pone.0222231

Mchomvu, E., Mbunda, G., Simon, N., Kitila, F., Temba, Y., Msumba, I., Namamba, J., Kilindimo, S., Mgubike, H., Gingo, W., Hatz, C., Paris, D. H., Weisser, M., & Rohacek, M. (2019). Diagnoses

made in an Emergency Department in rural sub-Saharan Africa. *Swiss Medical Weekly*. https://doi.org/10.4414/smw.2019.20018

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

Mehtälä, M. A., Sääkslahti, A., Inkinen, M., & Poskiparta, M. E. (2014b). A socio-ecological approach to physical activity interventions in childcare: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *11*(1), 22. https://doi.org/10.1186/1479-5868-11-22

Mellau, L. S. B., Kuya, S. L., & Wambura, P. N. (2009). Seroprevalence of brucellosis in domestic ruminants in livestock-wildlife interface: A case study of Ngorongoro Conservation Area, Arusha, Tanzania. *Tanzania Veterinary Journal*, *26*(1). https://doi.org/10.4314/tvj.v26i1.49234

Messmer, T. A. (2020). *Humans, Wildlife, and Our Environment: One Health is the Common Link*. Human-Wildlife Interactions 14 (1) 137-14.

Metta, E., Bailey, A., Kessy, F., Geubbels, E., Hutter, I., & Haisma, H. (2015). "In a situation of rescuing life": Meanings given to diabetes symptoms and care-seeking practices among adults in Southeastern Tanzania: a qualitative inquiry. *BMC Public Health*, *15*(1), 224. https://doi.org/10.1186/s12889-015-1504-0

Metta, E., Haisma, H., Kessy, F., Hutter, I., & Bailey, A. (2014). "We have become doctors for ourselves": Motives for malaria self-care among adults in southeastern Tanzania. *Malaria Journal*, *13*(1), 249. https://doi.org/10.1186/1475-2875-13-249

Miedany, Y. M. E., Gaafary, M. E., Baddour, M., & Ahmed, I. (2003). Human brucellosis: Do we need to revise our therapeutic policy? *The Journal of Rheumatology; 30 (12).*

Minas, M., Minas, A., Gourgulianis, K., & Stournara, A. (2007). *Epidemiological and Clinical Aspects of Human Brucellosis in Central Greece*. Journal of Infectious Diseases 60; 362-366.

Mirambo, M. M., Mgode, G. F., Malima, Z. O., John, M., Mngumi, E. B., Mhamphi, G. G., & Mshana, S. E. (2018). Seropositivity of Brucella spp. and Leptospira spp. antibodies among abattoir workers and meat vendors in the city of Mwanza, Tanzania: A call for one health approach control strategies. *PLOS Neglected Tropical Diseases*, *12*(6), e0006600. https://doi.org/10.1371/journal.pntd.0006600

Mngumi, E. B., Mirambo, M. M., Wilson, S., & Mshana, S. E. (2016). Predictors of specific anti-Brucella antibodies among humans in agro-pastoral communities in Sengerema district, Mwanza, Tanzania: The need for public awareness. *Tropical Medicine and Health*, *44*(1), 34. https://doi.org/10.1186/s41182-016-0034-5

Moritz, M., Ewing, D., & Garabed, R. (2013a). On Not Knowing Zoonotic Diseases: Pastoralists' Ethnoveterinary Knowledge in the Far North Region of Cameroon. *Human Organization*, *72*(1), 1–11. https://doi.org/10.17730/humo.72.1.72672642576gw247

Motsi, T. R., Tichiwangana, S. C., Matope, G., & Mukarati, N. L. (2013). A serological survey of brucellosis in wild ungulate species from five game parks in Zimbabwe. *Onderstepoort J Vet Res*, *80*(1), 4 pages. https://doi.org/10.4102/ojvr.v80i1.586

Mshana, G., Hampshire, K., Panter-Brick, C., & Walker, R. (n.d.). *URBAN–RURAL CONTRASTS IN EXPLANATORY MODELS AND TREATMENT-SEEKING BEHAVIOURS FOR STROKE IN TANZANIA*. 19.

Mtuy, T. B., Bardosh, K., Ngondi, J., Mwingira, U., Seeley, J., Burton, M., & Lees, S. (2020). Understanding hard-to-reach communities: Local perspectives and experiences of trachoma control among the pastoralist Maasai in northern Tanzania. *Journal of Biosocial Science*, 1–20. https://doi.org/10.1017/S0021932020000553

Mtuy, T. B., Bardosh, K., Ngondi, J., Mwingira, U., Seeley, J., Burton, M., & Lees, S. (2021). Understanding hard-to-reach communities: Local perspectives and experiences of trachoma control among the pastoralist Maasai in northern Tanzania. *Journal of Biosocial Science*, *53*(6), 819–838. https://doi.org/10.1017/S0021932020000553

Muela, S. H., Ribera, J. M., & Tanner, M. (1998). Fake malaria and hidden parasites—The ambiguity of malaria. *Anthropology & Medicine*, *5*(1), 43–61. https://doi.org/10.1080/13648470.1998.9964548

Mujuni, F., Andrew, V., Mngumi, E. B., Chibwe, E., Mshana, S. E., & Mirambo, M. M. (2018). Predominance of Brucella abortus antibodies among women with spontaneous abortion in the city of Mwanza: Unrecognized link or coincidence? *BMC Research Notes*, *11*(1), 792. https://doi.org/10.1186/s13104-018-3906-4

Muma, J. B., Samui, K. L., Oloya, J., Munyeme, M., & Skjerve, E. (2007). Risk factors for brucellosis in indigenous cattle reared in livestock–wildlife interface areas of Zambia. *Preventive Veterinary Medicine*, *80*(4), 306–317. https://doi.org/10.1016/j.prevetmed.2007.03.003

Muma, J. B., Samui, K. L., Siamudaala, V. M., Oloya, J., Matope, G., Omer, M. K., Munyeme, M., Mubita, C., & Skjerve, E. (2006). Prevalence of antibodies to Brucella spp. And individual risk Factors of Infection in Traditional Cattle, Goats and Sheep Reared in Livestock–Wildlife Interface Areas of Zambia. *Tropical Animal Health and Production*, *38*(3), 195–206. https://doi.org/10.1007/s11250-006-4320-9

Munyua, P., Bitek, A., Osoro, E., Pieracci, E. G., Muema, J., Mwatondo, A., Kungu, M., Nanyingi, M., Gharpure, R., Njenga, K., & Thumbi, S. M. (2016). Prioritization of Zoonotic Diseases in Kenya, 2015. *PLOS ONE*, *11*(8), e0161576. https://doi.org/10.1371/journal.pone.0161576

Musallam, I. I., Abo-Shehada, M. N., & Guitian, J. (2015b). Knowledge, Attitudes, and Practices Associated with Brucellosis in Livestock Owners in Jordan. *The American Journal of Tropical Medicine and Hygiene*, *93*(6), 1148–1155. https://doi.org/10.4269/ajtmh.15-0294

Mustafa, A., & Hassan, H. (2010). Human Brucellosis in Khartoum State: A Commonly Underdiagnosed Disease. *Sudan Journal of Medical Sciences*, *5*(3), 213–216. https://doi.org/10.4314/sjms.v5i3.62010

Mutua, E. N., Bukachi, S. A., Bett, B. K., Estambale, B. A., & Nyamongo, I. K. (2016a). Lay knowledge and management of malaria in Baringo county, Kenya. *Malaria Journal*, *15*(1). https://doi.org/10.1186/s12936-016-1542-9

Mutua, E. N., Bukachi, S. A., Bett, B. K., Estambale, B. A., & Nyamongo, I. K. (2017c). "We do not bury dead livestock like human beings": Community behaviors and risk of Rift Valley Fever virus infection in Baringo County, Kenya. *PLOS Neglected Tropical Diseases*, *11*(5), e0005582. https://doi.org/10.1371/journal.pntd.0005582

