EFFECT OF FRONTLINE HEALTH WORKERS' TRAINING AND E-BASED TECHNOLOGY ON AWARENESS AND REPORTING OF BRUCELLOSIS IN PASTORAL COMMUNITIES IN TANZANIA

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ABSTRACT

Brucellosis is an endemic bacterial disease reported in many sub-Saharan Africa countries. Awareness of frontline healthcare workers (FHWs) influences diagnosis, reporting and management of the disease. This study assessed the effect of FHWs' training on knowledge, attitude and practices (KAP) as well as the use of digital technology on reporting of brucellosis in pastoral communities. A quasi-experimental study was conducted from December 2019 to December 2020 to assess KAP of (FHWs) following training about brucellosis enhanced by application of electronic-based technology supported by *AfyaData* to promote early detection and reporting of brucellosis. A pre- and post-intervention survey was conducted to assess KAP among FHWs regarding brucellosis using a structured questionnaire uploaded in *AfyaData app*. Blood sera samples were collected from 141 patients with febrile illnesses attending selected health facilities for treatment in pastoral community. The blood samples were screened for brucellosis using Rose Bengal plate test (RBPT) and positive samples confirmed by Competitive Enzyme Linked Immunosorbent Assay (c-ELISA) test. KAP was assessed by 5-point Likert scale. Descriptive analysis for frequencies and proportion was performed. Chi-square/fisher exact test were used to compare for KAP and categorical variables while analysis of continuous variables was done by t-test and ANOVA. Results revealed that majority of the participants were not aware about brucellosis in both humans and animals, although they had good attitude towards brucellosis prevention. Participant's awareness, practice and attitude increased significantly ($p=0.003$, $p=0.001$, $p=0.032$), respectively, after the intervention. Out of 141 tested patients 17(12.1%) were positive on RBPT and four (2.8%) were confirmed by c-ELISA. Participants' KAP was mostly poor and after the training a significant

improvement was achieved. These findings highlight the need to strengthen FHWs knowledge, practices and diagnostic capacities related to brucellosis.

DECLARATION

I, Belinda Joseph Mligo, do hereby declare to the Senate of Sokoine University of Agriculture that this thesis is my own original work, which is done within the period of registration, and that it has never been submitted nor is it being concurrently submitted in any other institution.

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DEDICATION

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LIST OF ABBREVIATIONS AND SYMBOLS

µl	Micro liter
ANOVA	Analysis of Variance
C-ELISA	Competitive Enzyme Linked Immunosorbent Assay
CFT	Complement Fixation Test
cAMP	Cyclic Adenosine Monophosphate
DC	District council
DNA	Deoxyribonucleic acid
FAO	Food and Agriculture Organization
FHWs	Frontline Health Workers
ICT	Information Communication Technology
IgG	Immunoglobin G
IgM	Immunoglobin M
IHR	International Health Regulation
KAP	Knowledge, Attitude and Practice
LMIC	Lower Middle-Income Countries
MRCO	Morogoro Regional Commissioner Officer
NBS	National Bureau of Statistics
PBS	Phosphate Buffer Solution
PH	Potential Hydrogen
RBPT	Rose Bengal Plate Test
SAT	Serum Agglutination Test
WHO	World Health Organization
OIE	World Organization for Animal Health

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Brucellosis is a world-wide spread zoonotic disease which causes severe illness in human and abortion in animals with devastating effects in developing countries (Pappas *et al.,* 2005; Zhang *et al.,* 2018). It is caused by several species of a bacterium under the genus *Brucella* (Pappas *et al.,* 2010). It affects mostly the pastoral and agro-pastoral communities due to their intimate contact with animals and their eating habits (Swai *et al.,* 2009). Animals serve as reservoir of the disease for human infection (Nonga and Mwakapeje, 2017).

Brucellosis in animals is mainly manifested by abortion, reduced fertility, weak offspring and reduction in milk production although, in some cases, infected animals may not show any clinical signs (Kunda *et al.,* 2010; Kansiime *et al.,* 2015). In sub clinical form, infected animals shed the bacterium to the environment infecting other animals and humans (Kunda *et al.,* 2010). The disease is spread amongst animals when the infected animal aborts or gives birth. The bacteria causing the disease can survive outside the animal in the environment for several months, especially in cool moist conditions remaining infectious to other animals which become infected by ingesting the bacteria. The bacteria also infect the female animal's udder spreading infections through milk (Radostits, 2007). As it is with humans, animals can acquire infections through cuts in the skin, or through mucous membranes. The disease affects wild animals that serve as reservoirs without clear clinical manifestations, thus complicating the eradication efforts (Radostits, 2007). Affected animals are the major source of infection to humans. Human

acquire the infection through ingestion of raw or under cooked animal products such as milk, meat or blood and direct contact with infected animals or their products like meat, aborted fetuses and foetal membrane (Pappas *et al.,* 2005; Nonga and Mwakapeje, 2017).

The disease in humans present with varied clinical signs including fever and general body weakness (Minas *et al.,* 2007). Other clinical signs and symptoms depend on the affected body system. Clinical features like headache, sweating, loss of appetite, muscular pain, lumber pain and weight loss are not uncommon (Habib *et al.,* 2003; Bosilkovski *et al.,* 2007; Minas *et al.,* 2007). Infection involving skeletal, nervous and urogenital systems can lead to arthritis, sacroiliitis, spondylitis, abortions and epididymal-orchitis (Bosilkovski *et al.,* 2007).

In Tanzania, brucellosis in animals was first reported in 1927 following an outbreak of abortion in cows in Arusha region (Shirima, 2005). Since that time studies have been conducted in livestock and humans indicating variation in disease seroprevalence in different locations of the country (Makala *et al.,* 2020). In a relatively few studies conducted in humans in Tanzania, the reported prevalence of the disease in Morogoro was 21% (James, 2013), in northern Tanzania was 8.3%, 3.5% and 5.8% respectively (Shirima, 2005; Bouley *et al.,* 2012; Nonga and Mwakapeje, 2017), in Tanga 5.5% (Swai *et al.,* 2005), and Lake zone the reported prevalence was 5.6% (Shirima *et al.,* 2016).

Diagnosis of human brucellosis remains challenging mainly because of inadequate awareness of the disease among healthcare workers as well as the overlapping clinical manifestations with malaria that often results in its misdiagnosis (Mantur *et al.,* 2008). In addition, less attention is paid by the medical practitioners to brucellosis as a cause of illness in the course of clinical assessment at the primary health care facilities,

contributing to under/mis-diagnosis of the disease (Kunda *et al.,* 2008). For effective control of the disease, adequate knowledge of causes, mode of transmission, signs and symptoms, as well as appropriate practices and positive attitude relating to the disease are required (Lindalh *et al*., 2015). Several studies have shown limited awareness among healthcare providers on zoonotic diseases in Tanzania (Chipwaza *et al*., 2014; Cash-Goldwasser *et al.*, 2018: Zhang *et al*., 2019). Brucellosis largely remains undetected and misdiagnosed as other causes of febrile illnesses (WHO, 1997). For instance, a study carried out in northern Tanzania from 2012 to 2014, revealed that up 50 (8.9%) of 562 febrile patients enrolled in hospitals after receiving health care had brucellosis, that had not considered during their diagnosis and hospitalization (Cash-Goldwasser *et al.,* 2018). It has been observed that despite the prevalence of brucellosis in Tanzania, clinicians still misdiagnose and manage it as malaria (Kunda *et al.,* 2008). Involvement of both healthcare workers and community health workers provides an opportunity for collaboration for early detection and response to brucellosis in Tanzania (Chipwaza *et al*., 2014; Narbirye *et al.,* 2017).

