EPIDEMIOLOGICAL INVESTIGATIONOF MOST PREVALENT CLINICAL SIGNS AND SYMPTOMS OF ANIMAL AND HUMAN DISEASES IN NGORONGORO DISTRICT, TANZANIA

VALENTINA THOBIAS SANGA

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ABSTRACT

Emerging and re-emerging diseases in middle and low income countries particularly in agro-pastoral and pastoral communities pose major concern in animal and public health sectors which affect livelihoods and economy of communities. Improved surveillance system approaches could help to ensure prompt detection, reporting, recording and analyzing the incidence of diseases and response to outbreaks. A retrospective epidemiological study, was conducted to investigate common clinical signs and symptoms of diseases reported by Community Health Reporters (CHRs) in the pastoral and agro-pastoral communities in Ngorongoro district between December 2014 and May 2015, was carried out to identify most prevalent and determine trend of signs and symptoms in animals and human populations. Data collected by CHRs were retrieved from the Southern African Centre for Infectious Disease Surveillance (SACIDS) database, collated and analysed. Descriptive statistics including frequencies and proportions were computed. In addition, spatial analysis wascarried out to establish spatial distribution of clinical signs and symptoms. Cluster analysis was performed using space-time permutation modeling approach. A total of 10 study villages (in six wards) were studied, two villages out of 10 had high frequency of reported signs and symptoms in human of 65% and 25.5% respectively, with high frequency of reported signs and symptoms in female (56.6%) than males 43.4% (p=0.0057). In human, fever, coughing, headache, diarrhoea, joint pain, nausea and vomiting were reported more frequently than other clinical signs and symptoms in Malambo (65%) and Esere (25.4%). In animals, three villages namely Esere, Misigiyo and Alailelai recordedhigh frequency of reported signsof 34.0%, 21.2%, and 14.1%, respectively. There werethree identified statistically significant spatio-temporal clusters of clinical signs and symptoms in human and two in animals. Hence, use of CHRs is useful in capturing early signs and signals of diseases at community level. This system

should be encouraged and strengthened particularly in remote areas where traditional surveillance could not promptly detect disease outbreaks.

DECLARATION

I, Valentina Thobias Sanga, I declare to the Senate of Sokoine University of Agriculture that this dissertation is my original work, done within the period of registration and that it has neither been submitted nor being simultaneously submitted in any other institution.

_____ _____

Valentina Thobias Sanga Date

(MSc. Candidate)

The declaration is hereby confirmed by;

_____ _____

Prof. E. D. Karimuribo Date

(Supervisor)

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DEDICATION

This work is dedicated to the Almighty God, source of my strength and wisdom; to my beloved Dad Thobias Sanga, my sisters: Sr. Adili, Sabina, Kanisia, Eleonora and brothers Longnus and Thoby Sanga for their encouragement and prayers.

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ABBREVIATIONS AND ACRONYMS

AFP	Acute Flaccid Paralysis
ARIs	Acute Respiratory Infections
BTB	Bovine Tuberculosis
CAHWs	Community Animal Health Workers
CBPP	Contagious Bovine Pleuro-Pneumonia
CDC	Centers for Diseases Control and Prevention
CHIKV	Chikungunya virus
Children	
CHRs	Community Health Reporters
CHWs	Community Health Workers
DVO	District Veterinary Officer
DVS	Director of Veterinary Services
EBOV	Ebola virus
ECF	East Coast Fever
EIDS	Emerging Infectious Diseases
FAO	Food and Agriculture Organization
FMD	Foot and Mouth Disease
GPS	Global Positioning System
HIV/AIDS	Human immunodeficiency virus/Acquired immunodeficiency syndrome
HMIS	Health Management Information System
HPAI	Highly Pathogenic Avian Influenza
IDRC	International Development Research Centre
IDSR	Integrated Disease Surveillance and Response system

IDWE	Infectious Disease Week Ending
IHR	International Health Regulations
ILRI	International Livestock Research Institute
MoALF	Ministry of Agriculture, Livestock and Fisheries
MoHCDGEC	Ministry of Health Community Development Gender, Elderly and
N	Number of clinical signs and symptoms
NGO	Non Government Organization
OIE	World Organization for Animal Health
RVF	Rift Valley Fever
RVFV	Rift Valley Fever virus
SACIDS	Southern African Centre for Infectious Disease Surveillance
SARI	Severe Acute Respiratory Illness
SARS	Severe Acute Respiratory Syndrome
TAWIRI	Tanzania Wildlife Research Institute
TB	Tuberculosis
TNBS	Tanzania National Bureau Statistics
UTI	Urinary Tract Infection
VHWS	Village Health Workers
VIC	Veterinary Investigation Centres
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Emerging and re-emerging diseases in middle and low income countries particularly in agro-pastoral and pastoral communities pose major concern in animal and public health sectors which affect economy and livelihoods of affected communities. Experiences show that there is delayed detection, confirmation and response to such diseases in these countries (Dikid*et al*., 2013; Jones *et al*., 2008). Improved surveillance systems is one of the approaches that could help to ensure prompt detection, reporting, recording and analysing the incidence of diseases and thus respond to outbreaks (Mghamba *et al.*, 2004). Surveillance is crucial as some diseases spread rapidly and cause serious losses which could be prevented (Day *et al*., 2012).

Infectious diseases are worldwide reported and can cause considerable socio-economic disruptions as well as loss of lives.This is supported by recent experience from Ebola outbreak in West African countries where majority of people lost their lives due to such disease outbreak (Chowell and Nishiura, 2014). Some of these disease outbreaks such as the Rift Valley fever (RVF) can cause deaths in both human and animals (Sindato *et al*., 2011). In livestock, particularly sheep and cattle, RVF causes high mortality in neonatal animals and adults for 100 % and 10 % to 20 % respectively, high abortion rates occur mostly in infected pregnant animals (Sindato *et al*., 2014). In humans, clinical signs and symptoms of RVFinclude high fever, severe headache, body pain, dizziness, nausea and vomiting, pain within the eyes, loss of weight and bleeding through body cavities (Sindato *et al*., 2011; Heinrich *etal*., 2012; Sindato *et al*., 2014). Highly Pathogenic Avian influenza (HPAI) is another example of infectious diseases that caused high case fatality as reported

in Egypt at 35.8% during 2014 and is still the public health threat with limited epidemiological information in low income countries (Cattoli *et al*., 2009). Other countries in South East Asia including South Korea, Thailand, Viet Nam, Japan and Indonesia have been affected by highly pathogenic avian influenza (HPAI) (Silkavute*et al.,* 2013). Q-fever outbreaks were reported in Bangladesh (Gebreyes *et al*., 2014) and New Zealand (Samad, 2011) and the disease has also affected East African countries including Kenya and Tanzania recently(Vanderburg *et al*., 2014).

A number of studies recommend adoption of the 'One Health' approach as it has been reported that about 75% of most emerging and re-emerging infectious diseases are zoonotic in nature(Gebreyes *et al.*, 2014), and 75% estimate is caused by viral origin from wildlife and domestic animals and are likely transmitted by vectors such as mosquitoes and ticks. Primitive settings for grazing and petting zoos with limited hygienic environment, human interaction with wild animals and exotic pets, human activities contribute in exposure to zoonoses such as Escherichia coli O157:H7, salmonellae and *Coxiella burnetii*. It has also been found that infectious agents of wildlife have potential to affect both human health and agricultural production as well wildlife-based economies and wildlife conservation (King, 2004; Chomel *et al*., 2007). However, developing countries particularly sub-Saharan Africa are faced with challenges of diverse management practices, tradition and customs and unhygienic environmental conditions for animal husbandry in rural and (peri) urban areas that can contribute the risk of transmitting zoonoses. Tanzania is among the countries with over 80% of its people keeping animals under poor sanitary conditions (Swai *et al*., 2010). Under such conditions, humans are at risk to zoonotic diseases like tuberculosis (TB), anthrax, brucellosis, Q-fever, taeniasis, yersiniosis and echnococcosis (Ope *et al*., 2013).

In maintaining health of the public, it is essential to prevent and control diseases, best approach being through understanding epidemiological determinants of such diseases including the causative agent, host, route of transmission, and risk factors that contribute to spread of infections. Integrated One Health approach that brings key sectors such as human, animal and environmental sectors to collaborate in surveillance and response to such diseases is key in managing and eradicating emerging and re-emerging infectious diseases particularly those which are shared by humans, domestic animals and wild animals(Mariner *et al*., 2011;Scotch *et al*., 2011- 2012).

Studies carried out previously identified different infectious agents transmitted from animals to humans. For instance,studies in Tanzania reported prevalence of bovine tuberculosis (Cleaveland *et al*., 2005) andtyphus fever(Dill *et al*., 2013).Delayed health care seeking, lack of awareness, poor infrastructure,lack of communication and sharing disease information between and across sectors, and inappropriate management of these diseases contribute to increased risks of spreading infectious diseases leading to increase morbidity, reduced manpower and economic impact to the community and nation. Zoonotic diseases remain one of the major public threats because they are not prioritized by health systems at national and international levels though they affect many people particularly those from developing countries (Swai *et al*., 2010: Samad, 2011). Lack of joint planning (animal and human health) and reporting, misdiagnoses of endemic zoonoses and lack of diagnostic tests to validate infections are causes that exacerbate problems of disease detection.

This study focused on investigation of common clinical signs and symptoms of disease prevalent in the pastoral and agro-pastoral communities to determine trend of disease occurrence in animals and human populations.

1.2 Problem Statement and Justification of the Study

High prevalence of infectious diseases in agro-pastoral and pastoral communities contributes to increased public health threats. This is aggravated by sub-optimal performance of surveillance and response systems particularly in most of African countries that leads to delayed detection, confirmation and response to such diseases. Socio-cultural practices and behaviours such as living in proximity with animals or consumption of raw animal products such as milk, meat and blood could also contribute to increased public health risks among agro-pastoral and pastoral communities. In these communities; it is not uncommon to have animals sharing houses with human especially young and sick animals which contribute to increase risks of infectious disease transmission. In these communities, it is also common to have delayed health seeking behaviour through official health systems as a result of continued increase in transmission, high morbidity and mortality which otherwise could be avoided. Animal diseases could also lead to reduced production, restriction of animal and animal product trade and consequently resulting to devastating socio-economic impact in the community.

Currently, there is scanty information on the magnitude of infectious diseases prevalent and transmitted between animals and humans in Tanzania. Lack of holistic One Health surveillance approach in disease control and prevention could contribute to delay or misdiagnosis and reporting of common infectious diseases occurring in human and animal populations. The misdiagnosis of infectious diseases could lead to improper treatment which could contribute to development of drug resistance.

1.3 Justification

This study was carried out to provide epidemiological information on most prevalent clinical signs and symptoms affecting pastoral and agro-pastoral communities interacting

with wild and domestic animal. Findings of the study will contribute in strengthening One Health surveillance approach, early detection, response, and prevention of disease outbreaks in the community by understanding the trend of occurrence of clinical signs and symptoms in animals and humans population in pastoral and agro-pastoral settings. This will helps not only the notifiable diseases to be reported but also neglected infectious diseases to be managed and consequently reducing the burden of diseases and mortality to communities and their livestock and thus improve livestock productivity and social economic status of the community and nation.

1.4 Research Question

The research questions were

i. What are the most common clinical signs and symptoms occurring in animal and human population?
ii. What is the trend of occurrence of clinical signs and symptoms in animals and humans population in the pastoral and agro-pastoral settings?

1.5 Research Objectives

1.5.1 Overall objective

The main objective was to carry out an epidemiological investigation of most prevalent clinical signs and symptoms of animal and human diseases in agro-pastoral and pastoral communities in Ngorongoro district.

1.5.2 Specific objectives

The specific objectives of this study were

i. To establish trend of clinical signs and symptoms recorded by the Community Health Reporters in human and animal health sectors in Ngorogoro district.

ii. To determine the spatial patterns of disease events and assess clustering of signs and symptoms reported in Ngorongoro district

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Infectious Zoonoses

Zoonoses are the naturally transmissible infections or diseases from animals to human and *vice versa*. Humans may acquire zoonotic diseases through occupational and traditional activities for example hunting; career works in livestock industries, livestock keeping, wildlife activities and consumption of poorly prepared animal products from potentially infected animals (Vanderburg *et al*., 2014). The causative agents that infect humans are estimated to be 40% of fungi, 50% of bacteria, 70% of protozoa, 80% of viruses, and 95% of helminthes, but more than 50% of the identified agents of human can infect other animal hosts (Asokan and Asokan, 2015). Nearly 15 years ago, the world has run into more than 15 deadly zoonotic or vector-borne outbreaks caused by both viral such as Hanta, Ebola, highly pathogenic avian influenza [H5N1 and recently H7N9], West Nile, Rift Valley fever, norovirus, severe acute respiratory syndrome [SARS], Marburg, influenza A [H1N1]), Rabies, Equine Encephalitis complex bacterial such as *Escherichiacoli* O157:H7, *Yersinia pestis*, and *Bacillus anthracis*, the causes of hemolytic uremic syndrome, plague, and anthrax respectively(Gebreyes *et al*., 2014). The most prevalent parasitic zoonoses include hydatid cysts (cysts of *Echinococcus granulosus* found in the liver of cattle and sheep), cryptosporidiosis which causesdevastating, protracteddiarrhoea in immunosuppressed patients, trypanosomiasis, schistosomiasis, taeniasis and girdiasis (Swai *et al*., 2010).The majority of food-borne parasitic diseases are associated with diarrhoea disease, as well as vector borne parasitic diseases like tick bornediseases;leishmaniasis anddengue can affect animals and humans (Gebreyes *et al*., 2014).

Bacterial zoonoses such as brucellosis and leptospirosis as reported by Allan *et al.* (2015) and Chipwaza *et al.* (2015) cause non malarial febrile infections which are both directly liable for human illness and death, and indirectly impact human well-being as a result of reduced livestock productivity and food security. Fungal zoonoses such as ringworm, blastomycosis, histoplasmosis, cryptococosis are widespread and can be present in the soil, environment and animals which are the important reservoir and carriers for people in close contact to them and pose high risk to individuals with compromised immune system (FAO, 2004).

2.2 Causes and Mode of Transmission of Infectious Zoonoses

These diseases can be caused by bacteria, viruses, parasites and fungi (Samad, 2011). They can spread either directly between animal and human hosts or indirectly through consumption of milk, raw food containing tissue from domestic or in the natural habitat of animals, eating food and/or water contaminated by animal or human faeces such as *Cryptosporidium*infection. Other diseases can be transmitted viabody secretions (e.g. blood, urine, saliva), through arthropod vectors enhanced by ecological or climatic changes and airborne through small particle aerosol (Swai *et al.,* 2010). However, the drivers of emerging and re-emerging infectious disease occurrence is through a range of anthropogenic factors, that consist of: genetic and biological factors, such as microbial adaptation to macro- and micro environmental changes, changes in host susceptibility to infection; environmental factors, such as climate change, changes in ecosystems, changes in human and animal population densities; socioeconomic and political factors, such as raising international travel and commerce, social inequality, poverty, conflict, famine, lack of political will (Gebreyes *et al*., 2014).