Muturi, M., Bitek, A., Mwatondo, A., Osoro, E., Marwanga, D., Gura, Z., Ngere, P., Nganga, Z., Thumbi, S. M., & Njenga, K. (2018). Risk factors for human brucellosis among a pastoralist community in South-West Kenya, 2015. *BMC Research Notes*, *11*(1), 865. https://doi.org/10.1186/s13104-018-3961-x

Mwenesi, H., Harpham, T., & Snow, R. W. (1995). Child malaria treatment practices among mothers in Kenya. *Social Science & Medicine*, *40*(9), 1271–1277. https://doi.org/10.1016/0277-9536(94)00250-W

Nabirye, H. M., Erume, J., Nasinyama, G. W., Kungu, J. M., Nakavuma, J., Ongeng, D., & Owiny, D. O. (2017). Brucellosis: Community, medical and veterinary workers' knowledge, attitudes, and practices in Northern Uganda. *International Journal of One Health*, *3*, 12–18. https://doi.org/10.14202/IJOH.2017.12-18

Nabukenya, I., Kaddu-Mulindwa, D., & Nasinyama, G. W. (2013). Survey of Brucella infection and malaria among Abattoir workers in Kampala and Mbarara Districts, Uganda. *BMC Public Health 13:901*

Nantima, N., Ilukor, J., Kaboyo, W., Ademun, A. R. O., Muwanguzi, D., Sekamatte, M., Sentumbwe, J., Monje, F., & Bwire, G. (2019). The importance of a One Health approach for prioritising zoonotic diseases to focus on capacity-building efforts in Uganda: *Revue Scientifique et Technique de l'OIE*, *38*(1), 315–325. https://doi.org/10.20506/rst.38.1.2963

Ng'ang'a, C. M., Bukachi, S. A., & Bett, B. K. (2016). Lay perceptions of risk factors for Rift Valley fever in a pastoral community in northeastern Kenya. *BMC Public Health*, *16*(1), 32. https://doi.org/10.1186/s12889-016-2707-8

Nindi, S. J., Maliti, H., Bakari, S., Kija, H., & Machoke, M. (2014). Conflicts over land and water resources in the Kilombero valley floodplain, Tanzania. African Study Monograph, Suppl 50: 173-190.

Njenga, M. K., Ogolla, E., Thumbi, S. M., Ngere, I., Omulo, S., Muturi, M., Marwanga, D., Bitek, A., Bett, B., Widdowson, M.-A., Munyua, P., & Osoro, E. M. (2020b). Comparison of knowledge, attitude, and practices of animal and human brucellosis between nomadic pastoralists and non-pastoralists in Kenya. *BMC Public Health*, *20*(1), 269. https://doi.org/10.1186/s12889-020-8362-0

Njeru, J., Wareth, G., Melzer, F., Henning, K., Pletz, M. W., Heller, R., & Neubauer, H. (2016). Systematic review of brucellosis in Kenya: Disease frequency in humans and animals and risk factors for human infection. *BMC Public Health*, *16*(1). https://doi.org/10.1186/s12889-016-3532-9

Njuguna, J. N., Gicheru, M. M., Kamau, L. M., & Mbatha, P. M. (2017). Incidence and knowledge of bovine brucellosis in Kahuro district, Murang'a County, Kenya. *Tropical Animal Health and Production*, *49*(5), 1035–1040. https://doi.org/10.1007/s11250-017-1296-6

Nsungwa-Sabiiti, J., Kallander, K., Nsabagasani, X., Namusisi, K., Pariyo, G., Johansson, A., Tomson, G., & Peterson, S. (2004). Local fever illness classifications: Implications for home management of malaria strategies. *Tropical Medicine and International Health*, *9*(11), 1191–1199. https://doi.org/10.1111/j.1365-3156.2004.01319.x

Ntirandekura, J., Matemba, L. E., Kimera, S. I., Muma, J. B., & Karimuribo, E. D. (2020). Association of brucellosis to abortions in humans and domestic ruminants in Kagera ecosystem, Tanzania. *Transboundary and Emerging Diseases*, tbed.13516. https://doi.org/10.1111/tbed.13516

Ntirandekura, J., Matemba, L., Ngowi, H., Kimera, S., & Karimuribo, E. (2018). Knowledge, perceptions and practices regarding brucellosis in pastoral communities of Kagera Region in Tanzania.

Journal of Advanced Veterinary and Animal Research, *5*(3), 343. https://doi.org/10.5455/javar.2018.e285

Ntivuguruzwa, J. B., Kolo, F. B., Gashururu, R. S., Umurerwa, L., Byaruhanga, C., & van Heerden, H. (2020). Seroprevalence and Associated Risk Factors of Bovine Brucellosis at the Wildlife-Livestock-Human Interface in Rwanda. *Microorganisms*, *8*(10), 1553. https://doi.org/10.3390/microorganisms8101553

Nyamongo, I. K. (2002). Health care switching behaviour of malaria patients in a Kenyan rural community. *Social Science & Medicine*, *54*(3), 377–386. https://doi.org/10.1016/S0277-9536(01)00036-3

Nyaoke, B. A., Mureithi, M. W., & Beynon, C. (2019). Factors associated with treatment type of non-malarial febrile illnesses in under-fives at Kenyatta National Hospital in Nairobi, Kenya. *PLOS ONE*, *14*(6), e0217980. https://doi.org/10.1371/journal.pone.0217980

Oberländer, L., & Elverdan, B. (2000). Malaria in the United Republic of Tanzania: Cultural considerations and health-seeking behaviour. *Bulletin of the World Health Organization*, *78*(11), 1352–1357.

Obonyo, D. M. (2015). *Knowledge, Attitude and Practices towards Brucellosis among Pastoral Community in Kenya, 2013*. *4*(10), 10.

Ogoina, D. (2011). Fever, fever patterns and diseases called 'fever' – A review. *Journal of Infection and Public Health*, *4*(3), 108–124. https://doi.org/10.1016/j.jiph.2011.05.002

One Health Zoonotic Disease Prioritization for Multi-Sectoral Engagement in Tanzania. *(2017). United Republic of Tanzania*

Onono, J., Mutua, P., Kitala, P., & Gathura, P. (2019a). Knowledge of pastoralists on livestock diseases and exposure assessment to brucellosis within rural and peri-urban areas in Kajiado, Kenya. *F1000Research*, *8*, 1916. https://doi.org/10.12688/f1000research.20573.1

Ortega, C., Ortega, J., & Simón, M. C. (2022). Anthropology and One Health: A Transdisciplinary Approach to Understanding Diseases Emergence. *OALib*, *09*(06), 1–12. https://doi.org/10.4236/oalib.1108756

Owange, N. O., Ogara, W. O., Kasiiti, J., Gathura, P. B., Okuthe, S., Sang, R., Affognon, H., Onyango-Ouma, W., Landmann, T. T. O., & Mbabu, M. (2014). Perceived risk factors and risk pathways of Rift Valley fever in cattle in Ijara district, Kenya. *Onderstepoort J Vet Res*, *81*(1). https://doi.org/10.4102/ojvr.v81i1.780

Paling, R.W, Waghela, K, Macowan, J and Heath, B.R (1988). The Occurrence of Infectious Diseases in Mixed Farming of Domesticated Wild Herbivores and Livestock in Kenya. II. Bacterial Diseases. Journal of Wildlife Diseases, 24(2): 308-316.