According to WHO, there is high possibility for mobile technologies to enhance healthcare and public health service delivery in resource poor settings (WHO, 2011). Successful surveillance depends on timely and full gathering of information to assess disease status, determine appropriate control strategies, and monitor their impact (WHO, 2011). Control of infectious diseases mostly depend on the proper and operative surveillance programs which provide information on both animals and humans health for decision making and practices. The country surveillance system is based on the international health system IHR, (2005) and the World Organization for Animal Health (OIE) guidelines, which direct the flow of information from the community to international level (Wilson *et al.,* 2008). However, existing health systems in Tanzania

have been performing sub optimally (Jajosky and Groseclose, 2004). This raises the query of whether participatory engagement of local communities improves the performance of disease surveillance systems.

The fact that disease outbreaks typically occurs in communities, this suggests that communities are a key driver persuading the tenacity and transmission dynamic of infectious diseases (Azhar *et al.,* 2010). Majority of these communities are located on rural and remote areas where it's difficult to reach with unreliable communication. The broadening use of mobile phones in sub-Saharan Africa, where the dispersion rate has reached 67% (The Guardian, 2015), offers the opportunity to develop innovative participatory surveillance systems that rely on the design and placement of digital and mobile technology solutions. In many human health projects in resource-challenged areas, mobile technologies have emerged as a promising solution for obtaining, transmitting, and timely analyzing human health information (Missinou *et al.,* 2005; Diero *et al.,* 2006).

Application of information and communication technology (ICT) has been proposed to enhance early detection, timely reporting, and prompt response of brucellosis cases in humans (Karimuribo *et al.*, 2017). *AfyaData app* is a set of digital tools that eases the collection, analysis, documentation and feedback of public/animal health events. It has additional features of supporting expert-authored materials such as guidelines and health tips that can be accessed by healthcare workers for immediate use as reference to enhance decision making process in clinical diagnosis and laboratory confirmation. Impacts of the use of AfyaData in Tanzania include shortening the time from reporting of clinical cases to health facilities from an average of 10 days to 3 days; provision of automated feedback to data collectors in public and animal health surveillance systems and provision of

decision support to healthcare workers in human and animal health sectors (Karimuribo *et al.,* 2017).

This study was carried out to assess knowledge, attitude and practices of frontline health workers on brucellosis, effect of electronic-based technology and training in reporting and proper diagnosis on human brucellosis cases in the selected pastoral communities.

1.2 Problem statement and study justification

The burden of human brucellosis in Tanzania is mostly seen in poor individual living in close contact with animals (Kunda *et al.,* 2007). Previous studies conducted in Tanzania have reported the prevalence of brucellosis in human to be up 13% (Kunda *et al*., 2010). However, the level of knowledge, attitude and practices of frontline health workers regarding the disease in the country is not known. Furthermore, the use of information computer technology (ICT) in health care delivery will improve diagnosis and reporting of brucellosis, however its impact has not been assessed.

Most of the health facilities in Tanzania do not test for brucellosis (Kunda *et al.,* 2005). This might partly be contributed by low knowledge and lack of awareness among the health care providers and difficulty of the patients in accessing the health care services. As a consequence, the magnitude and incidence of brucellosis is not well understood in many sub-Saharan African countries (WHO, 2006). Similarly, there is no adequate data to guide the allocation of limited resources for public health interventions and disease control (WHO, 2006). Sparse information available in most of the medical departments show the disease prevalence to be variable (Kunda *et al.,* 2005). Lack of awareness among the healthcare providers can results into difficult in recognition of brucellosis in human (Kunda *et al.,* 2010). Some studies have been carried out in relation to diagnosis

of human brucellosis in Tanzania, but there are few studies about reporting and diagnosis of the disease.

The widespread use of mobile phones, including in rural areas, constitutes a potentially effective tool for real-time surveillance of infectious diseases (Thumbi *et al.,* 2019). Apart from using human healthcare and veterinary workers to collect and submit surveillance data, there has been an interest in crowd sourcing data to rapidly detect outbreaks using mobile phone (Freifield *et al.,* 2010; Stone *et al.,* 2016). Paper-based technology is often associated with delays in disease reporting. This is due to difficulties to submit hard copies of the disease surveillance forms because of poor road infrastructure, weather conditions or challenging terrain, particularly in the developing countries (Mwabukusi *et al.,* 2014).

The findings from this study will help in guiding the proper use of diagnostics tools and adoption of digital technologies to improve early detection and reporting of brucellosis in rural settings. Also, inform policies to ensure frontline health workers are provided with training on diagnosis, diagnostic and reporting tools to enable proper management of the disease.

1.3 Study objectives

1.3.1 General objective

Assessment of the effect of frontline health workers' training and electronic-based technology on management of human brucellosis in pastoral communities in Tanzania.

1.3.2 Specific objectives

1. To assess the effect of training on knowledge, attitude and practices of frontline health workers regarding brucellosis in human in selected pastoral communities,
2. To assess the effect of e-based technology on reporting of brucellosis cases in human in selected pastoral communities.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of brucellosis

Brucellosis is used to refer the animal and human infections is caused by several bacterial species under the genus *Brucella*. Others named the disease as undulant fever and Malta fever (WHO, 2006). In animals the disease is named as contagious abortion, abortus fever and epizootic abortion (Sathyanarayan *et al.*, 2011). The bacterium was first isolated from the spleen of service man in 1887 who died from unknown disease (Wyatt, 2000). Brucellosis is a most-wide spread contagious disease of livestock and human with significant health and economic impacts (WHO, 2006).

The disease in animals is characterized by abortions or reproductive failure. Recovered animals will be able to produce live but weak offspring following the initial abortion, however, they may continue to shed the bacteria. Although there has been great progress in eliminating the disease in many countries, still remain regions where the infection

persists in domestic animals and consequently transmitted to human population (WHO, 2006). Brucellosis is a disease of domesticated animals mainly sheep, goats, cattle, pigs, dogs, wildlife animals and humans as accidental hosts (WHO, 2006).

2.2 Aetiology of the disease

Brucellosis is caused by gram-negative bacilli bacteria, of the genus *Brucella* (Young *at el*., 2000). The bacteria are facultative intracellular parasites that cause chronic disease, which usually persists for life in infected individuals. The genus *Brucella* comprises of six classical species namely, *B. abortus, B. melitensis, B. suis, B. ovis, B. canis,* and *B. neotomae* (Pappas *et al*., 2010). Seven biovars are known for *B. abortus*, three for *B. melitensis* and five for *B. suis* (Bricker *et al.,* 2000). Despite of those biovars, the degree of genetic relatedness as shown by DNA hybridization studies is consistent with the existence of a single species within the genus *Brucella* (Bricker *et al.,* 2000).

Recent studies have reported the isolation and characterization of *Brucella* strains from a wide variety of marine mammals such as seals, porpoises, dolphins and a minke whale. These strains were identified as *brucellae* by conventional typing tests. However, their overall characteristics were unassimilable to those of any of the six currently recognized *Brucella* species and it was suggested that they comprise a new nomen species to be called' *B. maris'* (Cloeckaer*t et al.,* 2001). Caprine brucellosis, a chronic infectious disease caused by the gram-negative cocci-bacillus *B. melitensis*. Middle- to late-term abortion, stillbirths, and the delivery of weak offspring are the characteristic clinical signs of the disease that is associated with an extensive negative impact in a flock's productivity (OIE, 2010). *B. melitensis* is also the most virulent *Brucella* species for humans, responsible for a severely debilitating and disabling illness (OIE, 2010). In

human clinical symptoms include intermittent fever, chills, sweats, weakness, myalgia, abortion, osteoarticular complications, endocarditis, depression, anorexia and low mortality (Rosseti *et al.,* 2017).