2.3 Epidemiology of Infectious Zoonotic Diseases

2.3.1 An overview epidemiology of zoonotic diseases

Since the start of domestication of animals 10 000 years ago, infectious zoonotic diseases have been crucial concern to humans. Worldwide spread of infectious diseases accounts for significant cause of morbidity and mortality, approximately 75% are of emerging and re-emerging infectious diseases (EIDs) and >60% are zoonoses (Gebreyes *et al.,* 2014).Analysis done by McMorrow *et al*. (2015) on mortality due to severe acute respiratory illnesses (SARI) from 14 African countries indicated that 9.8% of patients hospitalized were associated with Influenza virus infection. More over a study by Abubakar *et al*. (2013) showed that communicable disease like tuberculosis and avian influenza are worldwide spread. Vanderburg *et al*. (2014) reported that about 3500 human cases were involved in Q-fever outbreak in Netherland. *Coxiella burnetii* causes non-malaria febrile illness and community acquired pneumonia. Tanzania is among the countries in Africa reported Q-fever.Symptoms in hospitalized patients are undifferentiated from febrile illness and the Q-fever is characterized by pneumonia and hepatitis in which 0.5- 2.0% of acute cases develop chronic disease such as endocarditis. Moreover diseases like Dengue and Chikungunya viral infections which are characterized by fever and thrombocytopenia have been reported in Tanzania. It has been reported by Moi *et al*. (2010) that surveillance of Dengue in Tanzania is not routinely done. Diseases like leptospirosis is also among the diseases that cause fever, but it is under reported (Chipwaza *et al.,* 2015). These diseases are among the neglected zoonotic diseases. However it has been reported that approximately 75% of newly human infections have risen, and are likely to continue rising, from an animal reservoir which include wild animals, companion animals and production animals (Scotch *et al*., 2012a, b), for example current outbreaks on Ebola in West Africa.

2.3.2 Geographical distribution of major emerging and zoonotic diseases

Infectious diseases pose a major burden in economic and public health in the world. Emerging and re-emerging infectious diseases cause high morbidity and mortality following disease outbreaks throughout the world (Fig. 1). Diseases such as Q fever outbreak affected over 3500 human cases in the Netherlands in 2007–2009 (Vanderburg *et al*., 2014), and recent studies has demonstrated that Q-fever is the common cause of febrile illness in hospitalized patientsin Tanzania (Crump *et al*., 2013). Furthermore in 2004-2005, outbreaks of Highly Pathogenic Avian Influenza (HPAI) in poultry were reported in eight countries as in Southeast and East Asia: China, Cambodia, Thailand, Viet Nam, Indonesia, South Korea, Japan (Silkavute *et al*., 2013). Later, the A/H5N1 virus spread from Qinghai Lake through Central Asia, Europe, the Middle East and African countries such as Nigeria, Egypt, Niger and Cameroon causing significant mortality in humans. In April 2006 Sudan, Burkina Faso, Djibouti and Ivory Coast were also affected by outbreaks as well as Ghana and Togo had an outbreak between May and June 2007, and Benin in December 2007 (Cattoli *et al*., 2009). Rift Valley fever virus (RVFV), was first found in 1930 during an outbreak in Kenya, and has attained endemic status nearly in all parts of sub-Saharan Africa and a number of epidemics have been reported in Egypt, Madagascar and the Comoros (Sindato *et al*., 2015). In 2001, outbreaksof RVF were reported in Yemen and Saudi-Arabia for the first time (Heinrich *et al*., 2012). Different parts of Tanzania have reported the occurrence of emerging and re-emerging diseases such as cholera, Influenza A, Plague and Rubella in human and CBPP, Giraffe Ear, Skin diseases, rift valley and Anthrax in animals (Karimuribo *et al.,* 2011).

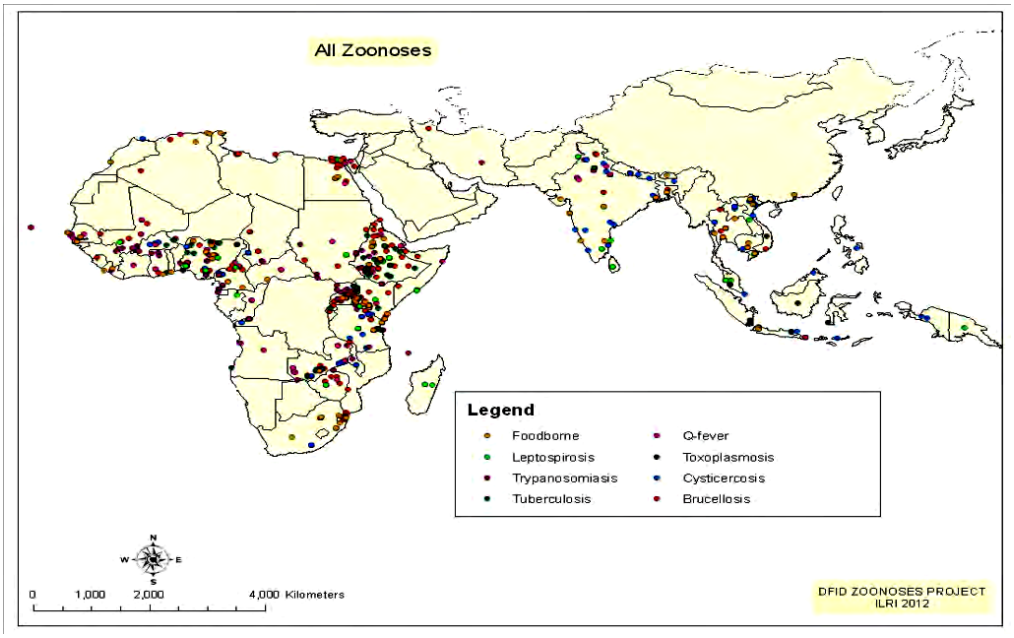

Figure 1: The distribution of zoonoses worldwide

Source: ILRI, 2012

2.3.3 Source and disease transmission pathways

Infectious diseases are caused by microorganisms (pathogens) such as bacteria, virus, protozoa, fungi and prions. Disease causation is complex and is best explained by an epidemiologic triad model of multiple causes (Fig. 2). There must be an external agent, a susceptible host and an environment that bring the host and agent together.

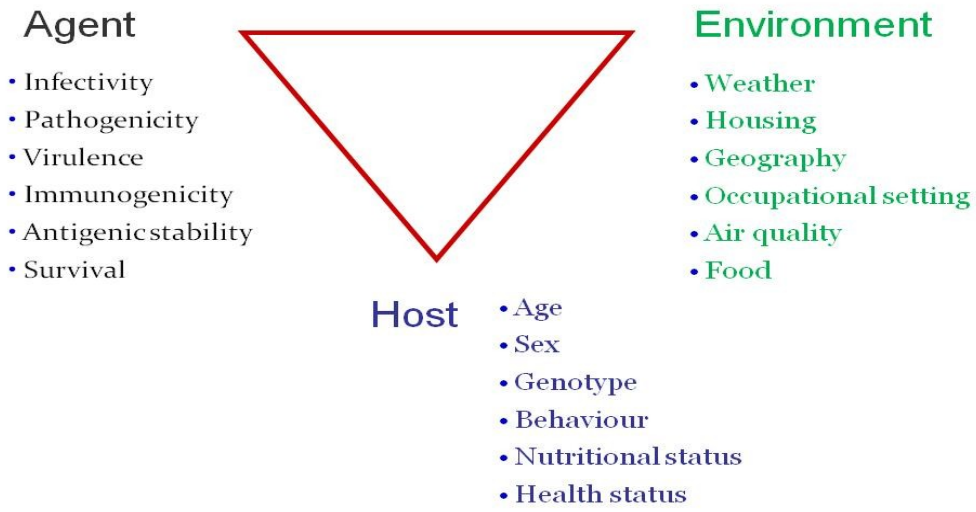

Figure 2: Epidemiologic triad that represents disease causation model

Source: Asokan and Asokan(2015)

More exclusively, transmission occurs when the agent leaves its reservoir or host through a portal of exit, is expressed by some mode of transmission, and enters through a suitable portal of entry to infect a susceptible host (Smith, 1994) as it is illustrated in the Fig. 3

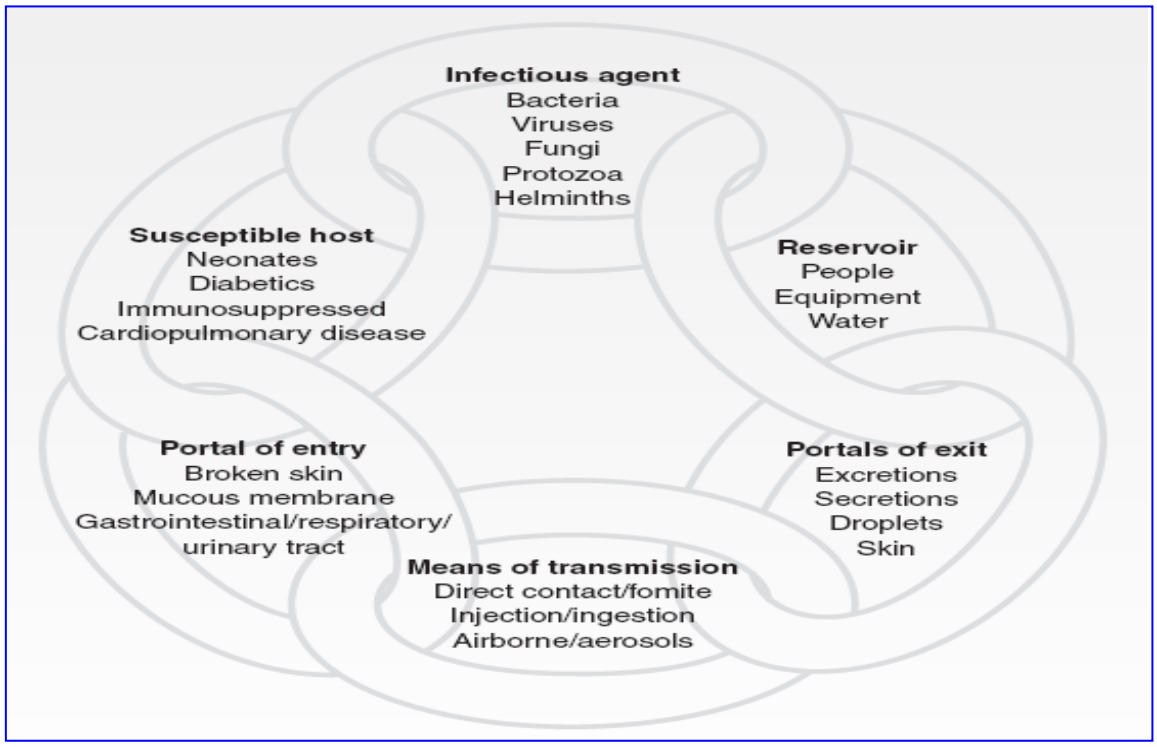

Figure 3: Diseases transmission cycle

Source: Dorak, 2012

2.3.4 Patterns of infectious disease occurrence

For an infectious disease to occur in the human population, changes in the ecological balance must exist, where there is directly or indirectly relationships between humans, animals, and possible microbial pathogens. The occurring diseases due to these changes may be manifested in different patterns namely endemic, epidemic, sporadic or pandemic (Dicker, 2006).A sporadic pattern is when a disease occurs infrequently and irregularly, while an endemic disease is continuous present and/or usual prevalence of a disease or infectious agent in a population within a geographic area. A continuous, high level of disease occurrence is termed as hyper endemic. Epidemic disease is characterised by a

sudden occurrence of disease in a vast increase in the number of cases of a disease in the population in a particular area. Pandemic means an epidemic which is spread in several countries affecting a large number of people(Dicker, 2006).

A number of epidemics and pandemics have been caused by these pathogens globally. The Severe Acute Respiratory Syndrome (SARS) was the first severe infectious diseases to occur in the twentyfirst century in Guandong province of China in November 2002 to July 2003, originating from civet cats, which spread quickly to 30 countries across Asia, Americas and Europe as well as Hong Kong and Taiwan (Province of China), Toronto in Canada, Singapore, and Hanoi in Vietnam (Dikid*et al*., 2013).

An influenza virus of types A, B and C is worldwide distributed, type A (H1N1 and H3N2) cause widespread influenza epidemics, while type B viruses generally cause sporadic outbreaks, and type C cause mild disease such as common colds and bronchitis in children. In March 2009, cases of H1N1 influenza were first reported in Mexico, and spread to the United States and the rest of the world including India. Chikungunya Virus (CHIKV) was first identified during a 1952 epidemic in Tanzania (Crump *et al*., 2013). The virus spread in most of sub-Saharan Africa, India, Southeast Asia, Indonesia, and the Philippines. In 2005-2007 exceptional spread of outbreaks affected at least 12 countries including localized outbreak in north-eastern Italy (Zyga and Zografakis-sfakianakis, 2011; Dikid *et al*., 2013). The Ebola virus (EBOV) was identified in 1976 in north-western Zaire (now Democratic Republic of Congo) andin southern Sudan during the first outbreak. At every 1.5 years average Ebola outbreaks have been reported, with a total of 7 prior outbreaks causing more than 100 reported cases(Muyembe-Tamfum *et al*., 2012; Chowell and Nishiura, 2014).

However, since2013 a complex epidemic of Zaire ebolavirus (EBOV) has been affecting West Africa with the first cases reported in southern Guinea (Chowell and Nishiura, 2014)

and has been circulating in West Africa for about a decade. However, in March 2014 the current epidemic was identified which make easy for several transmission chains to cross borders with nearest Sierra Leone and Liberia and caused restricted outbreak in Nigeria through commercial airplane in July 2014 (Chowell and Nishiura, 2014).

Moreover Rift Valley fever virus (RVFV), a member of the genus *Phlebovirus* in the family Bunyaviridae, was first identified in 1930 in Tanzania. The RVF epidemics occur in cycles of 5–15 years in the Eastern Africa region as a result of abnormally high rainfall, during the warm phase of the El Niño or floods causing damage in livestock populations and economies the last outbreak experienced was in 2006/2007(Heinrich *etal*., 2012; Sindato *et al*., 2014).

2.4 Disease Surveillance and Response Systems

2.4.1Definition of disease surveillance

Disease Surveillance means continuous systematic gathering, analysis, and interpretation of analysed information for use in planning, implementing and evaluating public health policies and practices (response)(OIE, 2010). Information collected through this on-going process are used to assist in early recognition and tracking of diseases and therefore help health teams to quickly respond to outbreaks, set priorities, plan interventions, mobilize and allocate resources (Mghamba *et al.*, 2008).