Pappas, G., Papadimitriou, P., Akritidis, N., Christou, L., & Tsianos, E. V. (2006). The new global map of human brucellosis. *The Lancet Infectious Diseases*, *6*(2), 91–99. https://doi.org/10.1016/S1473-3099(06)70382-6

Parker, M., & Harper, I. (2006). The Anthropology of public health. *Journal of Biosocial Science*, *38*(1), 1–5. https://doi.org/10.1017/S0021932005001148

Paul, S. (2016). The Perception of Risk. In R. J. Sternberg, S. T. Fiske, & D. J. Foss (Eds.), *Scientists Making a Difference* (pp. 179–182). Cambridge University Press. https://doi.org/10.1017/CBO9781316422250.040

Porter, J. D. H. (2006). EPIDEMIOLOGICAL REFLECTIONS OF THE CONTRIBUTION OF ANTHROPOLOGY TO PUBLIC HEALTH POLICY AND PRACTICE. *Journal of Biosocial Science*, *38*(1), 133–144. https://doi.org/10.1017/S0021932005001070

Racloz, V., Schelling, E., Chitnis, N., Roth, F., & Zinsstag, J. (2013b). Persistence of brucellosis in pastoral systems: -EN- -FR- -ES-. *Revue Scientifique et Technique de l'OIE*, *32*(1), 61–70. https://doi.org/10.20506/rst.32.1.2186

Rashid, S. F., Hadi, A., Afsana, K., & Begum, S. A. (2001). Acute respiratory infections in rural Bangladesh: Cultural understandings, practices and the role of mothers and community health

volunteers. *Tropical Medicine and International Health*, *6*(4), 249–255. https://doi.org/10.1046/j.1365-3156.2001.00702.x

Reyburn, H., Mbatia, R., Drakeley, C., Carneiro, I., Mwakasungula, E., Mwerinde, O., Saganda, K., Shao, J., Kitua, A., Olomi, R., Greenwood, B. M., & Whitty, C. J. M. (2004). Overdiagnosis of malaria in patients with severe febrile illness in Tanzania: A prospective study. *BMJ*, *329*(7476), 1212. https://doi.org/10.1136/bmj.38251.658229.55

Ribera, J. M., & Hausmann-Muela, S. (2011). The Straw That Breaks the Camel's Back Redirecting Health-Seeking Behavior Studies on Malaria and Vulnerability: Redirecting Health-Seeking Behavior Studies on Malaria and Vulnerability. *Medical Anthropology Quarterly*, *25*(1), 103–121. https://doi.org/10.1111/j.1548-1387.2010.01139.x

Roesel, K. (2014a). *Food Safety and Informal Markets: Animal Products in Sub-Saharan Africa* (1st ed.). Routledge. https://doi.org/10.4324/9781315745046

Roth, F., Zinsstag, J., Orkhon, D., Chimed-Ochir, G., Hutton, G., Cosivi, O., Carrin, G., & Otte, J. (2003). Human health benefits from livestock vaccination for brucellosis: Case study. *Bulletin of the World Health Organization*, *81*(12), 867–876.

Rubel, A. J., & Garro, L. C. (1992). Social and cultural factors in the successful control of tuberculosis. *Public Health Reports*, *107*(6), 626.

Russell, S., Tyrrell, P., & Western, D. (2018). Seasonal interactions of pastoralists and wildlife in relation to pasture in an African savanna ecosystem. *Journal of Arid Environments*, *154*, 70–81. https://doi.org/10.1016/j.jaridenv.2018.03.007

Sagamiko, F. D., Muma, J. B., Karimuribo, E. D., Mwanza, A. A., Mfune, R. L., Sindato, C., Kavunga, H., & Hang'ombe, B. M. (2019). *Seroprevalence of human Brucellosis and associated risk factors among high risk occupations in Mbeya Region of Tanzania* [Preprint]. Epidemiology. https://doi.org/10.1101/688705

Salerno, J., Ross, N., Ghai, R., Mahero, M., Travis, D. A., Gillespie, T. R., & Hartter, J. (2017). Human–Wildlife Interactions Predict Febrile Illness in Park Landscapes of Western Uganda. *EcoHealth*, *14*(4), 675–690. https://doi.org/10.1007/s10393-017-1286-1

Samuelsen, H., Tersbøl, B. P., & Mbuyita, S. S. (2013). Do health systems delay the treatment of poor children? A qualitative study of child deaths in rural Tanzania. *BMC Health Services Research*, *13*(1), 67. https://doi.org/10.1186/1472-6963-13-67

Sayer, K. (2016). Brucellosis in fact and fiction: The story of a zoonosis. *Veterinary History*, *18*(2), 165.

Schellenberg, J. A., Victora, C. G., Mushi, A., de Savigny, D., Schellenberg, D., Mshinda, H., Bryce, J., & Group, T. I. M. B. H. S. S. (2003). Inequities among the very poor: Health care for children in rural southern Tanzania. *The Lancet*, *361*(9357), 561–566.

Schelling, E., Diguimbaye, C., Daoud, S., Nicolet, J., Boerlin, P., Tanner, M., & Zinsstag, J. (2003c). Brucellosis and Q-fever seroprevalences of nomadic pastoralists and their livestock in Chad. *Preventive Veterinary Medicine*, *61*(4), 279–293. https://doi.org/10.1016/j.prevetmed.2003.08.004

Schlundt, J., & Erasmus, J. M. (1988b). Wildlife diseases in South Africa: A review: -EN- -FR- -ES-. *Revue Scientifique et Technique de l'OIE*, *7*(4), 807–821. https://doi.org/10.20506/rst.7.4.378

Schlundt, J., Kock, R. A., & Fisher, J. R. (2002). Infectious animal diseases: The wildlife/livestock interface: -EN- -FR- -ES-. *Revue Scientifique et Technique de l'OIE*, *21*(1), 53–65. https://doi.org/10.20506/rst.21.1.1322

Seleem, M. N., Boyle, S. M., & Sriranganathan, N. (2010). Brucellosis: A re-emerging zoonosis. *Veterinary Microbiology*, *140*(3–4), 392–398. https://doi.org/10.1016/j.vetmic.2009.06.021

Senior, K., & Chenhall, R. (2013). Health Beliefs and Behavior: The Practicalities of "Looking after Yourself" in an Australian Aboriginal Community. *Medical Anthropology Quarterly*, *27*(2), 155–174. https://doi.org/10.1111/maq.12021

Shaapan, R. M. (2016). The common zoonotic protozoal diseases causing abortion. *J Parasit Dis; 40 (4): 1116-1129.*

Shabani, S. S. (2015). *Knowledge, attitudes and practices on Rift Valley fever among agro pastoral communities in Kongwa and Kilombero districts, Tanzania*. 9.

Shaikh, B. T., & Hatcher, J. (2005). Health seeking behaviour and health service utilization in Pakistan: Challenging the policy makers. *Journal of Public Health*, *27*(1), 49–54. https://doi.org/10.1093/pubmed/fdh207

Shey-Njila, O., Nya, E., Zoli, P. A., Walravens, K., Godfroid, J., & Geerts, S. (2005b). *Serological Survey of Bovine Brucellosis in Cameroon*. Pathologie Infectieuse.

Shirima, G. M. (2005). *The epidemiology of brucellosis in animals and humans in Arusha and Manyara regions of Tanzania*. University of Glasgow.

Shirima, G. M., & Kunda, J. S. (2016). Prevalence of brucellosis in the human, livestock and wildlife interface areas of Serengeti National Park, Tanzania. *Onderstepoort J Vet Res*, *83*(1). https://doi.org/10.4102/ojvr.v83i1.1032

Sichewo, P. R., Michel, A. L., Musoke, J., & Etter, E. M. C. (2019). Risk Factors for Zoonotic Tuberculosis at the Wildlife–Livestock–Human Interface in South Africa. *Pathogens*, *8*(3), 101. https://doi.org/10.3390/pathogens8030101

Singer, M., Bulled, N., & Ostrach, B. (2012). Syndemics and Human Health. *Annals of Anthropological Practice*, *36*(2), 205–211. https://doi.org/10.1111/napa.12000

Singh, S., Sahu, D., Agrawal, A., & Vashi, M. D. (2019). Barriers and opportunities for improving childhood immunization coverage in slums: A qualitative study. *Preventive Medicine Reports*, *14*, 100858. https://doi.org/10.1016/j.pmedr.2019.100858

Smits, H. L. (2013a). Brucellosis in pastoral and confined livestock: Prevention and vaccination: -EN- -FR- La brucellose dans les systèmes d'élevage pastoral et confiné : prévention et vaccination -ES- Brucelosis en el ganado pastoreado o estabulado: prevención y vacunación. *Revue Scientifique et Technique de l'OIE*, *32*(1), 219–228. https://doi.org/10.20506/rst.32.1.2200