2.3 Epidemiology of brucellosis in human

2.3.1 Disease distribution

Brucellosis is a widespread disease affecting both livestock and humans of major economic importance in many countries in the world. The global epidemiology of human brucellosis has evolved over the past decades (Pappas *et al.,* 2006). It is projected worldwide that the real number of infected people is 26 times higher than the reported 500 000 new cases annually (Bosilkovoski *et al.,* 2009). Reported incidence of brucellosis in different areas varies from 0.1 to more than 200 per 100 000 populations (Lopes-Merino, 1998). The prevalence and occurrence have been changing in different areas, for example among the African countries Algeria is the leading country in reported brucellosis cases (Pappas, 2006). The disease is also endemic in many sub-Saharan countries (Pappas, 2006). Outside Africa, countries such as Peru, Kuwait and parts of Saudi Arabia have reported high incidence of the disease (Bret *et al.,* 2008). Highest brucellosis burden lies in countries of Mediterranean basin (Portugal, Spain, Southern France, Italy, Greece, Turkey and North Africa), Arabian Peninsula, India, Mexico, South and Central America, Eastern Europe, Asia, Africa, the Caribbean, and the Middle East (Abdulssalam and Fein, 1976; Al-Nassir *et al.,* 2009). This might be due to increased animal production, intensive keeping of animals under poor hygienic conditions, in addition to socio-economic and behavioral factors (Abdulssalam and Fein, 1976; Al-Nassir *et al.,* 2009).

2.3.2 Transmission of brucellosis in human

Brucellosis can be transmitted to humans through direct contact with *Brucella* organisms when exposed to infective discharge or tissues from infected animal or their products. Infections can be acquired through contact with discharges from aborted animal or aborted foetus or fetal membranes and drinking raw or improperly pasteurized infective milk (WHO, 2006; Corbel *et al.*, 2006). Human to human transmission is rare, it can occur when infective biological products such as blood used for transfusion, tissue or bone marrow used in transplants and also sexually (Godfroid *et al.,* 2005; Corbel, 2006).

2.3.3 Risk factors for brucellosis infection in human

Poor hygiene, close contact with infected animals, consumption of unpasteurized dairy products and undercooked meat products are considered to among the risk factors for brucellosis transmission (Osoro *et al.*, 2015). In human, older age has been identified as a risk factor for *Brucella* antibody seropositivity probably due to prolonged exposure (Cash-Goldwasser *et al.*, 2018). Acquiring infection through direct contact is possible to occupational groups such as veterinarians, famers, butcher men, milkers, laboratory workers and inseminators (Regassa *et al.,* 2009). Transmission in wildlife occurs through spill over from domestic animals and wild species. The interaction between wildlife, livestock and humans in pastoral and agro-pastoral communities facilitates transmission of the infection (Godfroid, 2002). In human, consumption of infected game meat can lead to spread of the infection (James, 2013). The growth in business and vacation travel to brucellosis-endemic countries has led to importation of the disease into non-endemic areas (OIE, 2010). Low knowledge on brucellosis, perception and practices among the pastoralist is one of the risk factors which led to brucellosis transmission. According to Kunda *et al.* (2007) the limited knowledge about the different manifestations of

brucellosis can be one of the causes in delaying diagnosis and treatment resulting in further persistence of the disease.

2.3.3 Clinical manifestations of brucellosis in human

The incubation period can take 2-4 weeks. The initial presentation of the disease is nonspecific with highly variable features such as fever, generalized malaise, arthralgia, myalgia, fatigue, headache and night sweat (Pappas, 2005). Focal infections are common and can affect most organs in the body (Corbel, 2006; CDC, 2017). In advanced cases the common clinical features of brucellosis are headache, undulant fever, fatigue, back pain, joint pain, loss of appetite and night sweat (Habib *et al*., 2003: Minas *et al.,* 2007). The infection also causes focal abrasions in bones, joints, genitourinary tract and other organs. Complications may include swelling, sacroiliitis, spondylitis and disorders of the central nervous system. *Brucella* can cause abortions in women mostly in the first and second trimesters of pregnancy while in males can result to epididymis-orchitis (Wattam *et al.,* 2009). Multiple and non-specific features contribute to difficulties in the diagnosis of the disease in areas where other diseases with similar clinical features such as malaria, tuberculosis, typhoid and joint diseases co-exist (Gul and Khan, 2007).

2.4 Diagnosis of brucellosis in human

The disease history and clinical signs like frequent fever, history of working with animals, food and eating habits, abortions, swelling and epididymis-orchitis may be indicative of a disease (David and Arthur, 1998). There is a wide range of diagnostic tests available for brucellosis, including direct methods such as bacteriological culture or DNA detection. Isolation of *Brucella* spp by culture enables confirmation of positive infection status. Although RBPT test sensitivity is 100%, specificity is low (Godfroid *et al.,* 2010). Factors

like biosafety can impact test sensitivity. But the limitation of the technique is that it takes long time, and needs detailed tests to characterize the bacteria. In order to be able to screen a large number of humans, the diagnostic tests should be “inexpensive, easy to perform, rapid, highly sensitive and fairly specific”. Several serological tests have been designed to meet these requirements (Mangen *et al.*, 2002).

2.4.1 Serological tests

The detection of specific antibody in serum remains the most practical diagnosis of brucellosis (WHO, 2006). There are several serological tests available for detecting the antibody response, thus used for screening purposes (Minga and Balemba, 1990). Those tests include Serum agglutination test (SAT), Complement Fixation Test (CFT), indirect enzyme linked immunosorbent assay (i-ELISA), Competitive ELISA (c-ELISA) and Rose Bengal Plate Test (RBPT).

2.4.1.1 Rose Bengal plate test (RBPT)

The Rose Bengal plate test is one of the methods which is known as the buffered *Brucella* antigen tests which relies on the principle of the ability of IgM antibodies to bind to the antigen at low pH (WHO, 2006). Often used as a rapid screening test in the diagnosis of brucellosis (Ruiz-Mesa *et al.*, 2005). This method is known to be a simple spot agglutination test where by drops of the stained antigen and serum sample are mixed on the plate and any resulting agglutination signifies a positive reaction (WHO, 2006). The RBPT is capable of detecting infected humans prior to Serum agglutination test (SAT) due to its capability to detect the presence of IgG, which is produced early after exposure (Nielsen *et al.*, 1996).

It is recommended that RBPT positive samples should therefore be subjected to SAT or Complement Fixation test (CFT) for confirmation (Arthur *et al.,* 1989). Although the sensitivity of RBPT is reported to be very high, its specificity can be insufficiently low due to cross reaction with other microorganisms (Barroso *et al.,* 2002). It is the most useful method where a weak positive suspected individual is considered negative (Abduharfeil and Aboshehada, 1998). Even though the RBPT has been shown to be highly in sensitivity, there are recognized challenges for its use in clinical settings. False positivity can occur due to cross-reactivity with non-target pathogens or due to detection of antibodies attributable to previous exposure rather than the current illness, which is a significant challenge in brucellosis-endemic areas (Diaz *et al.*, 2011).

2.4.1.2 Enzyme Linked Immunosorbent Assay (ELISA)

The Enzyme-Linked Immunosorbent Assay (ELISA) is a technique used to discover antibodies or antigen of infectious agents. An antibody ELISA indicate whether or not an animal has been in contact with a certain pathogen while the antigen ELISA indicates the current infections (WHO, 2006). This technique has high sensitivity and specificity with a minimum of equipment requirement and readily accessible (Munir *et al.,* 2008). It can be used on either serum samples or milk samples from different species (Vanzini *et al.,* 2001). Among the ELISA methods the competitive ELISA (c-ELISA) has been reported to be more reliable and easier to accomplish compared to other serological methods. The c-ELISA has high sensitivity and specificity (Nielsen *et al.,* 1996). Competitive ELISA is especially useful to measure low concentrations of analytes in the Pico molar range, such as the low-abundant cAMP in cell lysate which presents challenges in terms of sensitivity. High possibility of false positive or negative results because of insufficient blocking of the surface micro titer plate immobilized with antigen, antibody instability,

labor intensive and expenses associated with antibody and culture media preparations are some of the limitations of the technique (Sakamoto *et al.,* 2018).