Worldwide efficient surveillance system is an important tool for early detection of infectious disease epidemics including emerging and re-emerging diseases. However in Africa disease epidemics continue to occur and costs life of the community at large, Tanzania being one of the countries in Africa.

2.4.2 Global surveillance network

For the past 10 years, each region in the world has faced a lot of health, economic, social, and environmental changes. Global surveillance and response systems in preventing the

spread of diseases through integrated surveillance system is done by World health organisation (WHO) and World Organisation for Animal Health (OIE) and Food and Agriculture Organization (FAO) (OIE, 2010).Information on disease events is receivedfrom different official sources such as Ministries of Health from its member states under the International Health Regulation, 2005 (WHO, 2008) which provides the framework for the detection, notification, verification and early response to public health events that may cross borders and make threats to people worldwide (Mghamba *et al*., 2008; WHO, 2009).

2.4.3 National and sub-national surveillancesystem in human health sector in Tanzania

Despite of having global surveillance system, nations are emphasized to establish and implement effective surveillance and response systems to detect and contain public health threats national and internationally.

In Tanzania disease surveillance system is guided by the Integrated Disease Surveillance and Response system (IDSR) in which Infectious Disease Week Ending (IDWE)reports epidemic prone diseases and is integrated with the Health Management Information System (HMIS); Vertical systems for specific diseases like Tuberculosis (TB)/Leprosy; Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome (HIV/AIDS); and Acute Flaccid Paralysis (AFP)/Poliomyelitis), under the Ministry of Health and Social Welfare(Mghamba *et al*., 2004). In all these systems, initial point of registering and reporting is at the health facility such as dispensaries, health centres or hospitals. The information obtained from health facilities is conveyed to higher levels at district, regional and to the national level, the Ministry of Health Community Development Gender Elderly

and Children (MoHCDGEC) which is responsible for WHO meanwhile taking all measures for those infections which need prompt action to prevent the spread.

Furthermore, community health workers (CHWs) currently identified as village health workers (VHWs) are volunteer workers addressing health problems at the community level supported by the health system. CHWs serve as an important link between communities and the health delivery system in disease identification, prevention and control.CHWs contribute in lessening child morbidity and mortality, promote immunization uptake, encourage breastfeeding, and improve outcomes for tuberculosis patients and children suffering from acute respiratory infection (ARIs) or malaria(Greenspan *et al*., 2013; Tulenko *et al.,* 2013).

2.4.4National and sub-national surveillance system in animal health sector in Tanzania

Surveillance system in animal health is carried out from lower level to higher level as in human health systems. Surveillance for animal diseases starts officially at the village/ward level using livestock field officers who submit data to the districts level. The district veterinary officer submits surveillance reports to the Zonal Veterinary Centres (formally called Veterinary Investigation Centres- (VIC)) who are responsible to submit data/reports to the ministry.

The helpful approach for improving primary-level delivery of veterinary services and disease surveillance in rural areas of developing countries is to use community-based animal health workers (CAHWs) which is not official but has been supported by different NGOS and researchers to enhance animal health surveillance system in Tanzania.CAHWs are chosen by their communities and skilled in the prevention or treatment of a limited range of animal health problems, they act as the link between livestock keepers and official disease surveillance systems.

The information from the farmer or CAHWs is send to a veterinarian or a paraprofessional who then reports the matter to theinspector for confirmation of the disease, meanwhile taking measures to control the disease. The inspector is the one after confirmation of the reportable diseases to notify the District veterinary officer(DVO), the DVO reports to the Zonal Veterinary Centres and finally to the Director of Veterinary Services (DVS) in the ministry responsible for Ministry of Agriculture, Livestockand Fisheries(MoALF, 2003).

2.5 Integrated Surveillance Systems and One Health Approaches

2.5.1 Integrated surveillance systems

Despite the fact that the integration of surveillance systems across animal, food and human sectors has been carried out in some countries and regions, the majority of surveillance systems are usually non-integrated with limited collaborative work (Nsubuga *et al*., 2002; OIE, 2010). However, studies report that surveillance done by different disease control programs under different authorities lead to variation in reporting systems due to inefficient and incoherent information (Abubakar *et al*., 2013). One Health approach gives more emphasis to the importance of collaborative efforts between human and veterinary medicine sectors, where there have been little systematic researches of the teamwork between animal and human health agencies during surveillance (Scotch *et al*., 2012b).

Strengthening infectious disease surveillance and response systems in an integrated approach is important in early detection of epidemic outbreaks in the community (Mboera *et al*., 2005), for example veterinary surveillance and inspectorate infrastructure at the slaughter houses is very important measure to detect food borne infections such as hydatid cysts. Through inter-disciplinary and inter-sectoral collaboration public health risks associated with food can be managed (Gebreyes *et al*., 2014).However a number of constraints including limited resources and supporting policy is a challenge in

implementing surveillance. Cross border transmission of infectious diseases between countries is a major public health problem which requires integrated intervention to encounter the population exposure (Ope*et al*., 2013). Integrated surveillance consists of series of systems which together are aimed at controlling and preventing diseases through detection, reporting, analysis and interpretation, feedback, and commence action for improving public health(World Health Organization, 2010). Integrated surveillance and participatory surveillance which mean the use of different ways in obtaining information such as involving the community or stakeholders to identify and solve their own problems (Jost *et.al*., 2007)is crucial for defining problems and taking action using epidemiological methods that help planers to set priorities, plan interventions, allocate resources and early predict or detect outbreaks(World Health Organization, 2010).

2.5.2 Community-based participatory disease surveillance

Syndromic surveillance is the public health surveillance that uses proper pre-diagnostic data and statistical tools to identify and clarify peculiar activity for more public health investigation to find out early outbreaks or health events and monitor health status of the community. It enables the practitioners to collect new data for the purpose of quick response to outbreaks(Samoff *et al.*, 2012).Quality data are considered necessary for communicable disease surveillance, communicable disease reporting is not complete, and many cases are reported later than is necessary for public health action.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area and Study Population

The study was carried out in Ngorongoro District of Arusha region located in the Northern Tanzania. Through the IDRC-funded project, the SACIDS research team designed and deployed a Community-based surveillance system which collected data on disease events that occurred between December 2014 and May 2015. The surveillance data were collected using Community Health Reporters (CHRs)who submitted data on clinical signs and symptoms from humans and domestic ruminants. The district has total population of 174 278 people (TNBS, 2013). The study villages were Malambo, Esere, Naiyobi, Oloirobi, Endulen and Mokilal. The district was selected due to the existence of human activities and interactions between humans, livestock and wild animals in the Ngorongoro Conservation Area Authority and its surroundings. The elevation data of the district were not available in range but rather in average values which is located atan average elevation of 1553 meters above sealevel with its centroid coordinates which are2º 45' 0" S and 35º 30' 0" E . The district, with a total area of 14036km^2,is bordered by Kenya to the north, Monduli district to the East, Karatu district to the South and Mara region to the West as shown in Fig. 4.The district and ward-specific geo-coordinates wereobtained from the Tanzania National Bureau Statistics (TNBS, 2013).

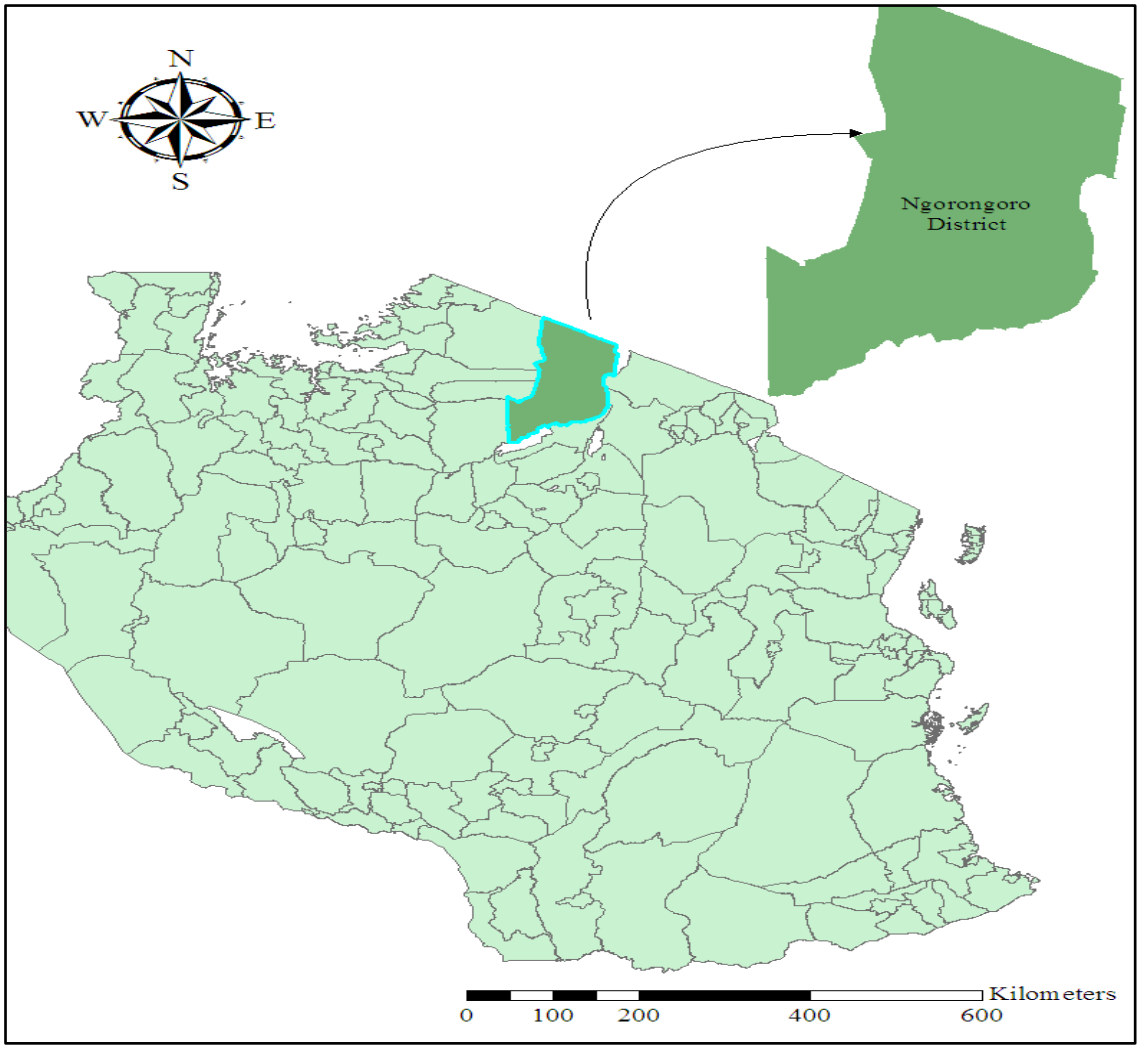

Figure 4:The map of Tanzania showing the location of the Ngorongoro district shaded in dark green colour

3.2 Categorization of Study Wards/ Villages

The study wards/villages were arbitrary classified into three non-overlapping categories namelylow altitude, medium altitude and high altitude meters above sea level represented by 1200 m.a.s.l., ≤1200 – 2000 m.a.s.l. and >2000 m.a.s.l., respectively to ease data interpretation. Low-lying ward/village in this study was Malambo, medium- altitude wards/villages were Esere, Endulen, Olbalbal,Alailelai, Laitole, Meshili. While the high-altitude wards/villages were Naiyobi, Mokilal, Oloirobi Nainokanoka and Misigiyo.

3.3 Study Design

A retrospective study was carried out where data were retrieved from the Southern African Centre for Infectious Diseases Surveillance (SACIDS) database for analysis which included clinical signs and symptoms from animals and human collected in Ngorongoro district from December 2014 to May 2015. Signs are physical manifestations of an illness detectable by a medical practitioner when examining the patient for example fever, while symptoms aremanifestations of an illness experienced by a patient as communicated to a medical practitioner for example pain (Marcovitch, 2005).

3.4 Inclusion and Exclusion Criteria

All clinical signs and symptoms collected from animals and human were included in statistical analysis; only reports with geo-tagged data were included in geo-spatial analysis

3.5 Sample Size

The sample size data was all records available in the SACIDS database collected during the reference period which were 376 records. A record represents one case/ individual who reported clinical signs and symptoms. Data were collected by CHRs present in the community and send to server electronically through mobile phones.

3.6 Data Analysis

3.6.1 Data management and screening

Data was retrieved from SACIDS database and were screened based on the inclusion and exclusion criteria, sorted into individual variables and then coded and organised using excel spread sheet. All animal and human signs and symptoms presented in all villages were coded into individual variable for analysis such as fever, coughing, headache, colic abdominal pain, diarrhoea, nausea and vomiting, joint pain/swelling and general body malaise.

3.6.2 Analysis for trend

Analysis was carried out using EPI INFO 7 software, version 7.1.4.0 from Centre for Disease Control and Prevention (CDC, 2014). Frequencies of clinical signs and symptoms were computed and comparison analysis was conducted to estimate the occurrence by time period. Chi square test was used to analyse the proportions of dichotomous categorical variables with confidence interval of 95%, p-value <0.05 which was considered significant.

3.6.3 Spatial mapping of clinical signs and symptoms

Data were cleaned prior to spatial mapping, all data that were falling away from the reported ward were considered as outliers, and there-after ArcGIS 10.3 software (Esri, 2014) was used to show spatial distribution of the geo tagged clinical signs and symptoms in the study villages.

3.6.4 Analysis for clusters of clinical signs and symptoms

3.6.4.1 Data preparation

The geo coordinates were used to identify the location where the clinical signs and symptoms occurred. All coordinates were included in the analysis. The analysis focused on spatio-temporal description of clinical signs and symptoms, the frequency of clinical signs and symptoms were used as a case count.

3.6.4.2 Grouping of clinical signs and symptoms

Related clinical signs and symptoms in human were grouped according to respective system for example respiratory events (coughing, coughing up blood, sore throat and chest tightness), Gastrointestinal tract events (nausea and vomiting, colicky abdominal pain, diarrhoea, and bloody diarrhoea),Central nervous system events(drowsy, unconsciousness,

confusion), Systemic events(fever, General body malaise,headache, and joint pain), and Other events (conjunctivitis, abscess, and unknown signs and symptoms). Likewise in animals for example respiratory events (coughing, dyspnoea, mucoid nasal discharge), Gastrointestinal tract events (diarrhoea, abdominal fullness, halitosis and mouth sores), Skeletal events (sores on foot, swelling of joints, difficult walking, wasting), skin condition events, sudden death events, abortion events and Other events (blindness, bleeding, and unknown signs).

3.6.5 Spatio- temporal cluster analysis

A retrospective space-time analysis was carried out; the Space-time permutation modelling (based on the presence only data) was implemented using SatScan 9.4.2 software (Information Management Services Inc, Calverton, Maryland) to identify location with high rates of clusters of clinical signs and symptoms. Space-time permutation model requires only case data (presence only data) for which location and time is known, but no information is needed for controls and population at risk. The model parameters for spatial and temporal window size were set so that a cluster could include a maximum of 50% of population at risk, minimum temporal cluster size of a day and maximum of 50% of study period. The number of replication was set at 999 so that the minimum detectable p-value would be 0.001. Data were checked to ensure all cases (present-only data) are within the specified temporal study period and all observations are within the specified geographical areas. The findings are projected onto maps using ArcGIS 10.3 software (Esri, 2014).