Spangler, S. A. (2011). "To Open Oneself Is a Poor Woman's Trouble": Embodied Inequality and Childbirth in South-Central Tanzania: Embodied Inequality and Childbirth in South-Central

Tanzania. *Medical Anthropology Quarterly*, *25*(4), 479–498. https://doi.org/10.1111/j.1548-1387.2011.01181.x

Srivastava, P., & Hopwood, N. (2009). A Practical Iterative Framework for Qualitative Data Analysis. *International Journal of Qualitative Methods*, *8*(1), 76–84. https://doi.org/10.1177/160940690900800107

Stoddard, R. A., Morrissey, A. B., Cleaveland, S., Crump, J. A., Bouley, A. J., Maro, V. P., Biggs, H. M., Bartlett, J. A., Kinabo, G. D., Afwamba, I. A., & Saganda, W. (2012a). Brucellosis among Hospitalized Febrile Patients in Northern Tanzania. *The American Journal of Tropical Medicine and Hygiene*, *87*(6), 1105–1111. https://doi.org/10.4269/ajtmh.2012.12-0327

Stokols, D., Lejano, R. P., & Hipp, J. (2013). Enhancing the Resilience of Human–Environment Systems: A Social Ecological Perspective. *Ecology and Society*, *18*(1). https://doi.org/10.5751/ES-05301-180107

Tarimo, D. S. (2016). Community knowledge and perceptions on the management of non-malarial fevers under reduced malaria burden and implications on the current malaria treatment policy in Morogoro, Tanzania. *Asian Pacific Journal of Tropical Disease*, *6*(2), 163–166. https://doi.org/10.1016/S2222-1808(15)61005-2

The United Republic of Tanzania. (2015). *One Health Strategic Plan*.

Townsend, N., & Foster, C. (2013). Developing and applying a socio-ecological model to the promotion of healthy eating in the school. *Public Health Nutrition*, *16*(06), 1101–1108. https://doi.org/10.1017/S1368980011002655

Trostle, J. A., & Sommerfeld, J. (1996). MEDICAL ANTHROPOLOGY AND EPIDEMIOLOGY. *Annual Review of Anthropology*, *25*(1), 253–274. https://doi.org/10.1146/annurev.anthro.25.1.253

Tumwine, G., Matovu, E., Kabasa, J. D., Owiny, D. O., & Majalija, S. (2015). Human brucellosis: Sero-prevalence and associated risk factors in agro-pastoral communities of Kiboga District, Central Uganda. *BMC Public Health*, *15*(1), 900. https://doi.org/10.1186/s12889-015-2242-z

Wade, D. T., & Halligan, P. W. (2004). Do biomedical models of illness make for good healthcare systems? *BMJ*, *329*(7479), 1398–1401. https://doi.org/10.1136/bmj.329.7479.1398

World Health , & FAO (Eds.). (2006). *Brucellosis in humans and animals*. WHO.

Winch, P. J., Makemba, A. M., Kamazima, S. R., Lurie, M., Lwihula, G. K., Premji, Z., Minjas, J. N., & Shiff, C. J. (1996a). Local terminology for febrile illnesses in Bagamoyo District, Tanzania and its impact on the design of a community-based malaria control programme. *Social Science & Medicine*, *42*(7), 1057–1067. https://doi.org/10.1016/0277-9536(95)00293-6

Winch, P. J., Makemba, A. M., Kamazima, S. R., Lurie, M., Lwihula, G. K., Premji, Z., Minjas, J. N., & Shiff, C. J. (1996b). Local terminology for febrile illnesses in Bagamoyo District, Tanzania and its impact on the design of a community-based malaria control programme. *Social Science & Medicine*, *42*(7), 1057–1067. https://doi.org/10.1016/0277-9536(95)00293-6

Wolf, M. (2015). Is there really such a thing as "one health"? Thinking about a more than human world from the perspective of cultural anthropology. *Social Science & Medicine*, *129*, 5–11. https://doi.org/10.1016/j.socscimed.2014.06.018

Yeom, H. A., Fleury, J., & Keller, C. (2008). Risk factors for mobility limitation in community-dwelling older adults: A social ecological perspective. *Geriatric Nursing*, *29*(2), 133–140.

Zeng, J. Y., Ciren, D. J., Yundan, D. Z., Pu, Q., Gongjue, C. W., Jiumei, D. J., & Robertson, I. D. (2018). A study of the knowledge, attitudes and practices of Tibetan yak herders with respect to brucellosis. *International Health*, *10*(4), 294–301. https://doi.org/10.1093/inthealth/ihx076

Zhang, N., Zhou, H., Huang, D.-S., & Guan, P. (2019b). Brucellosis awareness and knowledge in communities worldwide: A systematic review and meta-analysis of 79 observational studies. *PLOS Neglected Tropical Diseases*, *13*(5), e0007366. https://doi.org/10.1371/journal.pntd.0007366

Zinsstag, J., Schelling, E., Roth, F., Bonfoh, B., de Savigny, D., & Tanner, M. (2007). Human Benefits of Animal Interventions for Zoonosis Control. *Emerging Infectious Diseases*, *13*(4), 527–531. https://doi.org/10.3201/eid1304.060381

Zvonareva, O., van Bergen, W., Kabanets, N., Alliluyev, A., & Filinyuk, O. (2019). Experiencing syndemic: disentangling the biosocial complexity of tuberculosis through qualitative research. *Journal of Biosocial Science*, *51*(3), 403–417. https://doi.org/10.1017/S0021932018000263

Appendices

Appendix 9.1: Statement of Consent

"Hello. My name is …….I am from the University of Nairobi. I am carrying out a study on the awareness, knowledge and attitudes on brucellosis in livestock and humans in this locality. I am also interested to know about your practices related to consumption of animal products and animal handling. This research also seeks to understand your treatment seeking behavior during a febrile illness episode. I am interested to know your opinions on the causes, symptoms and risk factors of the disease also. You have been purposively selected as one of my respondents in this study. Please feel free to discuss the above issues with me. Your name will not appear in any of the documents and all the information you provide will be treated with confidence. You are not under any obligation to respond to all the questions and you can withdraw from the study at any time. Thank you".

Consent Sheet

"I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have asked have been answered to my satisfaction. I consent voluntarily to participate in this study and understand that I have the right to withdraw from the discussion at any time with no consequences."

_____	_____
Informant's Name	Signature and Date
_____	_____
Researcher	Signature and Date

Appendix 9.2 Informed Consent Form (Swahili)

Kuomba idhini (Utambulisho juu ya utafiti)

“Habari, jina langu naitwa…….. Natoka chuo kikuu Nairobi. Nipo katika utafiti unaohusiana na Ugonjwa wa (brusela), na tiba ya ugonjwa huu wa brusela katika eneo hili. Nahitaji maoni yako kuhusu sababu, dalili na tiba ya brusela na pia shughuli za ufugaji ndani ya jamii hii. Umechaguliwa kushiriki kama mmojawapo wa washiriki katika utafiti huu. Tafadhali jisikie huru katika kujadili juu ya mada hiyo tukiwa pamoja. Jina lako halitaonyeshwa au kuchapwa sehemu yoyote katika tafiti hii na majibu yako yote ni siri. Ushiriki wako katika utafiti huu ni wa hiyari na pia huta lazimishwa kujibu maswali yoyote bali yale tuu unayo weza kujibu. Pia una haki kusitisha majadiliaono yetu wakati wowote pasipo madhara yoyote juu yako”

Karatasi ya Makubaliaono (Idhini)

“Nimesoma taarifa juu ya utafiti huu, au Amenisomea taarifa za awali juu majadiliano yetu. Na nimepata fursa ya kuuliza maswali juu ya utafiti huu na kila swali nililouliza limejibiwa kwa ufasaha na nimeridhika na majibu. Nimeelewa kuwa ushiriki katika utafiti huu ni wa hiyari na ninayo haki ya kusitisha kushiriki katika utafiti huu wakati wowote itakapo hitajika pasipo madhara yoyote juu yangu”