2.4.1.3 Serum Agglutination Test (SAT)

The word agglutination originates from the Latin word agglutinare, which means “to glue to.” The SAT has been used extensively for brucellosis diagnosis, although its low sensitivity and specificity makes its use to be limited to the absence of alternative techniques (Ariza *et al.,* 1992; Anderson *et al.,* 1995; Jiwa *et al.,* 1996; Swai, 1997; Mahlau and Hammond, 1962; WHO, 2006). The limitation to this test includes failure to differentiate natural infections from the effects of vaccination, failure to detect *Brucella* antibodies following abortion or early phase of the infection and also failure to detect chronic stages of the disease (Corbel, 1988; Bishop *et al.,* 1994).

2.5 Human brucellosis status in Tanzania

In Tanzania brucellosis is one of the prioritized zoonotic disease, but poor recognition of the disease among healthcare workers and lack of control strategies together with limited resources and lack of epidemiological data affect the control plan (WHO, 2006). According to OIE (2010), Tanzania is among the countries where brucellosis is prevalent in human and animals. Brucellosis in animals, has been reported in the Eastern zone with herd sero prevalence ranging from 12-14.1% (Shirima *et al.* 2004; Temba, 2012), Southern highland 0.6% (Assenga *et al.,* 2015). The sero prevalence of brucellosis in human in Morogoro was 21% (James, 2013), northern Tanzania was 8.3%,7.7%, 3.5% and 7.9%, respectively (Shirima, 2005; Kunda *et al.,* 2007; Bouley *et al.,* 2012; Makala *et al.,* 2020) and Kilosa was 15.4% (Chipwaza *et al.,* 2015). Most of these studies

involved fever and non-fever participants and they have used RBPT for screening and c-ELISA as a confirmatory.

2.6 Health workers knowledge on zoonotic diseases

Low knowledge of medical practitioners on zoonotic diseases especially brucellosis with respect to transmission, diagnosis and management has been reported in Northern Tanzania (Kunda *et al.,* 2008). This is due to the fact that there is limited regular continuing professional education opportunities which could make them acquire new knowledge on zoonosis (Asano *et al.,* 2003). Insufficient knowledge of any aspect of a disease is a budding causal factor to misdiagnosis and mistreatment and hence incurring unnecessary cost to patients. For instance, if a practitioner is not well informed of how the disease establishes or does not know how to investigate for its presence, there is a higher chance of misdiagnosis (Kunda *et al.,* 2008). The quantitative survey findings regarding brucellosis in particular, revealed that under-recognition of zoonosis may not only be driven by a lack of awareness or knowledge but also experience gained through daily practice which mad healthcare workers to focus on endemic diseases like malaria (Zhang *et al.,* 2016).

2.7 Mobile technology for disease surveillance

Up to the present, the number is by far 5.11 billion unique mobile users, 2.71 billion of them use smartphones around the world (WHO, 2011). The widening use of mobile phones in sub-Saharan Africa, where the penetration rate has reached 67% (The Guardian, 2015), offers the opportunity to develop innovative participatory surveillance strategies that rely on the design and deployment of digital and mobile technology solutions. Mobile phones are relatively cheap, with massive progress globally, mostly in

the sub-Saharan Africa. Mobile-phone–based health applications are proliferating rapidly and there are convincing reasons why mobile technologies offer such budding outcomes (WHO, 2011). They can be used at affordable cost to distribute accessible interventions, to tailor and identify care, and significantly, to support direct communication between frontline workers, program managers, patients, and communities (Free *et al.,* 2013).

2.7.1 Pros and cons of e-based surveillance tools

Digital technologies such as mobile phones are providing solutions for improving access to healthcare information and services in low- and middle-income countries (LMICs). The use of conventional mobile and wireless technologies to support health objectives is known as mobile health or m-Health (WHO, 2011). Mobile phones have the potential to improve access to healthcare information and services in low-resourced settings (Watkins *et al.,* 2018). Patients used their mobile phones to remind themselves to take medication or attend their clinic visits, and they appreciated receiving voice call reminders (Watkins *et al.,* 2018). Improving the speed of outbreak detection and reporting at the community level are critical in managing the threat of emerging infectious diseases, many of which are zoonotic. The widespread use of mobile phones, including in rural areas, constitutes a potentially effective tool for real-time surveillance of infectious diseases (Thumbi *et al.,* 2019).

Mobile phones, which are now used globally including in rural Africa, have provided opportunities to improve medical and public health practice including surveillance data collection, communication and delivery of preventive or restorative care (Robertson *et al.,* 2010; Lin *et al.,* 2011; Braun *et al.,* 2013; Mtema *et al.,* 2016). Mobile phones technology has demonstrated acceptance and feasibility in different communities under various conditions which contribute to a reduction of diseases (Carillo *et al.,* 2021).

These phone-based surveillance systems capture higher numbers of disease cases and time efficient compared to traditional health facility or veterinary office-based surveillance systems. But there is a growing concern on how to verify or corroborate such data, and the risk of reporting bias based on access to phones or the Internet or influenced by social, economic and behavioral variations within the population (Thumbi *et al.*, 2019). Other barriers such as mistrust of users, lack of training and technological problems affected the usability and outcomes of the health interventions (Adokiya *et al.*, 2015; Muller *et al.*, 2019). Furthermore, people with no formal education and the elders may have difficulties in adopting the technology (Watkins *et al.*, 2018; Thumbi *et al.*, 2019).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study areas

This study was conducted in two pastoral communities located in the eastern of Tanzania from December 2019 to December 2020. The communities were termed as treatment meaning the one which receive the intervention and control meaning the one which didn't receive the intervention. A treatment pastoral community, inhabiting Kilosa district which is situated between latitudes 6° South and 8° South and longitudes 36° 30' East and 38° East. Its population is estimated to be 438 175 (NBS, 2012), and covers 14 918 km^2 and divided into 9 division, 37 administrative wards and 164 registered villages (MRCO, 2016). It is estimated that 212 500 hectares of land is covered by the game reserve and/or Mikumi national park. Statistics of livestock available in the district veterinary office indicate that as in 2018, the district had 208 279 cattle, 133 029 goats and 31 079 sheep. A total of 73 health facilities were operating in the treatment pastoral community during the study period. This community was recruited as one of the study site due to the existence of high human-livestock-wildlife interactions and reported prevalence of brucellosis with low community knowledge on zoonotic diseases (Temba, 2012; James, 2013; Assenga *et al.,* 2015). The selected ward health facilities included Agape, Msowero, China Estate farm, Rudewa, Serengeti Kada D, Kimamba, Dakawa, Dumila health center, Dumila dispensary, Twatwatwa, Chanzuru, Tindiga, Changarawe, Ilonga, Dodoma Isanga and Msimba.

A control pastoral community is located in Chalinze district council and situated between latitude -6° 38' 16.22'' South and longitude 38° 21' 14.26'' East. It is quite a large

settlement area located about 40 miles east of Morogoro city. The community is a commercial spot, with the number of residents close to 30 000 people. It is dominated by the Kwere (crop farmers) and Maasai pastoralists. The community has population estimated at 245 000 (NBS, 2012) and 65 health facilities. In this study, this community was selected due to the high population of pastoralist. The ward health facilities selected were Lugoba, Tymer, Kibindu, Miono, Mkange, Msoga, Pongwe Msungura, Talawanda, Mbwewe, Msata, Pongwe Kiona, Bwilingu, Ubena Zomozi, Vigwaza and Mboga.