CHAPTER FOUR

4.0 RESULTS

A total of 376 records were retrieved from SACIDS database and analysed. Out of the 376, 220 (58.5 %) were human data representing the major signs and symptoms reported by Community Health Reporters (CHRs) while 156 (41.5%) were data from animals.

4.1 Human Signs and Symptoms

A total of 10 study villagesfrom six wards were involved in reporting the clinical symptoms, the proportion of reported information per village is presented in Table 1. Clinical signs and symptoms were reported more in females (56.5%) than in males (43.4%), the difference that was statistically significant (p=0.0057).

Table 1: Proportion distribution of human clinical signs and symptoms reported in each study village between 2014 and 2015

Village	Number of reports	Total Percent reported (N)	Female %	Male %
Malambo	143	65.0	38.6	26.4
Esere	56	25.4	13.2	11.4
Endulen	6	2.7	0.5	2.3
Alailelai	1	0.5	0.5	0
Mokilal	3	1.3	0.5	0.9
Olbalbal	1	0.5	0	0.5
Oloirobi	6	2.7	1.8	0.9
Nainokanoka	1	0.5	0	0
Laitole	1	0.5	0.5	0.5
Naiyobi	2	0.9	0.9	0.5
Total	**220**	**100**	**56.5**	**43.4**

The human clinical signs and symptoms reported by CHRs from the study villages were as represented in Fig.5. Fever, coughing, headache, diarrhoea, nausea/vomiting and joint pain were the major problems reported.

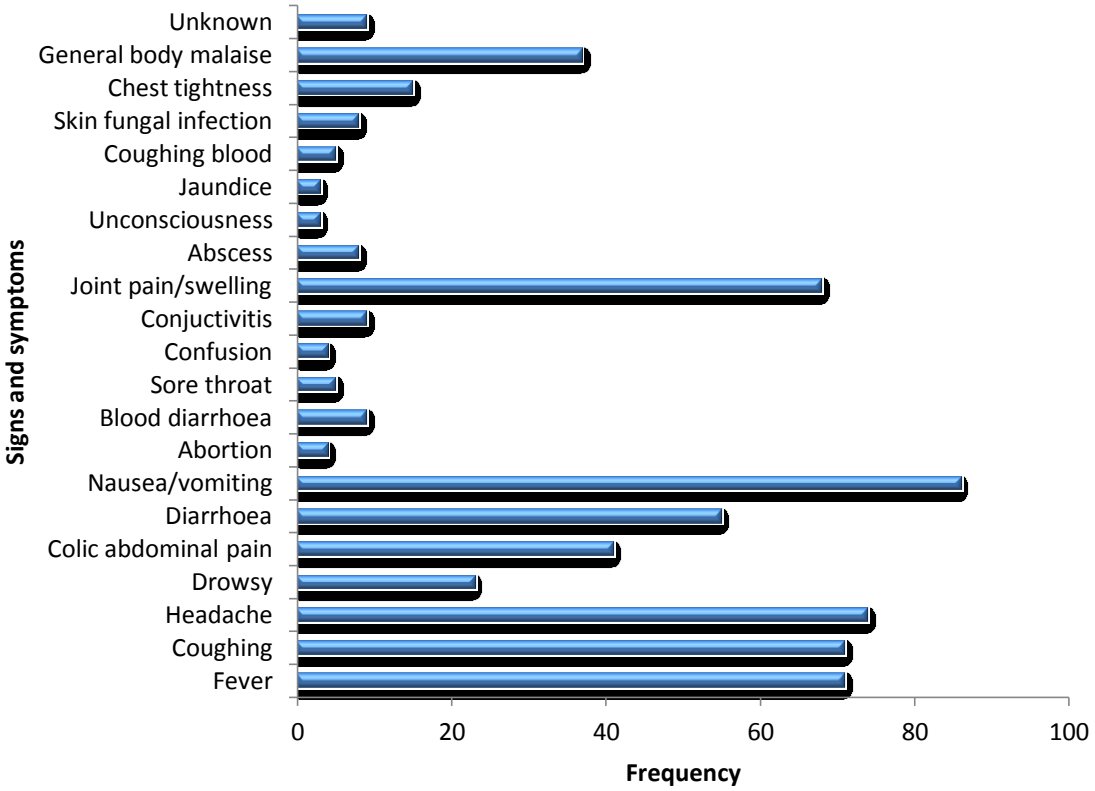

Figure 5: Human signs and symptoms commonly reported by Community Health Reporters in Ngorongoro District between 2014 and 2015

4.1.1 Comparison of signs and symptoms between villages

Malambo and Esere village had more frequency of reporting signs and symptoms for 65% and 25.4% respectively than other villages. Distribution of signs and symptoms reported by study village is summarised in Fig.6.

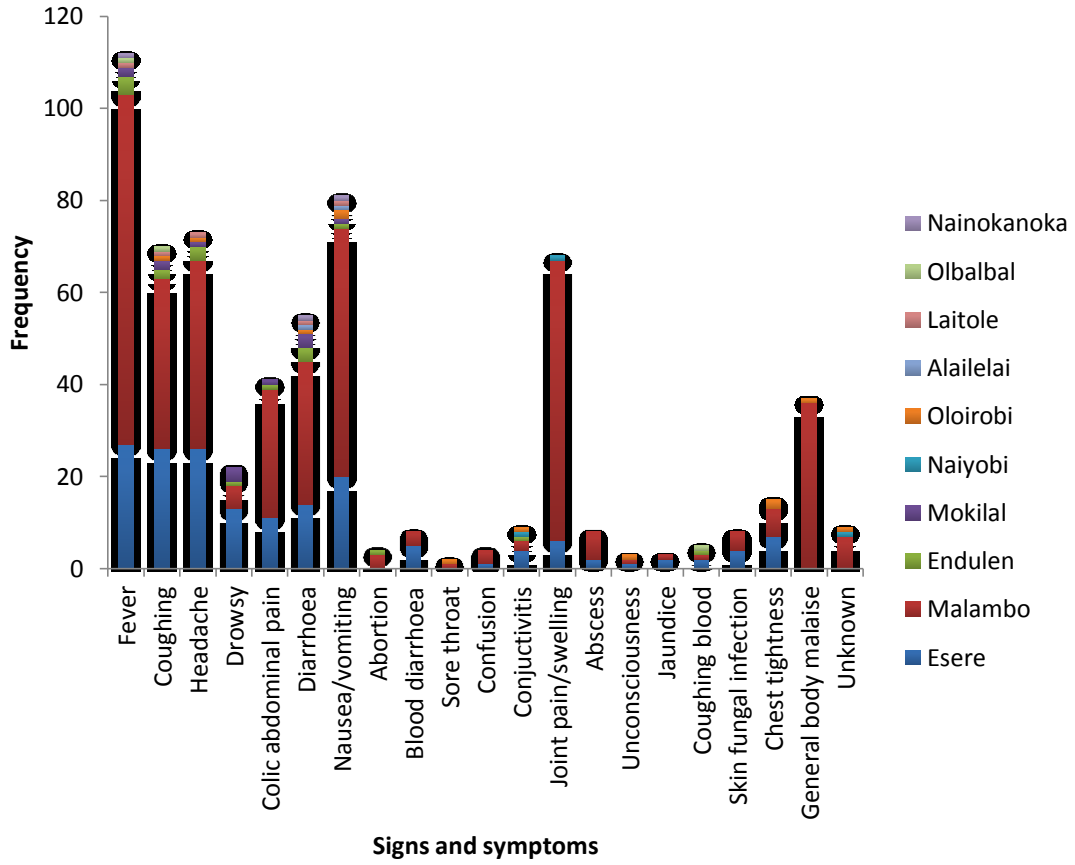

Figure 6: Distribution of human clinical signs and symptoms by villages in Ngorongoro district

4.1.2 Distribution of signs and symptoms in years

Though there is limited information for the year 2014, there is similar occurrence of signs and symptoms in 2014 and 2015.The distribution of clinical signs and symptoms were compared between December 2014 and other months in 2015 and observed for their occurrence pattern and their percentage as shown in Fig.7. December and January had almost related reports of clinical signs and symptoms indicating that there is a related factor that may cause diseases during this periodsuch as rain season. In March and April there were drop out of reports because CHR from malambo was absent.

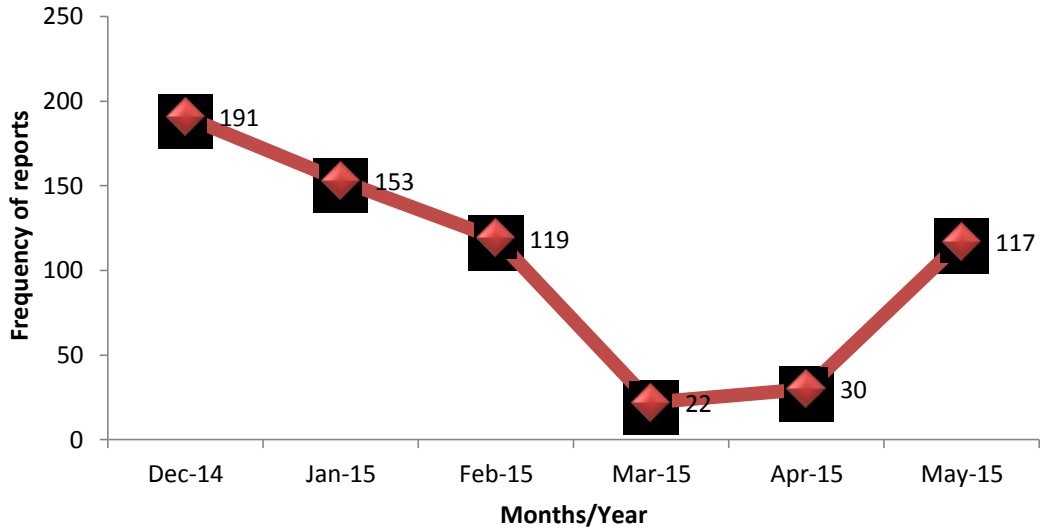

Figure 7: Temporal pattern of occurrence of clinical signs and symptoms in Ngorongoro district between December 2014 and May 2015

Despite of all clinical signs and symptoms being reported from all villages, there are most frequent clinical signs and symptoms in which some villages has been reported more frequently than other symptoms as shown in the Fig.8.

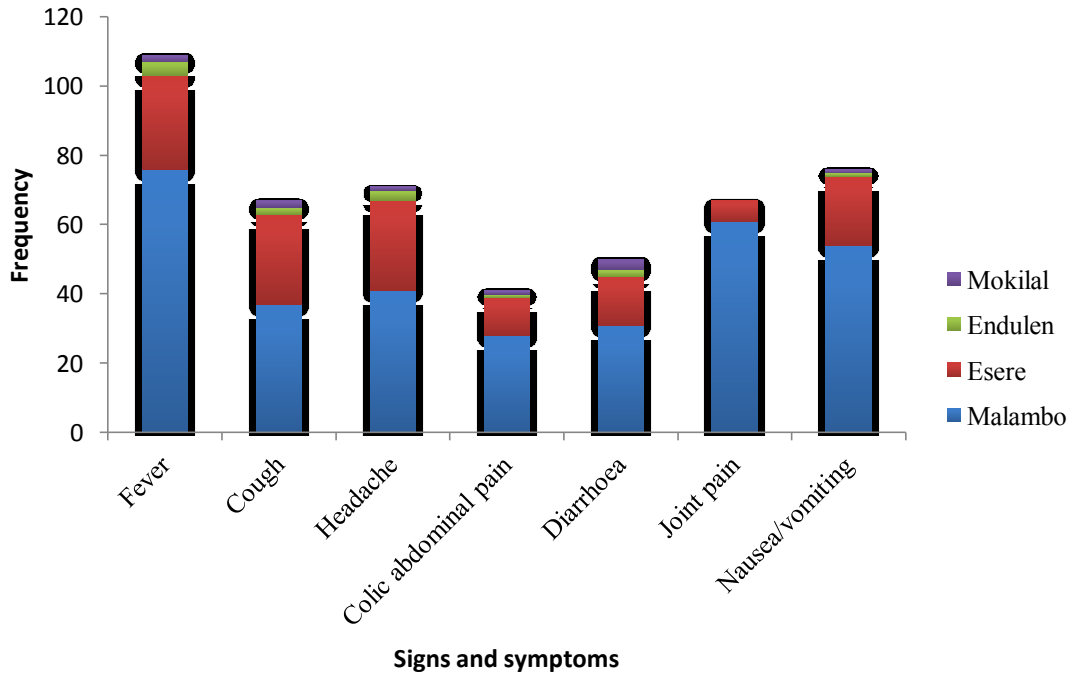

Figure 8: The most frequent human clinical signs and symptoms reported in the study villages between December 2014 and May 2015

Moreover the clinical signs and symptoms were reported from different age groups from age 0 to 65 years (Yrs.). Children less than five yrs. and 6-18 yrs of age were more affected than other age groups for all signs and symptoms with marked high level in Malambo village aspresentedin Table 2. Only two villages were presented due to fact that Malambo and Esere reported more clinical signs and symptoms for all age groups than other villages which reported only for 19-45 Yrs of age.

Table 2: Distribution of major clinical signs and symptoms reported in different villages

Village	Sign and symptom	<5 Yrs N (%)	6-18 Yrs N (%)	19- 45 Yrs N (%)	> 45 Yrs (N (%)
Malambo	Fever (n=76)	28 (38.8)	16 (21.1)	25 (32.9)	7 (9.2)
	Coughing(n=37)	16 (43.2)	8 (21.6)	10 (27.0)	3 (8.1)
	Headache(n=41)	11 (26.8)	11 (26.8)	13 (31.7)	6 (14.6)
	Diarrhoea(n=31)	12 (38.7)	5 (16.1)	12 (38.7)	2 (6.5)
	Joint pain(n=61)	21 (34.4)	13 (21.3)	21 (34.4)	6 (9.8)
Esere	Fever(n=28)	6 (21.4)	10 (35.7)	9 (32.1)	3 (10.7)
	Coughing(n=27)	7 (25.9)	11 (44.0)	5 (18.5)	4 (14.8)
	Headache(n=27)	6 (22.2)	8 (29.6)	9 (33.3)	4 (14.8)
	Diarrhoea(n=15)	3 (20.0)	4 (26.7)	7 (46.7)	1 (6.7)
	Joint pain(n=6)		2 (33.3)	2 (33.3)	2 (33.3)
Total		**110**	**88**	**113**	**38**

4.1.3 Spatial mapping of human signs and symptoms

The distribution of clinical signs and symptoms reported in human from the study villages is presented in Fig.9. Most of events were located in the same area.