_____	_____
Jina la Mshiriki	Sahihi na Tarehe
_____	_____
Jina la Mtafiti	Sahihi na Tarehe

Appendix 9.3: Structured Interview Guide

Household description

Region	
District	
Ward	
Village	
Sub-village	

Section 1: Demographic Information

1.	Sex	1. Male 2. Female	
2.	Age	1. 18-25 years 2. 26-33 years 3. 34-41 years 4. 42-49 years 5. >50 years	
3.	Marital Status	1. Single 2. Married 3. Separated 4. Divorced 5. Widowed	
4.	Highest level of Education	1. None 2. Primary 3. Secondary 4. College/University 5. Postgraduate	
5.	Religion	1. Christian 2. Muslim 3. Atheist 4. Traditionalist 5. Other	

6.	Tribe	1. Wamaasai 2. Wasukuma *3. Wanyakyusa* 4. Wasagara 5. Wakuguru 6. Wapogoro 7. Wandamba *8. Wanyamwezi* *9. Wamang'ati* *10. Warangi* *11. Wachagga* 12. Other (Specify)……	
7.	Main Livelihood Activity	1. Pastoralism 2. Agro pastoralism 3. Employed 4. Casual Labor 5. Self employed 6. Other (Specify)	

Section 2: Knowledge of brucellosis and treatment pathways for human brucellosis

8.	*Have you ever heard of the disease brucellosis in livestock?* *IF YES GO TO NO 9*	*1. Yes* *2. No*	
9.	*What are the major signs and symptoms of*	*1. Abortions* *2. Decreased milk production* *3. Birth of weak calves* *4. Still births*	

	brucellosis in livestock? (Mark all that apply)	*5. Infertility* *6. Weight loss* *7. Lameness* *8. Swollen joints (hygromas)* *9. Others (Please specify)*	
10.	Have you ever heard of the disease brucellosis in humans? *If yes go to No 11*	1. Yes 2. No	
	NB:	**Ask Questions 11 to 20 to only those who answer yes to Q 10**	
11.	What are the major signs and symptoms of brucellosis in humans?	1. Fever 2. Chills 3. Headache 4. Joint Pains 5. Abdominal pain 6. General malaise 7. Diarrhea 8. Vomiting 9. Sweating 10. Weight Loss 11. Other (Specify)…….	(TICK ALL THAT APPLY)
12.	What was the source of this information?	1. Family 2. Friends 3. Radio 4. TV 5. Posters/Pamphlets 6. School Teacher 7. Health Worker 8. Other (Specify)……..	(Tick all that apply)

13.	Have you or any of your family members ever suffered from brucellosis? ***If yes to No 13, ask the following questions***	1. Yes 2. No 3. Don't Know	
14.	If yes what symptoms did they exhibit?	1. Fever 2. Chills 3. Headache 4. Joint Pains 5. Diarrhea 6. Abdominal pain 7. Vomiting 8. Sweating 9. Weight Loss *10. Rash* 11. Other(s)(Specify)…….	*TICK ALL THAT APPLY*
15.	How do you think you/they contracted brucellosis?	1. Consuming raw milk 2. Consuming raw blood 3. Consuming raw or poorly cooked meat 4. Direct contact with animal fluids during calving	TICK ALL THAT APPLY

		5. Inhalation of infected aerosols 6. Other (Specify)	
16.	How did you know it was brucellosis you/they were suffering from?	1. Self diagnosis 2. Diagnosis made at a health facility 3. Other(specify)	
17.	What was your occupation or that of the patient at the time when they contracted brucellosis?	1. Pastoralist 2. Agro pastoralist 3. Housewife 4. Business owner 5. Other (Specify)……	CHOOSE ONE
18.	What was the initial course of action you or the patient took when you suspected you had brucellosis?	1. Visited a health facility 2. Took traditional herbs 3. Visited a healer 4. Home Remedies (Specify)……. 5. Prayer 6. Over the counter drugs 7. Other (Specify)……	CHOOSE ONE
19.	Why did you choose this course?	1. Most effective 2. Cheapest 3. Nearest	

		4. Other(specify)	
19.	Were there any subsequent steps you took after that in seeking treatment?	1. Visited a health facility 2. Took traditional herbs 3. Visited a traditional healer 4. Home remedies (Specify) 5. Prayer 6. Over the counter drugs 7. Other (Specify) ***8. None***	TICK ALL THAT APPLY
20.	In your opinion what is the most effective treatment for human brucellosis?	1. Traditional herbs 2. Hospital Medicines 3. Home remedies 4. Prayer 5. Other (Please specify)……..	CHOOSE ONE
	NB:	**Ask No 21-23 only to those who responded yes to Q 8 and 10**	
21.	Can brucellosis be transmitted from wildlife to livestock	1. Yes 2. No 3. I don't know	
	If yes how	List….	
22.	Can brucellosis be transmitted from livestock to humans? ***If***	1. Yes 2. No 3. I don't Know	

	yes go to No 23)		
23.	*If yes, how?*	*1. Consuming raw milk* *2. Consuming raw blood* *3. Consuming raw or poorly cooked meat* *4. Direct contact with animal fluids during calving* *5. Inhalation of infected aerosols* *6. Other (specify)*	*TICK ALL THAT APPLY*

Section 3: Perceived Vulnerability to Brucellosis

24.	**Statement on vulnerability to brucellosis**	***YES***	***NO***	***SOMETIMES(specify)***
a.	We milk our livestock when we know they are sick			
b.	We consume milk from animals that we know are sick			
c.	We boil our milk before consumption			
d.	We slaughter animals that are sick			
e.	We slaughter dead animals			
f.	We consume meat from animals that we know were sick			
g.	We consume meat from dead animals			
h.	We consume raw blood from animals			

i.	We consume meat that is raw or has not been cooked properly			
j.	We reside in the same house with livestock			
k.	We assist livestock to deliver using our bare hands			
l.	*We graze our livestock in areas with wild animals*			

25.	*Has any of your livestock aborted in the last one year?*	*Yes/No (If yes go to No 26)*
26.	*Which ones?* *1. Cattle* *2. Goats* *3. Sheep*	*(TICK ALL THAT APPLY)*
27.	*How did you dispose off the aborted material?* *1. Fed it to the dogs* *2. Buried it* *3. Left it to rot on the ground* *4. Other (specify)*	
28.	*What do you think was the cause(s) of the abortion?*	*(List causes)*
29.	*Have you had any cases of retained placenta in your herd in the last one year?*	*YES/NO (If yes go to Q 30)*
30.	*Which ones?* *1. Cattle* *2. Goats* *3. Sheep*	*(TICK ALL THAT APPLY)*

31.	*What do you think was the cause(s) of the retained placenta?*	*(List causes)*
32.	*Has any of your livestock delivered a still born offspring in the last one year?*	*YES/NO (If yes go to No 30)*
33.	*Which ones?* *1. Cattle* *2. Goats* *3. Sheep*	*(TICK ALL THAT APPLY)*
34.	*What do you think caused the still birth?*	*(List causes)*
35.	*Have you had any infertile livestock in your herd in the last one year?*	*YES/NO (If yes go to No 36)*
36.	*Which ones?* *1. Cattle* *2. Goats* *3. Sheep*	*(TICK ALL THAT APPLY)*
37.	*What do you think was the cause of the infertility?*	*(List causes)*

Section 4: Treatment pathways related to febrile illnesses

38.	*Have you or any of your family members had a fever in the last three months?*	*YES/NO (If yes go to No 39)*
39.	*What other symptoms (s) did they exhibit?* *1. Fever* *2. Chills* *3. Headache* *4. Joint Pains* *5. Diarrhea* *6. Abdominal pain* *7. Vomiting*	*TICK ALL THAT APPLY*