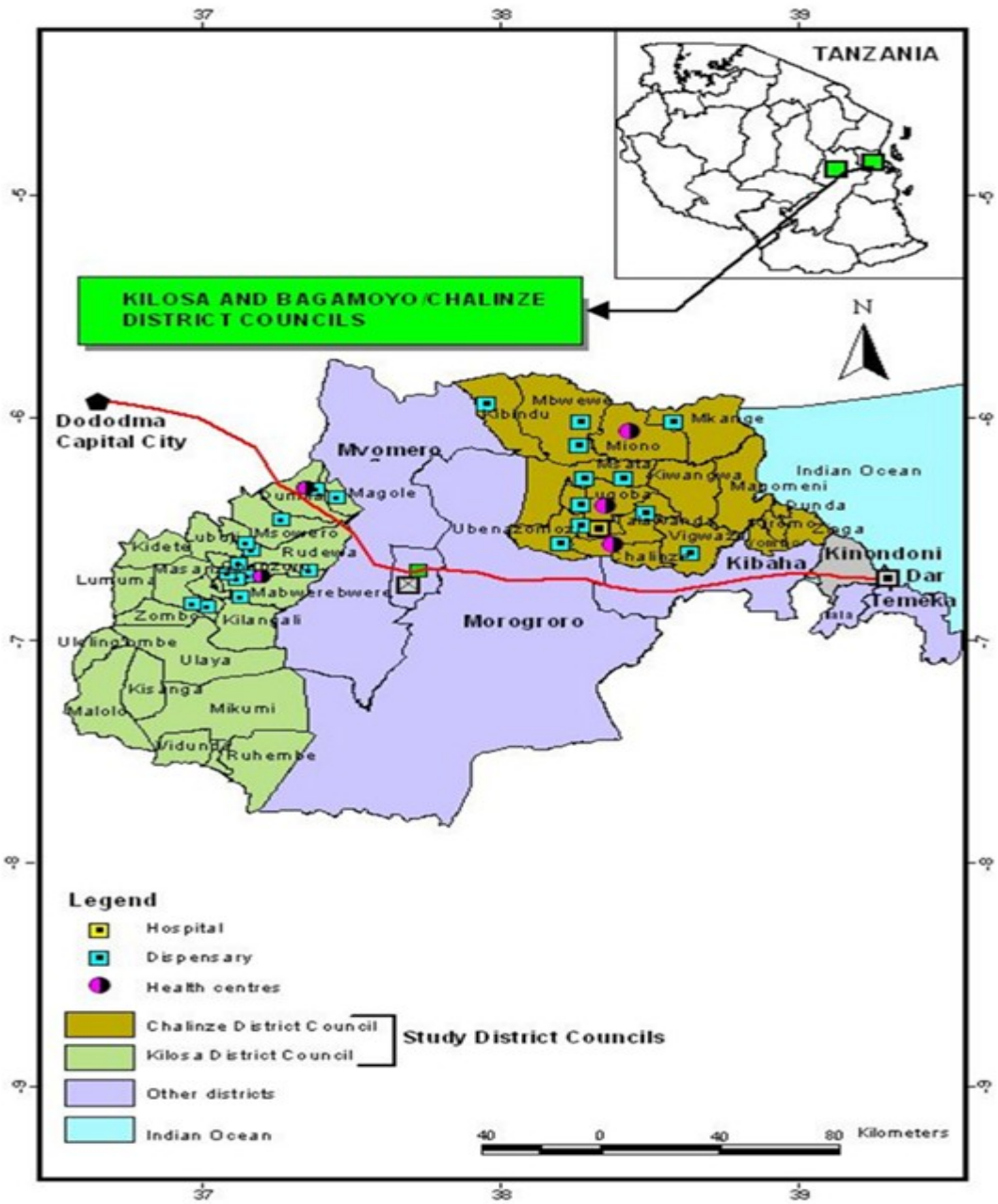

Figure 1: Showing study wards in Chalinze (control) and Kilosa (treatment) districts

3.2 Study design and participants recruitment

A quasi-experimental study was conducted in the two pastoral communities, with one being treatment and another a control. A cross-sectional survey involving systematic sampling of 16 wards in each pastoral community was conducted. In each ward one primary health facility, one HW and one CHW were purposely selected. An overall of 64 frontline health workers (FHWs), thus 16 healthcare workers (HWs) and 16 community health workers (CHWs) from each pastoral community were selected.

In treatment pastoral community, 14 dispensaries and two health centers, whereas in control pastoral community, three health centers and 13 dispensaries were included in the study. In treatment pastoral community, all selected health facilities (forming groups 1 and 2 described in the Table 1) were provided with *AfyaData,* rapid diagnostic test (Rose Bengal plate test) and technical backstopping during the study period. The frontline health workers (FHWs) were trained on proper brucellosis diagnosis and timely reporting enhanced by *AfyaData app*.

From eight wards of treatment pastoral community (group 1), the experimental setup was comprised of eight HWs and eight CHWs. Then later were trained on detection of clinical manifestations suggestive of human brucellosis, how to refer patients to primary healthcare facilities and CHWs were provided with referral forms. Another set of eight wards (group two) in treatment pastoral community were provided with treatment similar to that of group one except the CHWs component was not involved in the second group

of intervention. For 16 wards of control pastoral community, no treatment was provided.

Table 1: Wards distribution (group 1 and group 2) in treatment pastoral community

Group 1 (8 HWs and 8 CHWs) n= 8 (wards)	**Group 2 (8 HWs) n= 8 (wards)**
Changarawe	Kimamba
Tindiga	Rudewa
Dodoma Isanga	Twatwatwa
Msowero	Serengeti Kada
Dakawa	China Estate
Dumila health center	Agape
Dumila dispensary	Msimba
Ilonga	Chanzuru

3.2.1 The inclusion and exclusion criteria for the study

Inclusion criteria: Healthcare worker (HW) owning a smartphone and who was in charge of the health facilities and community health workers (CHWs) own a mobile phone from primary ward health facilities which have high population of pastoral communities were included in the study. If HW in charge didn't have a smartphone, another HW in same facility was recruited. All individuals seeking care at outpatient's department who were showing febrile symptoms in the selected health facilities in treatment pastoral community were eligible for brucellosis screening.

Exclusion criteria: Healthcare workers who were not in charge of the health facilities with no mobile phones and community health workers with no mobile phone were excluded from the study. Also, ward health facilities with no maximum population of

livestock and pastoral communities were excluded from the study. Patients with no febrile symptoms similar to that of brucellosis were excluded in the study.

3.3 Data collection

3.3.1 Socio-demographic information and assessment of knowledge, attitude and practices of frontline health workers

A structured questionnaire uploaded in the *AfyaData* platform (Karimuribo *et al.,* 2017) was used to collect pre and post data related to knowledge, attitude and practices (KAP) of the HWs and CHWs. In this study knowledge meant how the participants were aware of the brucellosis as a disease (its causes, mode of transmission, symptoms, treatment and prevention in humans), practice meant how the participants manage and report brucellosis cases while attitude meant how participants perceive the disease. The information collected included socio demographic characteristics (age, gender, education, workstation experience and length of stay in position), knowledge of brucellosis (causes, mode of transmission, symptoms, diagnosis, treatment and prevention), brucellosis practices (frequency of diagnosis, presence of reagents, types of samples for diagnosis, reporting practices and duration to receive feedback) and attitude regarding brucellosis prevention and control. Also, knowledge in other zoonotic diseases were explored. The post survey was conducted seven months after the training. The questionnaires were prepared in English then translated to Swahili so as to be understood by the majority and administered by the research team.