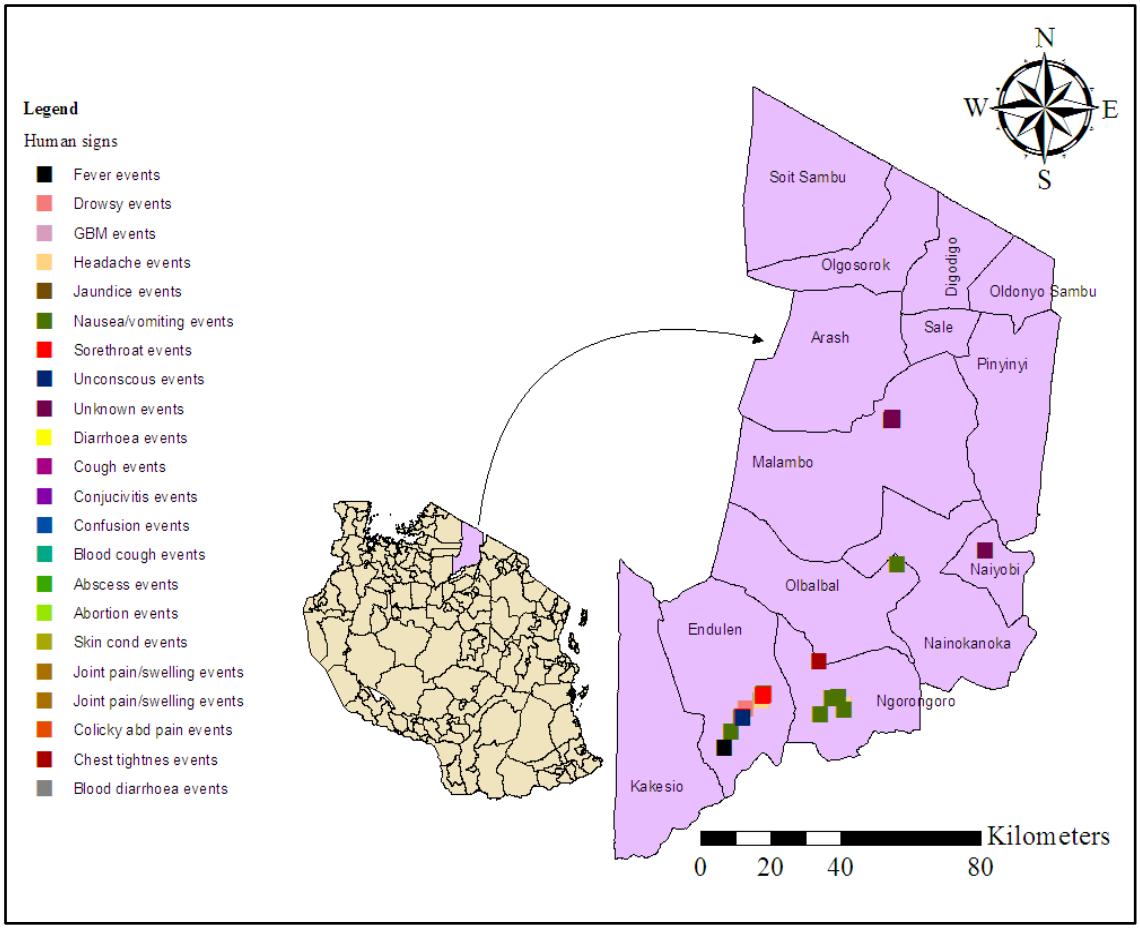

Figure 9: Spatial distribution of human clinical signs and symptoms in study wards, Ngorongoro district

The same clinical signs and symptoms were grouped into respective systems, the distribution were not different with that on Fig. 10 as it is shown in Fig.10.

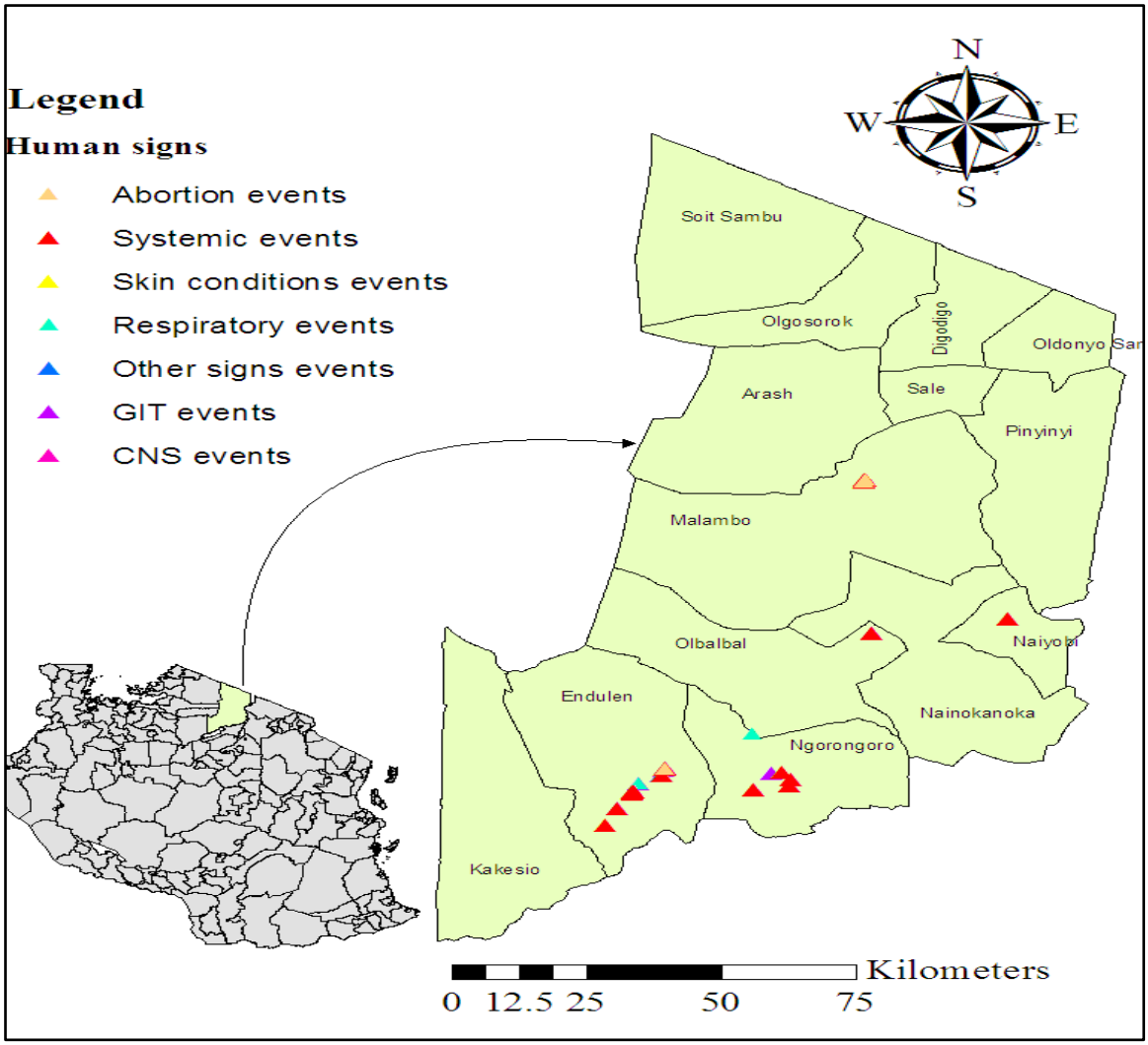

Figure 10: The distribution of grouped human clinical signs and symptoms in Ngorongoro ward

4.1.4Cluster analysis in human clinical signs and symptoms

Four out of 10 village-level clusters with high rate for most frequent clinical signs and symptoms reported in human were identified in Alailelai, Olbalbal, Endulen, Laitole, and Esere as projected in Fig.11.

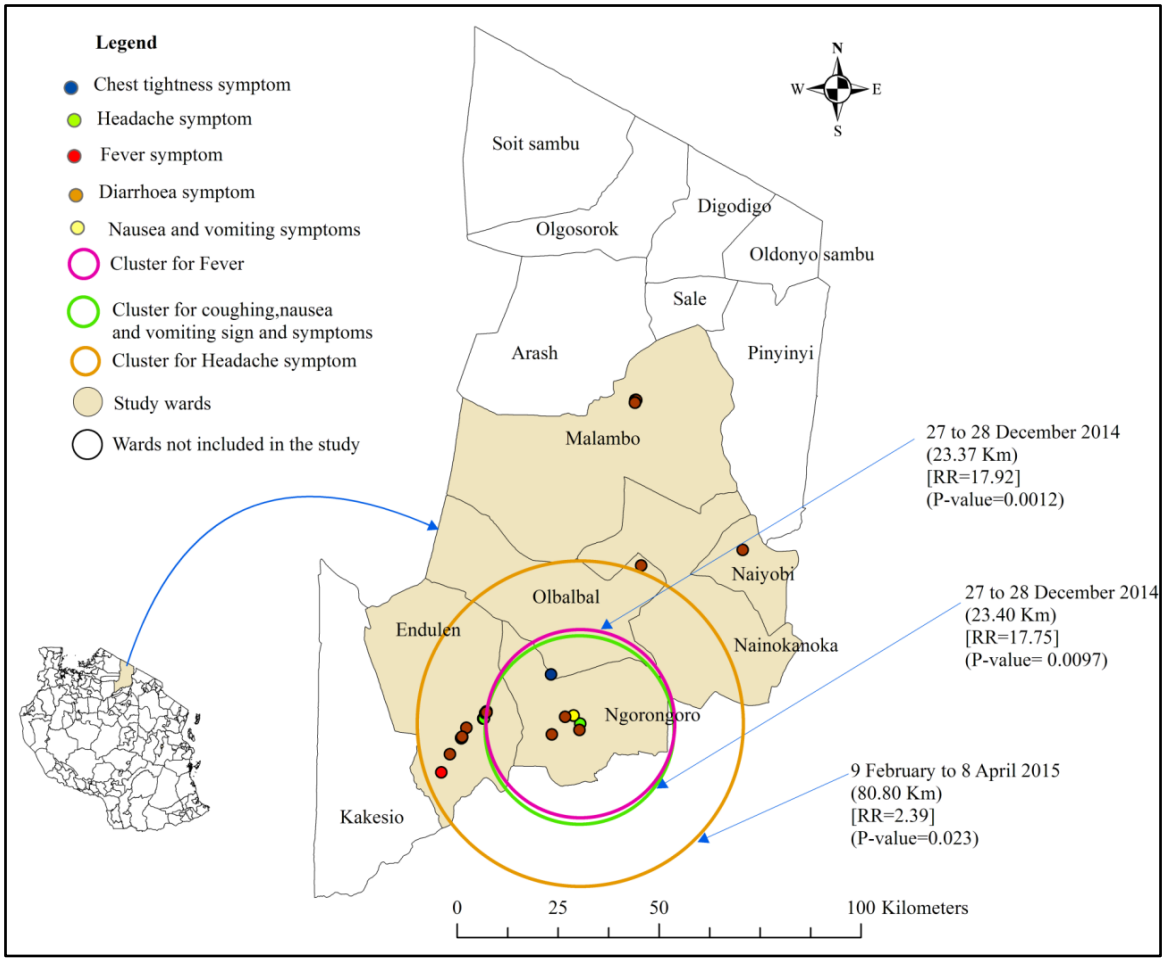

Figure 11: A map of Ngorongoro district showing the clusters detected in human clinical signs and symptoms between December 2014 and May 2015

4.2 Animal Clinical Signs

A total of 156 data that comprise of clinical signs from animals were collected from 10 study villages in Ngorongoro district. The frequency proportion of collected information from each village is presented in Table 3. Only 4 (2.6%) records had no information recorded and therefore were excluded in the analysis process.

Table 3: Proportion distribution of animal clinical signs reported in each study village between 2014 and 2015

Village	Number of reports	Percent
Malambo	12	7.7
Esere	53	34
Misigiyo	33	21.2
Alailelai	22	14.1
Mokilal	7	4.5
Meshil	7	4.5
Oloirobi	2	1.3
Iltulele	1	0.6
Kapenjiro	1	0.6
Naiyobi	14	9
Total	**152**	**97.5**

The distribution of animal clinical signs reported in all villages is displayed in the Fig. 12. Diarrhoea, sores on mouth, skin condition and sores on foot, swelling and joint pain were the major problems affecting most of domestic animals.

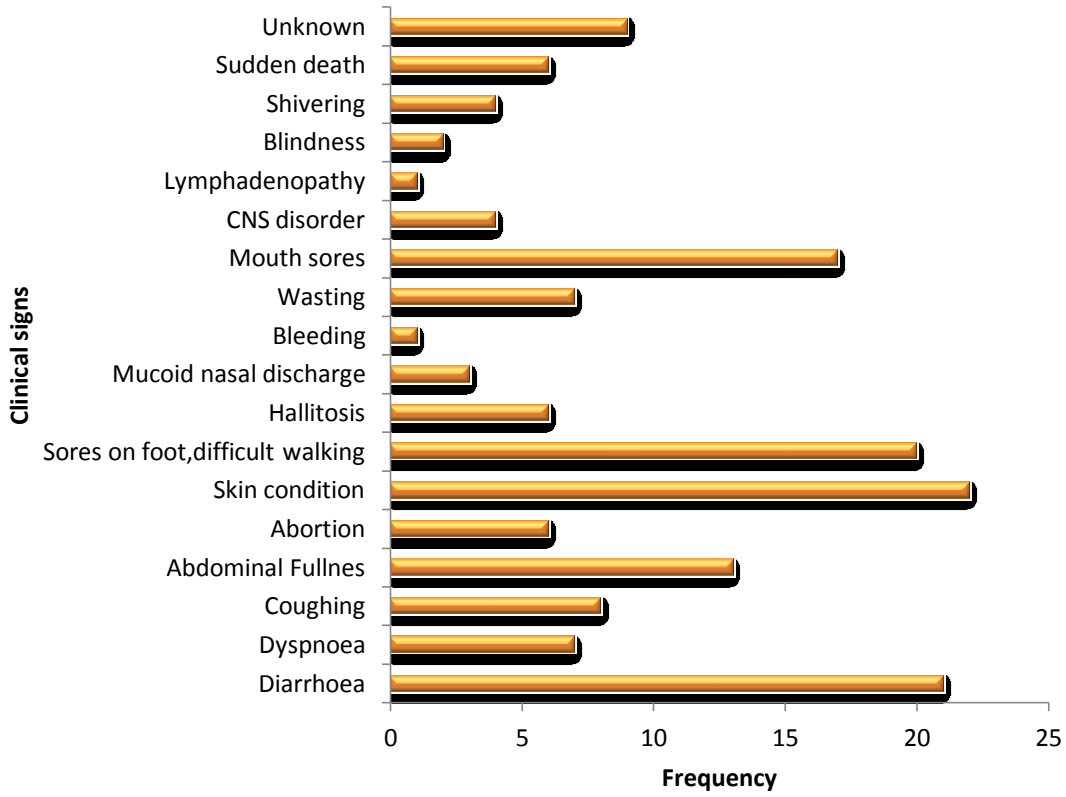

Figure 12: Frequency distribution of all animal clinical signs that occurred in study villages in Ngorongoro district

However, domestic animals such as cattle, goats, sheep and dogs were more affected by the clinical signs reported. Cattle and goatswere more affected representing 55% and 33% of total reports, respectively than sheep and dogs reported at 10% and 2%, respectively.