	8. Sweating *9. Weight Loss* *10. Rash* *11. Other(s)(Specify)……*	
40.	*What was initial course of action?* *1. Visited a health facility* *2. Took traditional herbs* *3. Visited a healer* *4. Home Remedies (Specify)……* *5. Prayer* *6. Over the counter drugs* *7. Other (Specify)……*	*CHOOSE ONE*
41.	*Were there any subsequent steps you took after that in seeking treatment?*	*YES/NO (If the answer is yes go to No. 42)*
42.	*1. Visited a health facility* *2. Took traditional herbs* *3. Visited a traditional healer* *4. Home remedies (Specify)* *5. Prayer* *6. Over the counter drugs* *7. Other (Specify)*	*TICK ALL THAT APPLY*

END

Appendix 9.4: Structured Interview Guide (Swahili)

Kiambatisho 2: Mwongozo wa Mahojihano

Taarifa (maelezo) ya kaya

Mkoa	
Wilaya	
Kata	
Kijiji	
Kitongoji	

Sehemu ya Kwanza: Taarifa binafsi za muhojiwa

1.	Jinsia	3. Mwanamme 4. Mwanamke	
2.	Umri	6. Miaka 18-25 7. Miaka 26-33 8. Miaka 34-41 9. Miaka 42-49 10. Zaidi ya Mika 50	
3.	Hali ya Ndoa	6. Hajaoa/ Kuolewa 7. Ameoa/ Ameolewa 8. Wameachana 9. Talaka 10. Mjane/ Mgane	
4.	Kiwango cha Juu cha Elimu	6. Hana Elimu (Hajasoma) 7. Shule ya Msingi 8. Secondari 9. Chuo/ Chuo Kikuu (diploma au shahada) 10. Shahada ya uzamili	
5.	Dini	6. Mkristu 7. Muislamu 8. Wapagani 9. Waumini wa kimila 10. Nyingine taja ……	

6.	Kabila	13. Wamaasai 14. Wasukuma 15. Wanyakyusa 16. Wasagara 17. Wakuguru 18. Wapogoro 19. Wandamba 20. Wanyamwezi 21. Wamang'ati 22. Warangi 23. Wachagga 24. Nyingine (taja)	
7.	Shughuli Kuu ya Uzalishaji Mali	7. Mfugaji 8. Ufugaji na Ulimaji 9. Mwajiriwa 10. Mfanyakazi wa kawaida 11. Amejiajiri 12. Nyingine taja ……	

Sehemu ya 2: Uelewa juu ya ugonjwa wa brusela na njia za tiba za ugonjwa wa brucela kwa binadamu

8.	Umeshawahi kusikia ugonjwa wa brusela kwa mifugo? (Kama ndio nenda kwa swali namba 9)	3. Ndio 4. Hapana	
9.	Je ni zipi dalili kuu na viashiria vya ugonjwa wa Brusela kwa mifugo? (weka alama kwa majibu yote anayotaja)	10. Kutoa mimba 11. Upungufu wa maziwa 12. Kuzaa ndama mnyonge 13. Kuzaa ndama mfu 14. Mnyama kuwa mgumba 15. Kukonda 16. Ulemavu 17. Kuvimba viungo	

		18. Nyingine (taja)	
10.	Umeshawahi kusikia ugonjwa wa brusela kwa binadamu? *(Kama ndio nenda kwa swali namba 11)*	1. Ndio 2. Hapana	
	NB:	**Uliza maswali namba 11 hadi 20 kwa wale waliojibu ndio kwa swali namba 10**	
11.	Ni zipi dalili za ugonjwa wa brucellosis kwa binadamu?	1. Homa 2. Kutetemeka 3. Maumivu ya kichwa 4. Maumivu ya viungo 5. Kuumwa na tumbo 6. Uchovu na ulegevu wa mwili 7. Kuharisha 8. Kutapika 9. Kutokwa jasho 10. Kupungua uzito 11. Nyingine taja…….	
12.	Je ni nini chanzo cha hizo taarifa? (weka alama kwa kila jibu)	9. Familia 10. Marafiki 11. Redio 12. TV 13. Mabango au Mjarida 14. Walimu wa Shule 15. Watumishi wa Afya 16. Nyingine taja ……..	
13.	Wewe au mwanafamilia wako yoyote hapa amewahi kuuguwa ugonjwa wa brusela? ***Ikiwa jibu ni ndiyo kwa swali la 13 uliza haya maswali yafuatayo***	1. Ndio 2. Hapana 3. Sijui	

14.	Kama ndiyo je zipi dalili zilizo onekana kwake? taja…….	1. Homa 2. Kutetemeka 3. Maumivu ya Kichwa 4. Maumivu ya viungo(jointi) 5. Kuharisha 6. Kuumwa na tumbo 7. Kutapika 8. Kutokwa na jasho jingi 9. Uzito kupungua 10. Upele 11. Nyingine (taja)	
15.	Ni kwa namna gani unafiriki ugonjwa wa brusela uliupata au aliupata?	1. Kunywa maziwa mabichi 2. Kwa kula damu mbichi ya mifugo 3. Kula nyama ambayo ni mbichi au ambayo haijaiva vizuri 4. Mwingiliano wa majimaji wakati wa uzalishaji wa mifugo 5. Kuvuta pumzi yenye maambukizi kutoka kwa mifugo 6. Nyingine (Taja)	
16.	Ulijua je kwamba uliigua au waliugua ugonjwa wa brusela?	1. Nilifikiri tu mwenyewe 2. Nilielezwa na mtaalamu katika zahanati au hospitalini 3. Nyingine (taja)	
17.	Je ipi ilikuwa kazi yako au kazi ya mtu ambaye aliugua ugonjwa wa brusela kwa kipindi hicho?	1. Mfugaji 2. Mfugaji na Mkulima 3. Mama wa nyumbani 4. Biashara ya binafsi 5. Nyingine taja……..	

18.	Je njia gani mahususi ambayo ulichukuwa au mgonjwa alichukuwa alipogundua ana ugonjwa wa Brusela?	1. Kutembelea kituo cha afya 2. Kutumia dawa za kienyeji 3. Kuwatembelea waganga wa nyumbani 4. Tiba ya nyumbani (taja) 5. Kufanya maombi 6. Matumizi ya madawa ya kununua kwa duka bila kumuona daktari 7. Nyingine (taja)	
19.	Kwa nini uliichagua (tiba) njia hiyo?	5. Inafaa zaidi 6. Gharama nafuu 7. Inapatikana karibu 8. Nyingine (taja)	
19.	Je kulikuwa na njia zingine zilizofuata ambazo ulichuzichukuwa hapo baadaye kutafuta matibabu?	1. Kutembelea kituo cha afya 2. Kutumia dawa za kienyeji 3. Kuwatembelea waganga wa nyumbani…. 4. Tiba ya nyumbani (taja) 5. Maombi 6. Matumizi ya madawa ya kununua kwa duka bila kumuona daktari Nyingine (taja)	
20.	Kwa maoni yako je ni tiba gani inafaa kwa mtu mwenye brusela?	1. Dawa za kienyeji 2. Dawa za hospitali 3. Tiba za nyumbani 4. Maombi 5. Nyingine (taja)	
	NB:	**Uliza maswali numba 21-23 kwa wale walio jibu ndio kwa maswali numba 8 na 10**	

21.	Je ugonjwa wa brusela waweza kuambukizwa kutoka wanyama wa porini na kwenda kwa wanyama wa kufuga?	1. Ndio 2. Hapana 3. Sijui	
22.	Je ugonjwa wa brusela unaweza kuambukizwa kutoka kwa wanyama wa kufugwa kwenda kwa binadamu? ***(Kama ndio jibu swali namba 23)***	4. Ndio 5. Hapana 6. Sijui	
23.	Kama ndio, kwa njia zipi?	1. Kutumia maziwa ambayo hayajachemshwa 2. Kunywa damu za mifugo ikiwa mbichi 3. Kula nyama mbichi au ambayo haijaiva vizuri 4. Mwingiliano wa majimaji wakati wa uzalishaji wa mifugo 5. Kuvuta hewa yenye maambukizi kutoka kwa mifugo	