3.3.2 Training program arrangement

The training was prepared by the research team adopting One Health approach. It has used a plain teaching style of lecture and discussion. The participants were subjected to

attend the lecture on introduction of brucellosis then practical session of brucellosis case management using a rapid test (RBPT), where they were required to draw blood from one of the participants which will be used as a demo and put it in the vacutainer. Then the blood was centrifuged to obtain a serum. The serum obtained was used during practical session to demonstrate how brucellosis was diagnosed using RBPT, then followed by introduction to *AfyaData app* and its installation into their smartphones. The handouts regarding brucellosis and *AfyaData app* set ups were given to all participants after finishing the session.

3.3.3 Training on diagnosis and reporting of brucellosis using a rapid test and e-based technology to the frontline health workers

In May, 2020 a training was conducted in treatment pastoral community involving 24 participants (16 HWs and 8 CHWs) from 16 health facilities. The *AfyaData app* was set to support electronic-based training and awareness enrichment among FHWs to enhance early detection, timely presentation to health facilities and appropriate diagnosis of brucellosis cases. A laboratory component feature was developed on *AfyaData app* to track brucellosis samples from health facilities to main laboratory at the College of Veterinary Medicine and Biomedical Sciences, SUA, Morogoro, Tanzania (the laboratory facility is located approximately 140 km away from a treatment pastoral community), and shared results back to health facilities for near-to-real time access. In addition, the knowledge repository including the standard case definition for brucellosis was uploaded to *AfyaData app* platform and access was provided to health officials from the primary healthcare facilities to enhance the disease diagnosis. The functionality of the model to enhance tracking of samples and communication of laboratory test results was built using barcode feature embedded in the *AfyaData* platform. At the health facility, the patient

meeting the standard case definition were screened for brucellosis. A barcode with unique patient identification number was attached to the patient clinical assessment form that was presented to the laboratory at the health facility for Rose Bengal plate test. Once the RBPT test was completed, the clinical management of the positive patients was initiated. Aliquots of RBPT-positive serum samples in cryo-vials were refrigerated (2-8ºC) and transported in cool box with ice pack to a specialized laboratory at SUA where they were stored at -20ºC until confirmation of *Brucella* spp. exposure/infection using Enzyme-linked immunosorbent assay (ELISA). Using bar-coding system integrated in the *AfyaData* platform, laboratory results was sent back to respective health facility within 2-4 days so that proper management of suspected cases could start immediately using guidelines, which were developed by this study and distributed to the intervention site. Active interactions supported by *AfyaData app* was carried out between healthcare provider and patients either directly or through community-based volunteers in the respective areas, to enhance follow up of the patients' course of medical condition and reminder messages on adherence to treatment regime.

3.3.4 Blood samples collection

Patients who attended the selected facilities in the treatment pastoral community with symptoms suggestive of brucellosis/ febrile illness were identified and their particulars were recorded using the *AfyaData* app, barcodes were used as patient's identification. Participants from a particular facility aseptically collected 5 mls of blood from the cephalic veins of patients using a 5cc sterile disposable syringe into pre-labelled plain vacutainer tubes after relating the patient history with brucellosis clinical signs. The collected blood samples were centrifuged at 1500g for 10 minutes to obtain sera. All collected sera were transferred to clean labelled cryovial. The cryovials were labeled

using the same barcode as that from patient's information to enable easy tracking of the samples. At the health facility, the screened sera were stored in a refrigerator until shipment to the college of Veterinary Medicine and Biomedical Sciences laboratory at Sokoine University of Agriculture where were stored at -20C^{o} until serological analysis. A structured questionnaire was uploaded in the *AfyaData app* and used to collect information on patient demographic data, variables on exposure to animals and animal products, consumption of raw milk and being in contact with aborted materials from animals.

3.3.5 Laboratory analysis

3.3.5.1 Rose Bengal Plate Test (RBPT)

It was done by taking a drop of test serum using clean Pasteur pipette and placed onto the clean microscopy slide beside the drop of RBPT antigen recommended for animal sera, manufactured by Animal and Plant Health Agency (APHA), New Haw, Addlestone, Surrey (KT15 3NB), UK. Then the mixture was made by a sterile applicator stick. The mixture was then shaken manually for eight minutes before examination. The presence of pink granules (agglutination) was recorded as positive while a sample with no granules was recorded as negative. RBPT was used because of its sensitivity and specificity also because being easy to perform and cheap (Omer *et al*., 2002). After RBPT test both positive and negative samples were stored in the nearby health facility laboratory for seven days, then transported in cool box with ice packs to Sokoine University of Agriculture and stored at -20ºC until when c-ELISA was performed.

3.3.5.2 Competitive Enzyme Linked Immunosorbent Assay (c-ELISA)

Analysis with c-ELISA was done according to Nielsen *et al.* (1996) using a commercial kit SVANOVIR® BRUCELA-Ab c-ELISA, adopting a test procedure and interpretation

of results as recommended by the manufacturer (Svanova Biotech AB SE-751 Uppsala, Sweden). In brief, stored serum samples were left to thaw, then all the reagents were left to equilibrate at room temperature (18-25^{0}C) before use. 45µl of sample dilution buffer was added into each well in plates which contained *Brucella* antigen used for serum controls, serum samples and conjugate controls. 5 µl of positive, weak positive, negative and conjugate controls were added into the appropriate wells in the c-ELISA plates followed by 5µl of test samples into appropriate wells. All test samples and serum controls were run in duplicates. Then 5µl of sample dilution buffer was added to the two appropriate wells designated for conjugate controls followed by 50 µl of monoclonal antibody solution into wells used for controls and samples. The plates were sealed and mixed by plate shaker for 10 minutes then incubated for 30 minutes followed by rinsing the plates 4 times with Phosphate Buffer Solution (PBS) Tween Buffer. Then 100µl of conjugate solution was added into each well then sealed and incubated for 30 minutes at room temperature followed by rinsing 4 times with PBS tween buffer. 100µl substrate solution was then added into each well and incubated for 10 minutes at room temperature. To stop the reaction 50 µl of stop solution was added to each well and mixed thoroughly. Optical density of controls and samples was measured at 450 nm in a micro plate photometer 15 minutes after adding the stop solution. Then mean of the optical density (OD) of the samples and controls were calculated followed by percent inhibition (PI) values using the following formula,

$$\mathbf{PI = 100 - \left(\frac{^{OD}\ samples\ or\ control \times 100}{^{OD}\ Conjugate\ control\ (Cc)} \right)}$$

PI=Percent inhibition, **OD sample**= optical density of the sample/control, **OD conjugate**= optical density of conjugate, cut-off for validity of samples were **<30%** negative and **>30%** are positive. Only the patients that were tested positive c-ELISA were

regarded as *Brucella* seropositive. The specificity used was estimated 99.6% and sensitivity 99.5% (Trangadia *et al.,* 2014).

3.6 Data analysis

The collected data was submitted on daily basis to the server located at the Sokoine University of Agriculture, Morogoro, Tanzania. Data were exported from *AfyaData app* to the Microsoft excel sheet where they were coded then exported into Statistical Package for Social Sciences (SPSS) version 20 software for analysis. Descriptive analysis for frequencies, percentages and proportions was carried out. Knowledge and attitude of the participants were assessed using 5-point Likert scale, (strongly agree, agree, Neutral, disagree and strongly disagree) that were measured using scoring method ranging from 5 to 1. The scores of the items were summed up and the total divided by number of the items giving a mean score for the part. The higher the mean score the better the knowledge, practice and attitude. Knowledge was assessed using 36 Likert questions and one open question and one binary question (Yes/no). The overall score for Likert questions in knowledge was 180 i.e. (36*5). Attitude was assessed using nine Likert questions giving the overall score of 45 i.e. (9*5). In practice ten questions were measured by scoring method as follow yes option 1 score and no option zero score, frequently option 2 scores, rarely option 1 score and none at all option 0 score. The total score for practice was 16. Awareness on other zoonotic diseases was assessed using binary variable which were Yes/No. analysis involved computing percentages, medians, standard deviation (SD) and ranges of the score and generating graphs. The association between individual subject level factors and brucellosis (*Brucella* sero-status: negative and positive) was explored in Mantel-Haenszel chi-square tests. Comparison between

continuous variables (i.e., KAP mean scores) was done by t-test \and ANOVA. P-value less than 0.05 was considered indicative of a statistically significant difference.