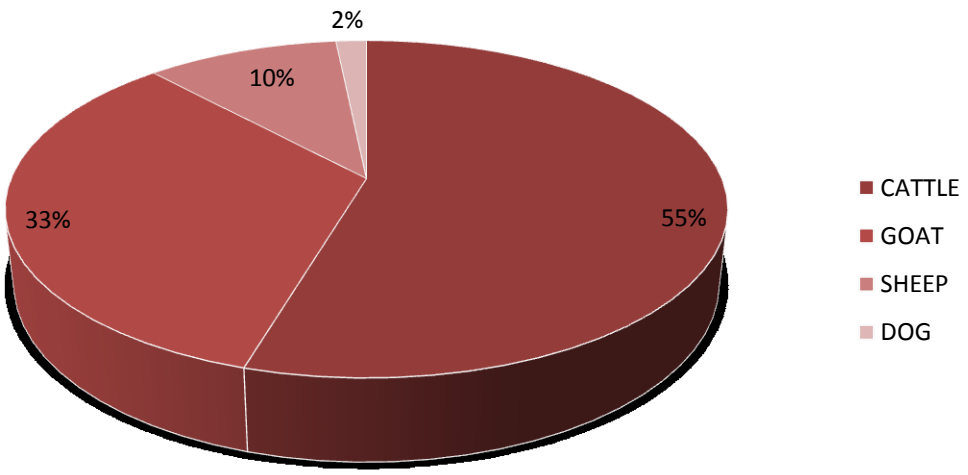

Figure 13: The percentage of animals showed clinical signs in the study wards/villages

Distribution of clinical signs byreporting village is summarized in Table 4. Diarrhoea, abortion, skin conditions, difficult walking, mouth sore and sudden death reported more frequently. Alailelai, Misigyo and Mokilal had more frequency of abortion than other villages, likewise Alailelai and Esere had more frequency of sudden death than other villages. Cattle, sheep and goats were the speciesmore associated with abortion events.

Table 4: Proportion distribution of animal clinical signs reported in each study village between 2014 and 2015. Number of clinical signs reported (N) percentage (%)

Village	Diarrhoea	Abortion	Skin condition	Swelling/sore foot /difficult walking	Mucous nasal discharge	Mouth sores	Sudden death
Malambo	6 (50.0)	-	5 (41.6)	5 (41.6)	-	1 (8.3)	-
Esere	8 (15.1)	2 (3.8)	14 (26.4)	4 (7.5)	1 (1.9)	3 (0.6)	6 (11.3)
Alailelai	7 (31.8)	7 (31.8)	3 (13.6)	16 (30.2)	13 (24.5)	-	10 (18.9)
Mokilal	1 (14.3)	3 (42.9)	-	4 (57.1)	1 (14.3)	6 (85.7)	2 (28.6)
Naiyobi	2 (14.3)	1 (7.1)	3 (21.4)	2 (14.3)	1 (7.1)	5 (35.7)	-
Misigiyo	-	9 (27.3)	-	15 (45.5)	15 (45.5)	-	-
Others	1 (9.1)	7 (63.6)	-	9 (81.8)	-	2 (18.2)	1 (9.1)
Total	**25**	**29**	**25**	**55**	**31**	**17**	**19**

4.3 Mapping and Spatial Analysis

4.3.1Spatial mapping

The distribution of clinical signs reported in animals from the study villagesis presented in Fig.14 and 15. Most of events were located inthe same area. A total of 28 and 32 events in respiratory and musculoskeletal events had no coordinates recorded thus omitted from spatial mapping and analyses.

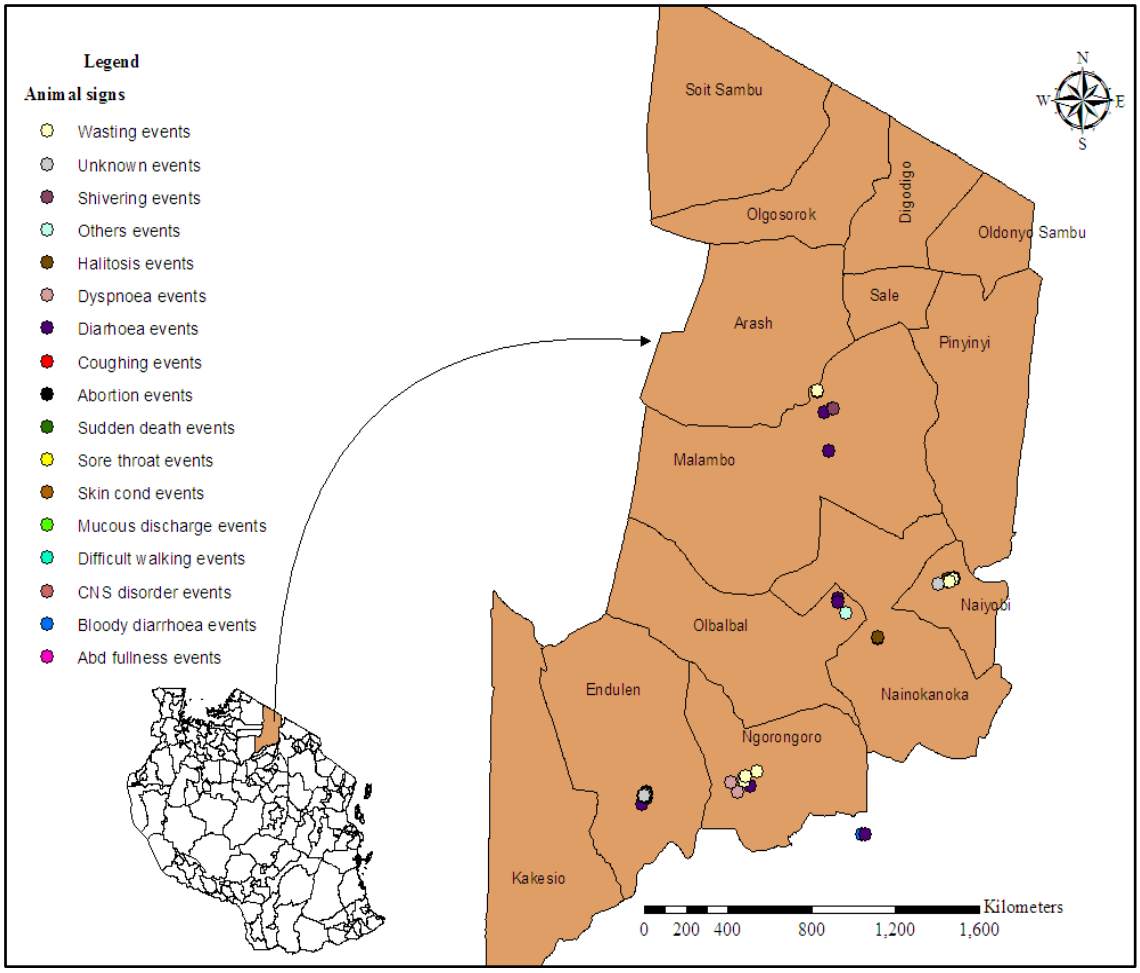

Figure 14: A map showing general distribution of all animal signs reported in Ngorongoro district (n=152)

The same clinical signs and symptoms were grouped into respective systems, the distribution were not different with that on Fig. 14as shown in Fig. 15.

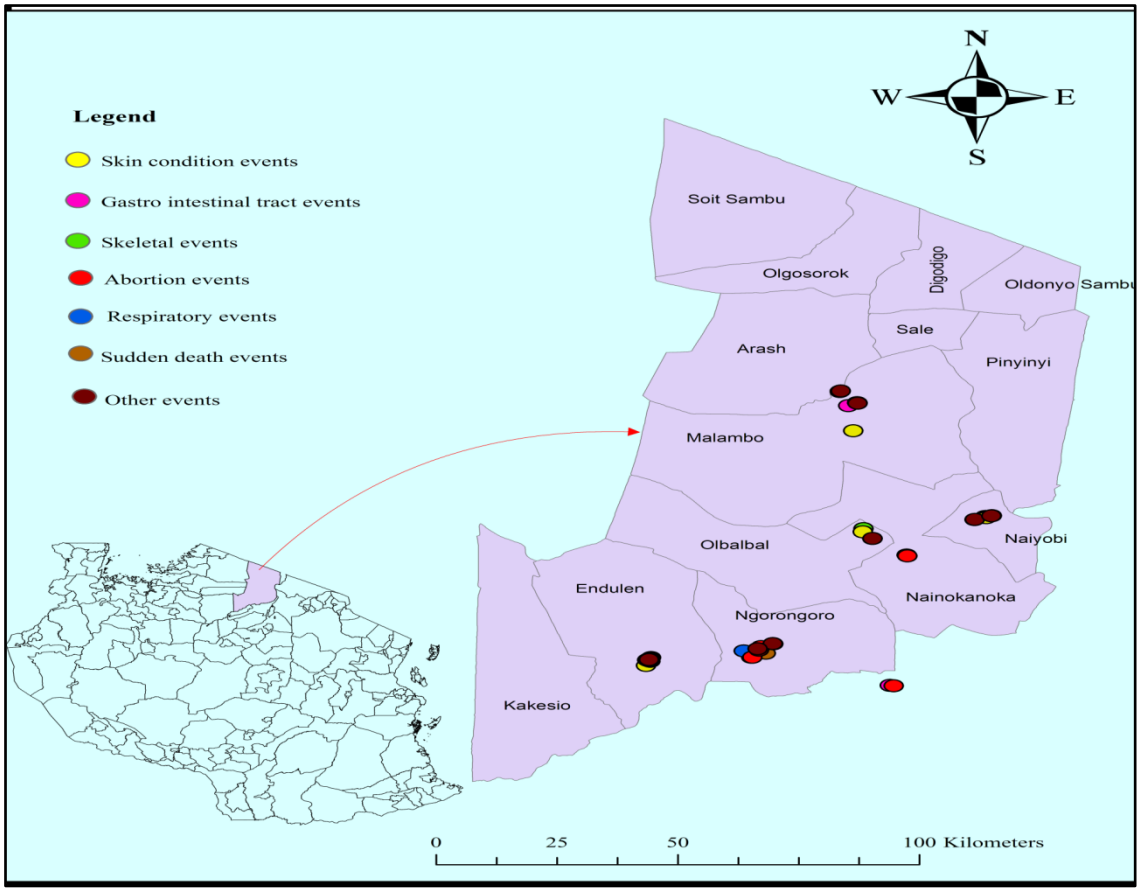

Figure 15: A map showing general distribution of grouped animal signs reported in Ngorongoro district (n=152)

4.3.2 Cluster analysis in animal clinical signs

Of all study villages, only two villages namelyAlailelai and Naiyobi had high rate clusters which were statistically significant as presented in Fig.16.

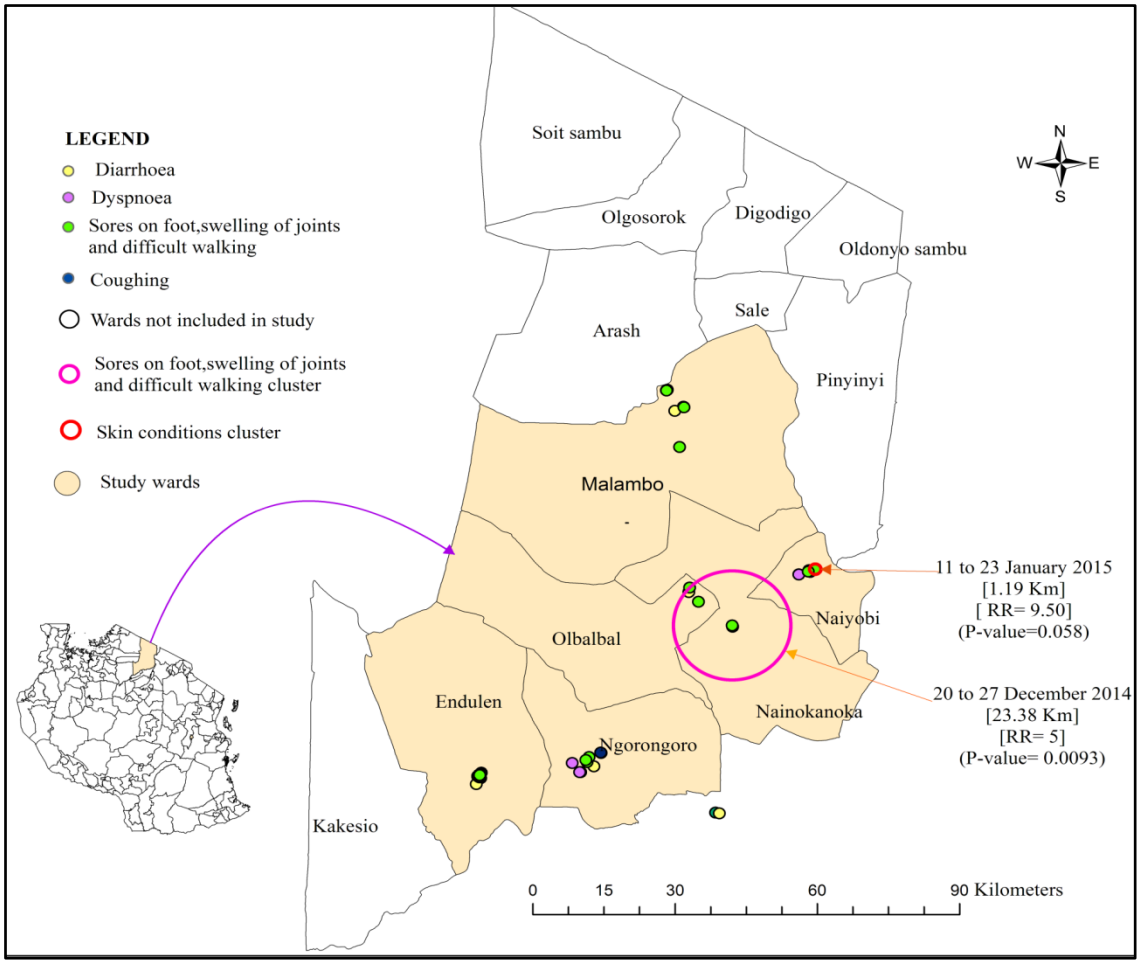

Figure 16: A map of Ngorongoro district showing the clusters detected in animal clinical signs and symptoms between December 2014 and May 2015.