Sehemu ya 3: Mtazamo juu ya athari ya brusela

24.	**Taarifa juu ya hatari za brusela**	**NDIO**	**HAPANA**	**WAKATI MWINGINE**
a.	Tunakamua maziwa mifugo yetu wakati tunajua wana ugonjwa			
b.	Tunatumia maziwa ya mifugo ingawa tunajua wana ugonjwa			

c.	Sisi tunachemsha maziwa kabla ya kuyatumia(kunywa)			
d.	Sisi huwachinja mifugo wenye ugonjwa			
e.	Sisi huwachinja mifugo ***wafu***			
f.	Sisi tunakula nyama za mifugo tunapojua wana ugonjwa			
g.	Sisi tunakula nyama ya mnyama aliyekufa			
h.	Sisi hutumia damu ghafi ya wanyama			
i.	Sisi tunakula nyama ambayo ni mbichi au ambayo haijaiva vizuri			
j.	Tunaishi pamoja na mifugo ndani ya nyumba moja			
k.	Sisi huwasaidia mifugo kwa kuwazalisha wakati wa kuzaa kwa kutumia mikono mitupu			
l.	Sisi tunalisha mifugo wetu pamoja na wanyama pori			

25.	Kuna mfugo wako yeyote ametoa mimba kwa kipindi cha mwaka mmoja uliopita?(Kama ndio jibu swali namba 26)	NDIO/LA
26.	Kama ndio Mifugo ipi? 1. Ng'ombe 2. Mbuzi 3. Kondoo	
27.	Uliondoa vipi ule uchafu wa mimba iliyotoka?	

	1. Niliwapa mbwa wakala 2. Niliufukia 3. Niliuacha uozee ardhini 4. Nyingine(taja)	
28.	Ulidhani ni nini kilisababisha mimba hiyo kutoka?	TAJA
29.	Kuna mfugo wako yeyote aliyezaa ndama mfu kwa kipindi cha mwaka mmoja uliopita?	NDIO/LA
30.	Kama ndio Mifugo ipi? 1. Ng'ombe 2. Mbuzi 3. Kondoo	
31.	Ulidhani ni nini kilisababisha ndama mfu kuzaliwa?	TAJA
32.	Umekuwa na mfugo yeyote ambaye ni mgumba kwa kipindi cha mwaka mmoja uliopita?	NDIO/LA
33.	Kama ndio Mifugo ipi? 1. Ng'ombe 2. Mbuzi 3. Kondoo	
34.	Ulidhani ni nini kilisababisha mnyama huyo kuwa mgumba?	TAJA

Sehemu ya 4: Njia za tiba za magonjwa yanayosababisha homa

35.	Wewe au mwanafamilia wako yoyote hapa amewahi kuuguwa ugonjwa unaoleta homa kwa kipindi cha miezi mitatu iliyopita? Ikiwa jibu ni ndiyo kwa swali la 35 uliza haya maswali yafuatayo	4. Ndio 5. Hapana 6. Sijui
36	Kama ndiyo je zipi dalili zilizoonekana kwake? (Taja)	1. Homa 2. Kutetemeka 3. Maumivu ya Kichwa 4. Maumivu ya viungo(jointi) 5. Kuharisha 6. Kuumwa na tumbo

		7. Kutapika 8. Kutokwa na jasho jingi 9. Uzito kupungua 10. Upele 11. Nyingine(taja)
37.	Je njia gani mahususi ambayo ulichukuwa au mgonjwa alichukuwa alipogundua ana ugonjwa wa Brusela? (Chagua moja)	1. Kutembelea kituo cha afya 2. Kutumia dawa za kienyeji 3. Kuwatembelea waganga wa nyumbani 4. Tiba ya nyumbani (taja) 5. Kufanya maombi 6. Matumizi ya madawa ya kununua kwa duka bila kumuona daktari 7. Nyingine (taja)
38.	Je kulikuwa na njia zingine zilizofuata ambazo ulichuzichukuwa hapo baadaye kutafuta matibabu?	NDIO/LA (Kama ndio, jibu swali namba 39)
39.	Njia zipi?	1. Kutembelea kituo cha afya 2. Kutumia dawa za kienyeji

		3. Kuwatembelea waganga wa nyumbani…. 4. Tiba ya nyumbani (taja) 5. Maombi 6. Matumizi ya madawa ya kununua kwa duka bila kumuona daktari 7. Nyingine (Taja)

Appendix 9.5: Focus group discussion checklist

ID NO:

Demographics:

Type of Group:

No in a Group:

Village:

Theme 1: Animal husbandry

- Describe the livestock practices: (herding, watering, milking, treating, slaughtering, preparation and consumption of animal and animal products, assisting in births, caring for diseased animals, where animals are kept) in terms of **age** and **gender** dynamics. **Probe**: boiling milk, using gloves during assisted parturition, handling aborted foetuses, residing with livestock. **Probe:** List of activities performed per age group

- Describe the livestock movement and grazing patterns. **Probe**: where and in which environments. **Mapping** exercise for spaces: homes, farms, grazing areas, wildlife areas, hospitals, chemists. **Probe**: seasonal variations, wild animals interaction with livestock, which categories of people are involved in this.

Theme 2: Knowledge and Perceptions regarding livestock diseases and brucellosis:

- Describe some of the common livestock diseases in this region and their symptoms. **Free listing** all the diseases of livestock and ranking in order of severity.
- Describe zoonotic diseases. **Probe**: Brucellosis. Risk factors perceptions like consumption of raw milk, handling aborted foetuses, residing with livestock. **Probe:** Age and gender of those most likely to be involved with each risk factor.

- Describe how symptoms like infertility, weak or still born calves, retained placenta, reduced milk yield, hygromas are understood and addressed eg **do they signal a big problem**. **Probe**: Perceptions, treatment strategies.

Theme 3: Treatment pathways for febrile illnesses

- Kindly name the common human diseases in this locality that cause fever. **Free listing** all human diseases and **ranking** in order of severity: **Probe**: Zoonotic diseases. **Probe**: Local names for fever and meaning, undulant fever, other common symptoms, causes, progression, degrees of severity

- What kinds of treatment are sought for febrile illnesses? **Probe**: Who determines treatment sought and that decision making process, Progression in seeking care and duration taken between each method, Differences between males and females, Children and adults, Utilization of health care facilities, Over the counter drugs, testing, alternative treatment sources

- Please tell me about the challenges you encounter in accessing treatment for febrile illnesses. **Probe**: Duration of illness, Cost, Accessibility of treatment, Preferred treatment, gender differences, other work commitments. **Probe**: perceptions related to the health care system.

- Kindly tell me about the difficulties you face after the treatment for a febrile illness. **Probe**: Any recurring symptoms, Actions taken.

Appendix 9.6: In depth Interview Guide

Background Information

No of interview:

Age:

Sex:

Marital Status:

Level of education:

Religion:

Introduction:

1.Please tell me the benefits of livestock

Probe: Cattle, goats, sheep

2.Kindly tell me how you acquire new stock

Probe: From where, transportation, what do you look for

3.Name the common livestock diseases in this region

Probe: Local names, Signs of each disease, Severity of diseases, Seasonality of diseases

2. Human- Animal interface dynamics

4.What do you know about zoonotic diseases?

Probe: Which ones, Risk factors

Probe: Brucellosis: causes, signs in livestock and humans, transmission

5.Please tell me about the gender roles in this household

Probe: Milking, herding, assisting in births and wearing of gloves, Residing with livestock, curing hides

6.What do you think about the consumption of raw milk/raw blood/raw meat?

Probe: Reasons why, when, who consumes it, boiling milk perceptions

7.What typically happens when an animal dies?

Probe: Consumption, how meat is considered safe/unsafe and any actions taken

8.Which diseases cause abortions in livestock*? (NB:B abortions between 5th-7th month*).

Probe: Stage at which abortions occur, one off or repeatedly, Why they occur, Actions taken, Abortion storms, Disposal of aborted fetuses

9.What do you think is the causes(s) of retained placenta in your livestock?

Probe: How is this addressed

10.What leads to infertility in your livestock?

Probe: Why, what is done, benefits or losses incurred, males and females

11.Please tell me about still births in your livestock?

Probe: Why, Actions taken

12.What do you think about the birth of weak calves or kids in your herd?