3.7 Ethical consideration

Privacy of the laboratory information was observed and the screened sera samples were used to detect brucellosis antibodies only. Ethical clearance was granted by the Medical Research Coordinating Committee of the National Institute of Medical Research in the United Republic of Tanzania (NIMR/HQ/R.8a/vol. IX/3235). Permission to conduct the study in the selected districts was obtained from the President's Office Regional Administration and Local Government in Morogoro (AB.175/245/01/219) and Pwani (DCD.128/40/01/109) regions. Written informed consent was obtained from each study participant (or parent/guardian in the case of minors under 18 years of age), after providing information on the study aim and procedures in the local language. After processing the sample, the results were transmitted to the medical personnel at the respective health facility through electronic platform (*AfyaData*) for follow up of patients.

CHAPTER FOUR

4.0 RESULTS

4.1 Socio demographic information's of the participants

A total of 64 frontline health workers were enrolled in the study. Their age ranged from 21 to 67 with an overall mean of 39.7, SD (±1.382) years. Participant's length of stay ranged from 1 – 40 years and 41(64%) of the participants were men (Table 2).

Table 2: Socio demographic information of the participants

Variable	Total	Control, N=32		Treatment, N=32	
Sex	**N=64**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Female	23	12	37.5	11	34.4
Male	41	20	62.5	21	65.6
Age in years					
21-30	19	6	18.8	13	40.6
31-40	18	13	40.6	5	15.6
41-50	15	7	21.9	8	25.0
>50	12	6	18.8	6	18.8
Education level					
No formal education	3	2	6.3	1	3.1
Incomplete primary	1	1	3.1	0	0.0
Primary	23	12	37.5	11	34.4
Secondary	11	2	6.3	9	28.1
College	26	15	46.9	11	34.4
Position					
Medical doctor	2	2	6.3	0	0.0
Medical officer	3	2	6.3	1	3.1
Medical Assistant	17	9	28.1	8	25.0
Nurse	7	3	9.4	4	12.5
Laboratory technicians	3	0	0	3	9.4
Community health worker	32	16	50	16	50
Length of stay in position (years)					
1-10	34	20	62.5	14	43.8
11-20	13	7	21.9	6	18.8
21-30	11	3	9.4	8	25.0
31-40	6	2	6.3	4	12.5
Working experience in workstation(years)					
Less than a year	6	3	9.4	4	12.5
1-5 years	26	19	59.4	20	62.5
>5 years	32	10	31.3	8	25.0

4.2 Healthcare workers' knowledge about brucellosis in pastoral communities

Healthcare workers knowledge on brucellosis transmission, clinical signs, diagnosis, prevention and control in both communities were found to increase in post treatment. Significant increase was found in treatment group after the training in transmission, clinical features and diagnosis (Table 3). The main source of information mentioned by participants was learning programs during their professional training (Figure 2).

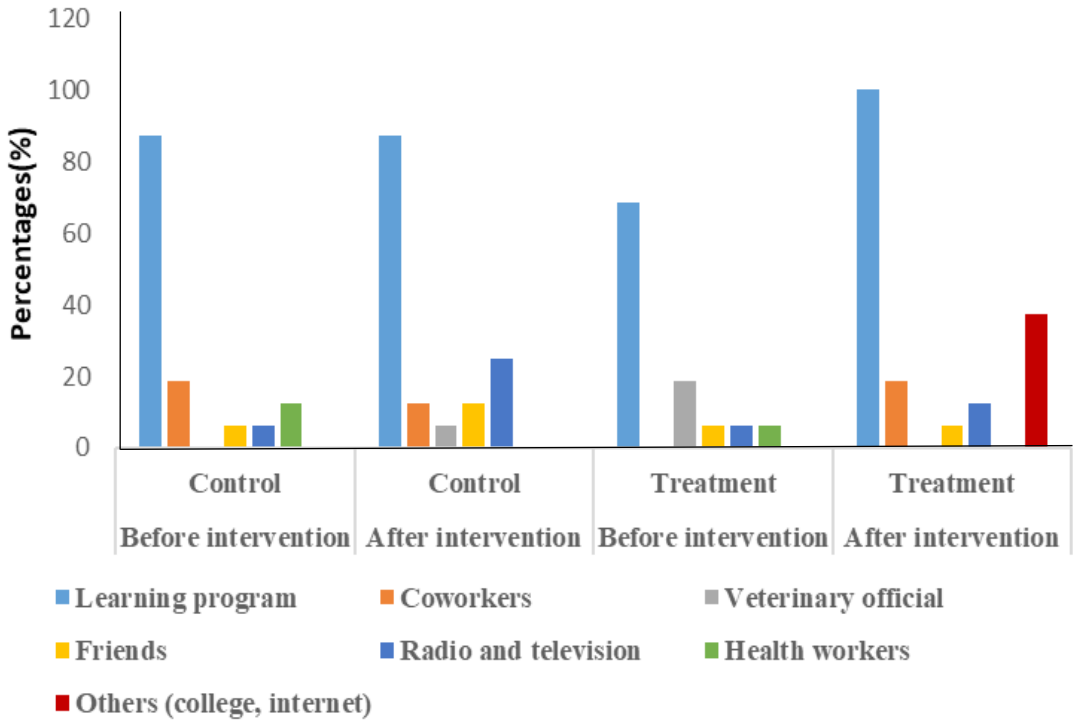

Figure 2: Sources of knowledge regarding brucellosis among healthcare workers in pastoral communities

Table 3: Healthcare workers knowledge regarding brucellosis in pastoral communities