CHAPTER FIVE

5.0 DISCUSSION

Surveillance is very important for the purpose of early detection, control and prevention of emerging and re-emerging infectious diseases (Mghamba *et al.*, 2004). The close watch of infectious diseases recently is of more significance due to the fact that it ensures prompt diagnosisand reporting,hence early warning of potential threats to public healthand timely disease outbreak prevention; control planning, preparedness and response action (Nsubaga *et al*., 2002).

5.1 General Results

Findings from this study indicate existence of high proportions of human clinical signs and symptoms reported in some villages particularly in Malambo and Esere village at 65.3% and 26.1% respectively. Major clinical signs and symptoms reported included: fever, diarrhoea, coughing, headache, colic abdominal pain, joint pain, nausea and vomiting. Thereare no previous published reports that coincide with these findings. Though there are limited studies on early investigation of diseases through clinical signs and symptoms, study results are in agreement with the study done by Chipwaza *et al.* (2015) who reported that females and children less than five years of age were more affected by bacterial febrile illnesses compared to others where fever were the common presenting clinical sign in Kilosa district. On the other hand, diarrhoea, abortion, skin conditions, mouth sores, swelling of joints and difficult walking and sudden death were the major clinical signs affecting animals inthe study areas. Some of clinical signs and syndromes reported could translate to distinct diseases such as Foot and Mouth disease characterised by mouth lesions and lameness.

The clinical signs were not equally distributed by occurrence as some areassuch as Mokilal, Alailelai and Misigiyo had more reports on abortions of 42.9%, 31.8% and

27.3% respectively compared to other places. Such findings might indicate variation in the prevalence and factors that contribute to the occurrence of diseases in different areas in Ngorongoro district. Cattle, goats and sheep were more affected by the abortion storms. Such findings suggest possibility for the prevalence of disease conditions that are clinically manifested by abortion in animals such as brucellosis or even low-grade Rift Valley fever which may be at low levels during inter-epidermic periods that do not warrant to be categorised as outbreaks. Study results are in agreement with the study on RVF in Tanzania done by Sindato*et al*. (2011; 2014) who reported high rates of abortion in animals particularly cattle, goats, and sheep. Also Assenga *et al.* (2015) reported 5.8% seroprevalence of brucellosis in cattle and goats in Katavi-Rukwa ecosystem causing loss in animal productivity. Vanderburg*, et al.* (2014) as well reported that small ruminants with history of abortion in Tunisia and South Africa were seropositive for *C. burnetii*, though the disease is asymptomatic in animals. The reported clinical signs correlate with other diseases such as Animal African trypanosomiasis in livestock as reported by Ruiz *et al.* (2015), echnococcosis in sheep, cattle and goats reported by Ernest*et al.* (2008) which has found infecting animals in Ngorongoro district as well as Røskaft *et al.* (2012) in their report of Tanzania wildlife research institute (TAWIRI) has indicated that diseases such as trypanosomosis, helminthosis, tuberculosis and Contagious Bovine Pleuro-Pneumonia (CBPP), East coast fever (ECF) affecting livestock in Ngorongoro district

5.2 Possible Disease Conditions in Human

Clinical signs and symptoms reported in humans in the study villages suggest the existence of endemic diseases which may be infectious or non infectious.It was further observed that there was clustering of signs and symptoms where short time frame with high risk of people to acquire infection when they enters the buffer zone indicates that, the particular infection present was infectious and spread rapidly as compared to cluster which

took almost threemonths with low relative risk of getting infection, indicated the infection was non-infectious and spread was slowly. Diseases such as salmonellosis, girdiasis, shigellosis, cryptosporidiosis, taeniasis, tuberculosis, leptospirosis, brucellosis, Q-fever, and helminthiasis are more reported to be endemic which are considered notof public health importancebutthey affects health of the communityas they are less reported. This concur with the study by Halliday *et al.* (2012) who reported the underreporting of endemic and neglected zoonotic diseases in low income countries. Also Røskaft *et al.* (2012) in their report of Tanzania wildlife research institute (TAWIRI) has indicated that diseases such as Malaria, diarrhoea/dysentery, brucellosis, tuberculosis, typhoid, pneumonia, measles, worm infestation and bed bugs affect pastoral communities in Ngorongoro district.

Moreover,febrile illnesses may be associated with the reported clinical signs and symptoms in human. In Africa Q-fever infected human, and was responsible for 2–9% of febrile illness hospitalizations.Vanderburg (2014) and Chipwaza *et al*. (2015) also reported diseases causing febrile illnesses in Africa and in Tanzania such as Q-fever, leptospirosis, and brucellosis

5.3 Possible Disease Conditions in Animals

Based on the study results, clinical signs reported from animals are indicative signs of diseases such as Brucellosis, Salmonellosis, Bovine tuberculosis, Anthrax Foot and mouth disease (FMD), Q-fever and skin conditions, in which animals are the predominant reservoir of diseases. Furthermore, a study by Shirima *et al*. (2003) reported clinical signs of diseases that were more prevalent in pastoral communities in northern Tanzania to be FMD, tuberculosis, brucellosis, skin conditions and anthrax. In the current study, cattle were more affected than other animals such as goats, sheep and dogs, this concur with the

study done by Sindato *et al.* (2014) who reported that cattle, goats and sheep were more affected by Rift valley fever outbreaks in Tanzania.

In the current study, there are signs that are likely to be shared between animals and human for example diarrhoea, respiratory conditions, skin conditions, weakness, joint pain, swelling and difficult walking. Conditions such as salmonellosis, tuberculosis, brucellosis, skin fungal infections are manifested by these clinical signs and symptoms reported though there are other signs. This is because diseases could be easily transmitted through direct contact with animal or animal products, via food/water borne transmission as well as through the environment (soil) as a reservoir of microorganisms (Shirima *et al*., 2003; Swai *et al.,* 2010). Fever which is associated by shivering also was reported in both human and animals, though in animals shivering could be a sign of hypothermia or when an animal gets into rigor state.

5.4 Factors that Contribute to Distribution of the Reported Signs and Symptoms

Based on the results of this study, all villages are equally predisposed to interaction with wildlife. This is so because all studied villages are situated within the natural wildlife reserve. Uncontrolled movement of livestock within the reserve such as seasonal movement of nomads and livestock in search of water and pastures, migration of wildlife as well as socio-economic factors such as livestock markets, have potential contribution to increasedtransmission and spread ofdiseases and pathogens from one place to another.

Distribution of clinical signs and symptoms of diseases in the study area varied depending on the climate and altitude. Signs and symptoms related to the respiratory system (coughing, dyspnoea), are likely to be found in high altitude while diarrhoeal problems, are common in low and medium altitudes which are associated with water availability.

However, the signs and symptoms are more severe in the high altitude as a result of low oxygen and lower temperatures.Clinical signs and symptoms pertaining to gastro intestinal tractproblems, bacterial, parasitic, and insect borne infections are more common in elevated temperatures and high humidity which create necessary conditions for vector and bacterial growth and proliferation (Mills *et al.,* 2010).

Furthermore gender, sex and cultural factors play an important role inhealth and illness. Different roles of men and women within the family may have predisposed them to infections such as physiological changes to immune, respiratory, and cardiovascular systems during pregnancy can cause severe outcome of some infectious diseases. Cultural norms have an effect on risks of infection (Vlassoff, 2007; WHO, 2009), in the Maasai culture, milking of cows is done by women,children of between 6- 18 yrsare more involved in daily animal care thispredisposes themtoinfections as they come close to livestock and wild animals during grazing(Chipwaza *et al.*, 2015). Factors such as poor hygiene and sanitation, early weaning and introduction of raw unpasteurized milk, malnutrition and low immunity predispose children less than 5years. Moreover, inadequate knowledge on zoonoses, consumption of raw meat and blood in pastoralist could be the source of getting infections (Swai *et al.,* 2010).

5.5 Use of Community Health Reporters

It is important to improve disease surveillance for early detection, reporting and diagnosis for prompt intervention in prevention and control of diseases. Using CHRs in this study to report the clinical signs and symptoms of diseases from the community have enhanced the reportof disease events in time and place of occurrence. Personal communication with animal and human medical departments in Ngorongoro has explained that presence of CHRs increase disease reporting due to fact that the CHRs are close and selected from

among the community members they trust. CHRs were used as the link between the livestock keepers and the official disease surveillance systems. Livestock keepers recognize them and report problems early for assistance. Thistherefore helps to capture and report information from the remote areas. The above is supported by a study on the use of CHWs in Tanzania who work in the rural areas to sensitize the communities in the use of health services, increased disease reporting and how they contribute in improving community health (Allport *et al*., 2005; Tulenko *et al.,* 2013).

Of all reported clinical signs and symptoms, highproportions havebeen reported in Malambo, Esere and Alailelai. Factors such as interaction with animals, open markets,altitude and humid environment with availability of water favours vector breeding and therefore increase the transmission of diseases. Clusters of clinical signs and symptoms in both human and animals were found located in areas depending on climate and altitude,for example,cluster for skin condition were located in high altitude villages. Through reported clinical signs and symptoms it is reasonable to assume presence of diseases such as brucellosis, tuberculosis, salmonellosis, fungal skin infections in the study area. Therefore close watch of clinical signs and symptoms of diseases is very important for early warning of potential threats to public health. Syndromic surveillance helps in early detection of diseases and plan for prevention and control. The use of CHRs in collection of data helps to capture information in a wider area in the community and link to the professionals for follow ups and therefore strengtheningof disease monitoring and surveillance.The findings of this study will help health officials (human and animals) in the district to plan the strategies on disease control and prevention, allocate resources depending to the areas much exposed to signs and symptoms of infections, and plan on how to sensitize the community on importance of reporting health issues in time for early disease detection and response thus prevent outbreaks.

CHAPTER SIX

6.0 CONCLUSIONS ANDRECOMMENDATIONS

6.1 Conclusions

The Current study hasshown the pattern and distribution of reported clinical signs and symptoms and its distribution in study villages/wards. The use of CHRs in disease surveillance helped to capture information in a wider area particularly in remote areas hard to reach and enabled the community to freely report their problems. The findings of this study will help health officials (human and animals) in the district plan interventions of disease control and prevention, and allocate resources depending to the areas much exposed to signs and symptoms of infections, as well plan on how to sensitize the community on importance of reporting health issues in time for early response. Hence based on the study results the following are recommended.

6.2 Recommendations

Based on the findings of this study of clinical signs and symptoms in human and animals in the study villages in Ngorongoro district, the following are the recommendations

i. Ministries (MoALF and Ministry of Health Community Development Elderly and Children (MoHCDGEC))should strengthen infectious disease surveillance and reporting through use of electronic system for early diagnosis and disease response.

ii. SACIDS in cooperation with Animal and human health departments in the Local Government Authority should improve data collection and reporting through community health reporters (CHRs), community health workers (CHWs) and community animal health workers (CAHWs).

iii. SACIDS in cooperation with Animal and human health departments should increase the number of reporters in the community to capture wider area thus enhance early identification of community health problems and early reporting of diseases for investigation.

iv. SACIDSand Ministries should involve both animal and human health professional on surveillance programme for the purpose of incorporating animal- human diseases (zoonotic diseases) to improve management of cases thus improve health of the community and prevent transmission (One Health approach).

v. SACIDS should implement health education to community health reporters on data collection and submission particularly the GPS coordinates is very important to accurately record the GPS and minimize errors in spatial references that help in field follow-ups and intervention of events as well asto accurately determine the spatial temporal clustering of clinical signs and symptoms of diseases.

vi. Further studies on syndromic surveillance are needed to ensure events from the community level are reported, analysed and presented in time, will help to come up with findings that will help in health policy makers to plan strategies on how to protect health of the community.

REFERENCES

Abubakar, A. A., Sambo, M. N., Idris, S. H., Sabitu, K. and Nguku, P. (2013). Assessment of integrated disease surveillance and response strategy implementation in selected Local Government Areas of Kaduna state. *Annals of Nigerian Medicine,7*(1): 0331-3131.

Allan, K. J., Biggs, H. M., Halliday, J. E. B., Kazwala, R. R., Maro, V. P., Cleaveland, S. and Crump, J. A. (2015). Epidemiology of Leptospirosis in Africa: A Systematic Review of a Neglected Zoonosis and a Paradigm for " One Health " in Africa*:PLOS Neglected Tropical Diseases*: 9(9):e0003899.doi:10.1371/journal.pntd.0003899.

Allport, R., Mosha, R., Bahari, M., Swai, E. and Catley,A. (2005).The use of community-based animal health workers to strengthen disease surveillance systems in Tanzania. *Revue scientifique et technique Office international des Epizootics*, 24 (3): 921-932.

Asokan, G. V. and Asokan, V. (2016). Bradford Hill's criteria, emerging zoonoses, and One Health. *Journal of Epidemiology and Global Health*.6, 125–129http://dx.doi.org/10.1016/j.jegh.2015.10.002 site visited on 12/4/2016.

Assenga, J. A., Matemba,L.E., Muller, S. K., Malakalinga, J. J. and Kazwala, R. R.(2015). Epidemiology of Brucella infection in the human, livestock and wildlife interface in the Katavi-Rukwa ecosystem, Tanzania. *BioMed Central Veterinary Research,*11(189): DOI 10.1186/s12917-015-0504-8.

Cattoli, G., Monne, I., Fusaro, A., Joannis, T. M., Lombin, L. H., Aly, M. M., Arafa, A. S., Sturm-Ramirez, K. M., Couacy-Hymann, E., Awuni, J, A., Batawui, K. B., Awoume, K. A., Aplogan, G. L., Sow, A., Ngangnou, A. C., El Nasri Hamza, I. M., Gamatie,D., Dauphin, G., Domenech, J. M. and Capua, I. (2009). Highly Pathogenic Avian Influenza Virus Subtype H5N1 in Africa. A Comprehensive Phylogenetic Analysis and Molecular Characterization of Isolates:*PLoS ONE* 4(3):1–9 e4842. doi:10.1371/journal.pone.0004842.

Chipwaza, B., Mhamphi, G. G., Ngatunga, S. D., Selemani, M., Amuri. M., Mugasa. J. P. and Gwakisa, P. S. (2015). Prevalence of Bacterial Febrile Illnesses in Children in Kilosa District, Tanzania. *PLOS Neglected Tropical Diseases,* 9(5). e0003750. doi:10.1371/journal.pntd.0003750 site visited on 7/3/2016.

Chomel, B. B., Belotto, A. and Meslin, F. (2007). Wildlife , Exotic Pets and Emerging Zoonoses.International Symposium on Emerging ZoonosesMarch 22–24, 2006. *Emerging Infectious Diseases,*13(1).

Chowell, G. and Nishiura, H. (2014). Transmission dynamics and control of Ebola virus disease (EVD). A review. *Bio Med Central Medicine*,12:196.