Probe: Why, Any actions

13.What causes reduced milk yield in cattle?

Probe: How do you determine reduced milk yield? How is that interpreted?

14.What is your opinion about about swollen/enlarged/inflamed joints in a cow?

Probe: Causes, Actions taken

Environmental interactions

15.Please tell me what typically happens when cattle are being moved from one place to another?
Probe: Migration, Who, Why, Where

16.What do you think about the interaction of livestock with wild animals?
Probe: Which wild animals? Where? Why? Movement of wild animals, Knowledge of potential risks? Gender and Age of people involved

Treatment pathways for febrile illnesses

17.Kindly name the common human diseases in this locality that cause fever.
Probe: Local names for fever and meaning, undulant fever, other common symptoms, causes, progression, degrees of severity

18.What kinds of treatment are sought for febrile illnesses?
Probe: How soon, Progression in seeking care, Differences between males and females, Children and adults, Utilization of health care facilities, Over the counter drugs, testing, alternative treatment sources

19.Please tell me about the challenges you encounter in accessing treatment for febrile illnesses
Probe: Duration of illness, Cost, Accessibility of treatment, Preferred treatment, gender differences

20.Kindly tell me about the difficulties you face after the treatment for a febrile illness
Probe: Any recurring symptoms, Actions taken

Closing questions

21.What are the major challenges you face as an agro pastoralists related to livestock diseases?
Probe: Zoonotic diseases

22.What do you think needs to be done to mitigate these challenges?

Probe: Access to veterinary services, treatment of livestock, awareness and education to local community

Appendix 9.7: Key Informant Interview Guide

1. What types of livestock are kept in this region? Please **elaborate** on what livestock are considered important to men, women, boys and girls and why. **Probe** for average numbers of cattle, goats, sheep in a household. **Probe** for why livestock is kept: uses.
2. Kindly explain to me the roles men, women, boys and girls play in livestock production. **Probe** for: specific roles such as grazing, milking, watering, taking care of ill animals, protecting livestock from predators, assisting in parturition, handling and processing skins and hides, handling and disposal of manure, handling and disposal of dead animals.
3. Tell me more about the livestock migratory patterns related to seasons. **Probe** for migration during the dry seasons, migration in search for pasture in wildlife areas, perceived challenges when herds move in search for water and pasture, food consumed during migration, who takes livestock and which ones, for how long.
4. Please tell me about the common livestock diseases in this region and their symptoms. Probe: Brucellosis signs in livestock and humans, causes, risk factors, transmission.
5. Please tell me the most common human diseases in this locality and their signs.
6. Please explain to me the consumption practices in this region related to meat and milk. **Probe** for boiling of milk, consumption of raw milk and by whom, consumption of raw or undercooked meat and by whom. **Probe** for when raw milk is likely to be consumed. **Probe** for when raw meat is likely to be consumed. **Probe** for how they determine safe and unsafe meat and milk,
7. Kindly tell me how sick animals are handled in this locality. **Probe** for what they do, the measures they take. **Probe** for how they determine when to seek help.
8. Explain to me how dead animals are handled in this area. **Probe** for aborted fetuses and aborted material too and how it is disposed.
9. What are some of the general disease risk reduction strategies for animals and humans.
10. Explain brucellosis in livestock. **Probe** for local name(s), causes, symptoms, perceived risk factors.
11. Please tell me more about brucellosis in humans. **Probe** for local name(s), causes, symptoms. **Probe** for specific attitudes and behavior related to consumption patterns, animal husbandry practices, grazing patterns, habitation, who are most likely to be infected.

12. Elaborate on how the local people perceive their susceptibility to brucellosis. **Probe** for perceived risk.

13. How is the disease treated, what steps are followed, what treatment options are available and describe each in detail, which options are preferred by local communities and why.

14. Describe in detail the measures that have been and are being taken by the community, health facilities and other stakeholders to control human brucellosis. **Probe** for effectiveness, benefits, challenges, what else can be done

Appendix 9.8: Observation Checklist

General observations: Types of houses/ dwellings, layout of the compound, types of livestock kept, types of activities going on, tasks performed by family members, gender roles and differentiation.

Specific observations: Milking, herding, assisting livestock during calving, handling manure, animal slaughter, cooking, boiling of milk, food handling and consumption practices, handling of hides and skins.

Appendix 9.9: Ethical clearance and Research permit

THE UNITED REPUBLIC OF TANZANIA

National Institute for Medical Research
3 Barack Obama Drive
P.O. Box 9653
11101 Dar es Salaam
Tel: 255 22 2121400
Fax: 255 22 2121360
E-mail: nimrethics@gmail.com

Ministry of Health, Community Development, Gender, Elderly & Children
University of Dodoma, College of Business Studies and Law
Building No. 11
P.O. Box 743
40478 Dodoma

NIMR/HQ/R.8a/Vol. IX/3102

23rd May, 2019

Coletha Mathew
Sokoine University of Agriculture
C/o Prof. Kazwala Rudovick
Sokoine University of Agriculture
P.O. Box 3021
Morogoro

RE: ETHICAL CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH IN TANZANIA

This is to certify that the research entitled: Approaches towards brucellosis control and prevention in Tanzania (Mathew C. et al), whose supervisor is Prof. Kazwala Rudovick of Sokoine University of Agriculture has been granted ethical clearance to be conducted in Tanzania.

The Principal Investigator of the study must ensure that the following conditions are fulfilled:

1. Progress report is submitted to the Ministry of Health, Community Development, Gender, Elderly & Children and the National Institute for Medical Research, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from National Institute for Medical Research.
3. Copies of final publications are made available to the Ministry of Health, Community Development, Gender, Elderly & Children and the National Institute for Medical Research.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III Section 10(2).
5. Sites: Morogoro, Mara, Arusha and Kilimanjaro regions.

Approval is valid for one year: 23rd May 2019 to 22nd May 2020.

Name: Prof. Yunus Daud Mgaya

Signature
CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE

Name: Prof. Muhammad Bakari Kambi

Signature
CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH, COMMUNITY DEVELOPMENT, GENDER, ELDERLY & CHILDREN

CC: Director, Health Services -TAMISEMI, Dodoma
RMO of Morogoro, Mara, Arusha and Kilimanajaro regions
DMO/DED of respective districts

UNITED REPUBLIC OF TANZANIA

TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY (COSTECH)

RESEARCH PERMIT

TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY P.O Box 1963 DAR-ES-SALAAM

Permit No.	2019-90- NA-2018- 375
Date	12th March 2019
Researcher's Name	Caroline M. Mburu
Nationality	Kenyan
Research Title	Cultural Drivers and treatment Pathways Related to Human Brucellosis in Morogoro
Research Area(s)/Region(s)	Morogoro
Validity	From: 12th March 2019 to 11th March 2020
Local contact/collaborator *(with affiliated institution)*	Prof. Rudovick Kazwala, Sokoine University, Morogoro

PROGRAMM OFFICER

for:DIRECTOR GENERAL

IMPORTANT REQUIREMENTS

- *Research permit that involve collecting human, plant or animal materials / data that will be exported outside Tanzania must submit a signed Material Transfer Agreement (MTA), Data Transfer Agreement (DTA) between Tanzania host institution and the foreign counterpart. The MTA/DTA will indicate terms for collecting, storing/managing, transporting, disposal or returning of the materials/DATA to Tanzania after the closure of the research project.*
- *Any patent or intellectual property and royalty emanating from any research approved by the National Research Registration Committee (NRRC) shall be owned as stipulated in the research proposals and in accordance with the IP policy of the respective research institutions.*
- *All researchers are required to report to a Regional Administrative Secretary (RAS) of the study area and present the introduction letter and activity schedule(plan) prior starting any research activity.*
- *All researchers are required to submit quarterly progress reports and all relevant publications made after completion of the research.*
- *All communications should be addressed to COSTECH Director General through rclearance@costech.or.tz; dg@costech.or.tz or +255222700749; +255 (022) 2771358. Terms and conditions of the permit are found at www.costech.or.tz*