Cleaveland, S., Mlengeya, T., Kazwala, R. R., Michel, A., Kaare, M. T., Jones, S. L., Eblate, E., Shirima, G. M. and Packer, C. (2005). Tuberculosis in Tanzanian Wildlife. *Journal of Wildlife Diseases,*41(2): 446–453.

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. and 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. doi:10.1371/journal.pntd.0002324.

Day, M. J., Breitschwerdt, E., Cleaveland, S., Karkare, U., Khanna, C., Kirpensteijn, J., Kuiken, T., Lappin, M.R., McQuiston, J., Mumford, E., Myers, T., Palatnik-de-Sousa, C.B., Rubin, C., Takashima, G. and Thiermann, A. (2012). Surveillance of zoonotic infectious diseases transmitted by small companion animals.*Emerging Infectious Diseases*, 18(12). http://dx.doi.org/10.3201/eid1812.120664.

Dicker, R. C. (2006). Principles of Epidemiology in Public Health Practice. *Cdc*, (May), Glossary of Epidemiology Terms.

Dikid, T., Jain, S. K., Sharma, A., Kumar, A. and Narain, J. P. (2013). Emerging and re-emerging infections in India. An overview. *Indian Journal of Medical Research,*138: 19–31.

Dill, T., Dobler, G., Saathoff, E., Clowes, P., Kroidl, I., Ntinginya, E., Machibya, H., Maboko, L., Loscher, T., Hoelscher, M. and Heinrich, N. (2013). High Seroprevalence for Typhus GroupRickettsiae, Southwestern Tanzania.*Emerging Infectious Diseases,*19(2): 317–320.

Dorak, M. T. (2012). Epidemiology of infectious Diseases. [Http://www.dorak.Info]site visited on visited on 15th Mar 2015.

Ernest,E., Nonga, H. E., Kasuku, A. A. and Kazwala, R. R. (2008).Hydatidosis of slaughtered animals in Ngorongoro district of Arusha region, *Tanzania. Tropical Animal Health and Production:*41(7): 1179-85Doi:10.1007/s11250-008-9298-z

FAO (2004).HIV Infections and zoonoses.FAO Animal Production and Health Paper 163pp.

FAO-OIE-WHO Collaboration (2010). Sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces.A Tripartite Concept Note.

Gebreyes, W. A., Dupouy-Camet, J., Newport, M. J., Oliveira, C. J. B., Schlesinger, L. S., Saif, Y. M., Kariuki,S., Saif, L. J., Saville, W., Wittum, T., Hoet, A., Quessy, S., Kazwala, R.,Tekola,B., Shryock,T., Bisesi, M.,Patchanee, P., Boonmar, S.and King, L. J. (2014). The Global One Health Paradigm: Challenges and Opportunities for Tackling Infectious Diseases at the Human, Animal, and Environment Interface in Low-Resource Settings. *PLoS Neglected Tropical Diseases*,8(11): e3257. doi:10.1371/journal.

Greenspan, J. A., Mcmahon, S. A., Chebet, J. J., Mpunga, M., Urassa, D. P. and Winch, P. J. (2013). Sources of community health worker motivation: A qualitative study in Morogoro Region, Tanzania. *Human Resources for Health*,11:52:doi:10.1186/1478-4491-11-52.

Halliday, J., Daborn, C., Auty, H., Mtema, Z.,Lembo,T., Bronsvoort, B. M., Handel, I.,Knobel, D., Hampson, K. and Cleaveland, S. (2012).Bringing together emerging and endemic zoonoses surveillance: shared challenges and a common solution. *Philosophical Transactions of the Royal Society B*: 367: 2872–2880.

Heinrich, N., Saathoff, E., Weller, N., Clowes, P., Kroidl, I., Ntinginya, E., Machibya, H., Maboko, L., Loscher, T., Dobler, G. and Hoelscher, M. (2012). High Seroprevalence of Rift Valley Fever and Evidence for Endemic Circulation in Mbeya Region , Tanzania , in a Cross-Sectional Study. *PLoS Neglected Tropical Diseases,*6(3): e1557. doi:10.1371/journal.pntd.0001557.

ILRI, (2012). Mapping of poverty and likely zoonoses hostpots. Zoonoses Project Report, Department for International Development, United Kingdom.

Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A., Balk, D., Gittleman, J. L. and Daszak, P. (2008). Global trends in emerging infectious diseases.*Nature,*451:990–994. doi:10.1038/nature06536.

Jost, C. C., Mariner, J. C., Roeder, P. L., Sawitri, E. andMacgregor-Skinner,G. J. (2007). Participatory epidemiology in disease surveillance and research. *Revue Scientifique et Technique Office International des Epizootics,*26(3): 537–547.

Karimuribo, E. D., Mboera, L. E., Mbugi, E., Simba, A., Kivaria, F. M., Mmbuji, P. and Rweyemamu, M. M.(2011).Are we prepared for emerging and re-emerging diseases? Experience and lessons from epidemics that occurred in Tanzania during the last five decades.*Tanzania Journal of Health Research,* 13(5): 387-98.

King, L. J. (2004). *Emerging and Re-emerging Zoonotic Diseases: Challenges and Opportunities*.72nd General Session Inernational Committee 23- 28, May. World Organization for Animal Health. Paris.33.

Marcovich, H. (2005).*Black's Medical Dictionary.* 41st Edition. A &C Black Publisher Limited, London. 849pp.

Mariner, J.C., Hendrickx, S., Pfeiffer, D.U., Costard, S., Knopf, L., Okuthe,S., Chibeu, D., Parmley, J., Musenero, M., Pisang, C., Zingeser, J., Jones, B.A., Ali, S.N., Bett, B., McLaws, M.,Unger, F., Araba, A., Mehta, P. and Jost, C.C. (2011). Integration of participatory approaches into surveillance systems. World organization for animal health, Paris. *Revue Scientifique et Technique Office International des Epizootics,*30(3): 653–659.

Mills, J. N., Gage, K. L. and Khan, A. S. (2010).Potential Influence of Climate Change on

Vector-Borne and Zoonotic Diseases: A Review and Proposed Research Plan., Atlanta, Georgia, USA.*Environmental Health Perspective,*118: 1507–1514.

Mboera, L. E. G., Rumisha, S. F., Mwanemile, E. J. Mziwanda, E.and Mmbuji, P. K. (2005). Enhancing disease surveillance reporting using public transport in Dodoma District, Central Tanzania. *Tanzania Health Research Bulletin,*7*:* 201–205.

McMorrow, M. L., Wemakoy, E. O., Tshilobo, J. K., Emukule, G. O., Mott, J. A., Njuguna, H., Waiboci, L., Heraud, J., Rajatonirina, S., Razanajatovo, N. H., Chilombe, M., Everett, D., Heyderman, R. S., Barakat, A., Nyatanyi, T., Rukelibuga, J., Cohen, A. L., Cohen, C., Tempia, S., Thomas, J., Venter,M., Mwakapeje, E., Mponela, M., Lutwama, J., Duque, J., and Lafond, K., Nzussouo, N.T., Williams, T. and Widdowson, M. (2015). Severe Acute Respiratory Illness Deaths in Sub-Saharan Africa and the Role of Influenza: A Case Series from 8 Countries. *The Journal of Infectious Diseases,* 212: 853–60.

Mghamba, J. M., Krekamoo, W., Senkoro, K. P., Rumisha, S. F., Shayo, E. and Mmbuji, P. (2004). Challenges of implementing an Integrated Disease Surveillance and Response strategy using the current Health Management Information System in Tanzania.*Tanzania Health Research Bulletin,*6(2): 57–63.

Mghamba, J., Mboera, L., Krekamoo, W., Senkoro, K., Rumisha, S., Shayo, E.H. and Mmbuji, P. (2008). Challenges of implementing an Integrated Disease Surveillance and Response strategy using the current Health Management Information System in Tanzania. *Tanzania Health Research Bulletin*,6(2): 57–63.

Ministry of Agriculture Livestock and Fisheries, (2003). The animal diseases act. United Republic of Tanzania Parliament, Government printer, Dar es salaam, Tanzania.

Moi,M.L., Takasaki, T., Kotaki, A., Tajima, S., Lim, C-K., Sakamoto, M., Iwagoe, H., Kobayashi, K. and Kurane, I. (2010).Importation of Dengue Virus Type 3 to Japan from Tanzania and Côte d'Ivoire.*Emerging Infectious Diseases*, 16 (11): 1770 -72 DOI: 10.3201/eid1611101061.

Muyembe-Tamfum, J. J., Mulangu, S., Masumu, J., Kayembe, J. M., Kemp, A. and Paweska, J. T. (2012). Ebola virus outbreaks in Africa: Past and present. *Onderstepoort Journal of Veterinary Research*,79(2): 8 pp.dx.doi. org/10.4102/ojvr.v79i2.451.

Nsubuga, P., Eseko, N., Wuhib, T., Ndayimirije, N., Chungong, S. and Mcnabb, S. (2002). Structure and performance of infectious disease surveillance and response, United Republic of Tanzania, 1998. *Bulletin of the World Health Orgazation (2002)*,80(3): 196–203.

OIE (2010). Training Manual on Wildlife Diseases and Surveillance. Workshop for OIE National Focal Points for wildlife. Paris, France.

Ope, M., Sonoiya, S., Kariuki, J., Mboera, L. E. G., Gandham, R. N. V., Schneidman, M., and Kimura, M. (2013). Regional Initiatives in Support of Surveillance in East Africa: The East Africa Integrated Disease Surveillance Network (EAIDSNet) Experience. *Emerging Health Threats Journal,*6: 19948 - http://dx.doi.org/10.3402/ehtj.v6i0.19948.

Røskaft,E., Fyumagwa, R., Gereta, E., Keyyu, J., Magige, F., Ntalwila, J., Nyahongo, J., Hassan, S., Bevanger, K., Graae, B., Lein, H., Skjærvø, G., Swenson, J. and Mfunda, I. (2012). The dynamics of large infrastrure development in conservation of the serengeti ecosystem – the case study of a road through serengeti national park.Tanzania wildlife research institute PHASE I REPORT.

Ruiz, J. P., Nyingilili,H. S., Mbata, G. H. and Malele, I. I.(2015).The role of domestic animals in the epidemiology of human African trypanosomiasis in Ngorongoro conservation area,Tanzania. Parasites and vectors.*Biomed Central* 8(510): DOI 10.1186/s13071-015-1125-6 retrieved on 18/7/2016.

Samad, M. A. (2011). Public Health Threat caused by zoonotic diseases in Bangladesh. *Bangladesh Journal of Veterinary Medicine*,9: 95–120.

Samoff,E., Waller, A., Fleischauer, A., Ising, A., Davis, M.K., Park, M., Haas, S.W., DiBiase, L. and MacDonald, P.D.M. (2012). Integration of Syndromic Surveillance Data into Public Health Practice at State and Local Levels in North Carolina.*Public Health Reports,*127: 310–317.

Scotch,M., Rabinowitz, P. and Brandt, C. (2012). State-level Zoonotic Disease Surveillance in the United States. NIH Public Access.*Zoonoses Public Health,*58(8): 523–528.

Scotch,M., Mattocks, K., Rabinowitz, P. and Brandt, C. (2011). A Qualitative Study of State- level Zoonotic disease surveillance in New England. NIH Public Access.*Zoonoses Public Health*,58(2): doi:10.1111/j.1863-2378.2009.01319.x.

Shirima, G. M., Fitzpatrick, J., Cleaveland, S.,Kambarage, D. M., Kazwala, R. R., Kunda, J. and French, N. P. (2003). Participatory Survey on Zoonotic Diseases Affecting Livestock Keeping Communities in Tanzania. *Journal of Animal and Veterinary Advances*, 2(4): 253-258.

Silkavute, P., Tung, D. X. and Jongudomsuk, P. (2013). Sustaining a regional emerging infectious disease research network: A trust-based approach. *Emerging Health Threats Journal*,6: 19957 - http://dx.doi.org/10.3402/ehtj.v6i0.19957.

Sindato, C., Karimuribo, E. D., Pfeiffer, D. U., Mboera, L. E. G., Kivaria, F., Dautu, G., Bernard, B. and Paweska, J. T. (2014). Spatial and Temporal Pattern of Rift Valley Fever Outbreaks in Tanzania; 1930 to 2007. *PLoS ONE*: *9*(2). e88897. doi:10.1371/journal.pone.0088897.

Sindato, C., Pfeiffer, D. U., Karimuribo, E. D., Mboera, L. E. G., Rweyemamu, M. and Paweska, J. T. (2015). A Spatial Analysis of Rift Valley Fever Virus Seropositivity in Domestic Ruminants in Tanzania, *PLoS ONE,*10(7): e0131873. doi:10.1371/journal.pone.0131873.

Sindato, C., Karimuribo, E. and Mboera, L. E. G. (2011). The epidemiology and socio-economic impact of rift valley fever epidemics in Tanzania: *A review. Tanzania Journal of Health Research,*13(1): dx.doi.org/10.4314/thrb.v13i5.1.

Smith, G. D. (1994). Basic Epidemiology. *Biomedical Journal*,308(6926): 483–483.

Swai, E.S., Schoonman, L. and Daborn, C.J. (2010).Knowledge and attitude towards zoonoses among animal health workers and livestock keepers in Arusha and Tanga, Tanzania. *Tanzania Journal of Health Research*, 12 (4): 282-288

TNBS (2013). 2012 Population and Housing Census, Population Distribution by Administrative Areas. Dar es Salaam, Tanzania

Tulenko, K., Møgedal, S., Afzal, M. M., Frymus, D., Oshin, A., Pate, M., Quain, E., Arletty, P., Wynd, S. and Zodpey, S. (2013). Community health workers for universal health-care coverage: from fragmentation to synergy. *Bulletin World Health Organ,*91:847–852.

Vanderburg, S., Rubach, M. P., Halliday, J. E. B., Cleaveland, S., Reddy, E. A. and Crump, J. A. (2014). Epidemiology of *Coxiellaburnetii* Infection in Africa: A OneHealth Systematic Review. *PLoS Neglected Tropical Diseases*: *8*(4). e2787. doi:10.1371/journal.pntd.0002787.

Vlassoff, C. (2007). Gender Differences in Determinants and Consequences of Health and Illness. *Journal of Health, Population and Nutrition*, 25(1): 47-61.

WHO (2008). *International Health Regulations (2005).* Second Edition, WHO Press Switzerland. 82pp.

World Health Organization (WHO) (2009). Global Surveillance during an Influenza Pandemic, (April).pp1–35.

World Health Organization, Centers For Disease Control, (2010). Technical Guidelines for Intergrated Disease Surveillance and Response in the African Region, (July), 400.[http://www.cdc.gov/globalhealth/dphswd/idsr/pdf/TechnicalGuidelines/IDSR Technical Guidelines 2nd Edition_2010_English.pdf] site visited on 12/06/2016.

Zyga, S. and Zografakis-sfakianakis, M. (2011). Emerging and re-Emerging Infectious Diseases: A potential pandemic threat.*Health Science Journal*, 5(3): 159–168.