	Control, n=16			Treatment, n=16		
Parameter	**Before, (n %)**	**After, (n %)**	**P-value**	**Before, (n%)**	**After, (n %)**	**P-value**
Heard about brucellosis	15(93.8)	15(93.8)	1.000	15(93.8)	16(100.0)	1.000
Causative agent being *Brucella* spp	7(43.8)	11(68.8)	0.285	8(50.0)	11(68.8)	0.478
Does not know the causative agent	9(56.3)	5(31.3)	0.285	8(50.0)	5(31.3)	0.478
Transmission route						
Brucellosis can affect ruminants	14(87.5)	15(93.5)	1.000	15(93.5)	16(100.0)	1.000
Brucellosis can affect human	15(93.5)	15(93.5)	1.000	15(93.5)	16(100.0)	1.000
Brucellosis can be transmitted from cattle to human	14(87.5)	15(93.5)	1.000	14(87.5)	16(100.0)	0.484
Brucellosis can be transmitted from sheep/goat to human	11(68.8)	14(87.5)	0.394	12(75.0)	16(100.0)	0.101
Contact with aborted fetus/placenta can lead to brucellosis	10(62.5)	12(75.0)	0.704	9(56.3)	16(100.0)	0.007**
Brucellosis can be transmitted through inhaling aerosolized bacteria	0(0.0)	3(18.8)	0.22	9(56.3)	16(100.0)	0.007**
Eating not well-cooked meat can lead to brucellosis	14(87.5)	15(93.5)	1.000	14(87.5)	16(100.0)	0.484
Clinical features in human						
Undulant fever	14(87.5)	15(93.5)	1.000	12(75.0)	16(100.0)	0.101
Fatigue	5(31.3)	13(81.2)	0.011*	9(56.3)	16(100.0)	0.007**
Loss of appetite	10(62.5)	12(75.0)	0.704	11(68.8)	16(100.0)	0.043
Joint pain	15(93.5)	14(87.5)	1.000	12(75.0)	15(93.5)	0.333
Headache	14(87.5)	14(87.5)	1.000	12(75.0)	16(100.0)	0.101
Abortion	6(37.5)	8(50.0)	0.722	10(62.5)	15(93.5)	0.083
Brucellosis Diagnosis						
History of fever	12(75.0)	14(87.5)	0.654	8(50.0)	16(100.0)	0.002
Patient's history of exposure to animal products	13(81.3)	14(87.5)	1.000	13(81.3)	16(100.0)	0.226
Serological test	10(62.5)	11(34.4)	1.000	9(56.3)	10(62.5)	1.000
Culture technique	12(75.0)	13(81.3)	1.000	8(50.0)	9(56.3)	1.000
Brucellosis prevention						
Drinking boiled milk	15(93.5)	15(93.5)	1.000	14(87.5)	16(100.0)	0.484
Eating cooked meat	15(93.5)	15(93.5)	1.000	15(93.5)	15(93.5)	1.000
Control of brucellosis in human depend on disease control in animals	15(93.5)	15(93.5)	1.000	14(87.5)	16(100.0)	0.484
Wearing gloves when handling aborted materials	14(87.5)	15(93.5)	1.000	14(87.5)	16(100.0)	0.484
Wash hands after contact with animals and/ their products	13(81.3)	15(93.5)	0.6	14(87.5)	16(100.0)	0.484
Proper disposal of infected materials	14(87.5)	16(100.0)	0.484	14(87.5)	16(100.0)	0.484

***Chi-square test significance at <5 %, **< 1%**

4.3 Healthcare workers' diagnosis and reporting practices of brucellosis in treatment and control pastoral communities

There was a highly significant difference between healthcare workers in treatment group than control group after the training. HWs in treatment group were found more effective on diagnosis and reporting of brucellosis cases in their facilities after training than the control group. Mobile phone technology was well adapted in reporting of cases and receiving of feedback as presented in (Table 5).

Table 4: Healthcare workers' practices in diagnosis and reporting of brucellosis before and after intervention in treatment and control pastoral communities

		Control, n=16			Treatment, n=16		
Healthcare workers	**Response**	**Before, n(%)**	**After, n(%)**	**P-value**	**Before, n(%)**	**After, n(%)**	**P-value**
Do you advice patients for testing brucellosis?	Yes/	0(0.0)	7(43.8)	0.007	4(25.0)	15(93.8)	0.000
How frequent do you consider brucellosis during diagnosis of febrile conditions	rarely	1(6.3)	4(25.0)	0.172	5(31.3)	11(68.8)	0.006
	frequently	1(6.3)	0(0.0)		0(0.0)	3(18.8)	
Do you perform any test for diagnosis of brucellosis?	yes	0(0.0)	0(0.0)		0(0.0)	15(93.8)	0.000
Which sample is used for brucellosis diagnosis	blood sample	6(37.5)	6(37.5)	1.000	0(0.0)	9(56.25)	0.001
Do you have reagents for testing brucellosis?	yes	0(0.0)	0(0.0)		0(0.0)	16(100.0)	0.000
What is the name of the reagent?	Rose Bengal	0(0.0)	0(0.0)		0(0.0)	13(81.3)	0.000
Do you refer samples elsewhere for brucellosis testing?	yes	0(0.0)	0(0.0)		0(0.0)	14(87.5)	0.000
If the answer is yes, where do you refer?	SUA	0(0.0)	0(0.0)		0(0.0)	14(87.5)	0.000
Do you receive feedback after referring samples?	yes	0(0.0)	0(0.0)		0(0.0)	14(87.5)	0.000
How often you receive feedback?	Within a day	0(0.0)	0(0.0)		0(0.0)	0(0.0)	0.000
	2-3 days	0(0.0)	0(0.0)		0(0.0)	0(0.0)	
	4-7 days	0(0.0)	0(0.0)		0(0.0)	3(18.8)	
	1-2 weeks	0(0.0)	0(0.0)		0(0.0)	6(37.5)	
	3-4 weeks	0(0.0)	0(0.0)		0(0.0)	3(18.8)	
	>month	0(0.0)	0(0.0)		0(0.0)	2(12.5)	
Which means do you use to communicate the feedback	Phone calls/sms	0(0.0)	0(0.0)		0(0.0)	1(6.3)	0.000
	Collected physically on paper	0(0.0)	0(0.0)		0(0.0)	0(0.0)	
	Digital technology	0(0.0)	0(0.0)		0(0.0)	13(81.3)	
Do you communicate results to	yes	0(0.0)	0(0.0)		0(0.0)	13(81.3)	0.000

patients?							
Which means do you use to communicate results to patients	Phone calls/sms	0(0.0)	0(0.0)		0(0.0)	12(75.0)	0.000
	Collected physically on paper	0(0.0)	0(0.0)		0(0.0)	2(12.5)	
	Digital technology	0(0.0)	0(0.0)		0(0.0)	0(0.0)	
Presence of guidelines for brucellosis testing	yes	0(0.0)	3(18.8)	0.226	2(12.5)	16(100.0)	0.000

4.4 Healthcare workers' attitude on brucellosis prevention and control in pastoral communities

Attitude of the majority of the healthcare workers in treatment group were found to increase compared to the control group after the intervention but the difference was not significant (Table 5).

Table 5: Healthcare workers' attitude on brucellosis prevention in pastoral communities

	Control, N=16			Treatment, N=16		
HWs' Attitude	**Before, n(%)**	**After, n(%)**	**P-value**	**Before, n(%)**	**After, n(%)**	**P-value**
Brucellosis is important in Tanzania	14(87.5)	14(87.5)	1.000	15(93.8)	16(100.0)	1.000
Brucellosis affects mostly pastoral communities	14(87.5)	14(87.5)	1.000	14(87.5)	15(93.8)	1.000
Brucellosis can be cured	14(87.5)	14(87.5)	1.000	14(87.5)	15(93.8)	1.000
Inadequate knowledge led to misdiagnosis of brucellosis	15(93.8)	15(93.8)	1.000	15(93.8)	16(100.0)	1.000
Collaboratory strategy with both sectors can prevent brucellosis	15(93.8)	15(93.8)	1.000	15(93.8)	16(100.0)	1.000
Use of guidelines/references can enhance detection of brucellosis	15(93.8)	15(93.8)	1.000	15(93.8)	16(100.0)	1.000
Engage CHWs can enhance quick detection	15(93.8)	15(93.8)	1.000	15(93.8)	16(100.0)	1.000
Public awareness is important for prevention of disease	14(87.5)	14(87.5)	1.000	15(93.8)	16(100.0)	1.000
Mobile phone enhances early detection and quick reporting of results	14(87.5)	14(87.5)	1.000	15(93.8)	16(100.0)	1.000

4.5 Correlation between pre- and post-intervention on knowledge, attitude and practice for the healthcare workers

A paired-samples t-test was conducted to compare the mean score of knowledge, attitude and practice of the treatment group and control group of the healthcare workers, before

the intervention and after the intervention. There was a significant correlation between mean of practice (p=0.016) and attitude (p=0.006) scores (Table 6). Also, there was a significant increase in knowledge scores (p=0.003), practice score (.000) and attitude score (p=0.032) (Table 7).

Table 6: A paired samples correlations between pre- and post-intervention knowledge, attitude and practice scores of the healthcare workers

Variable	Pair	N	Correlation	P-value
Knowledge	Pre-intervention knowledge vs post intervention knowledge scores	32	-.175	.337
Practice	Pre-intervention practice vs post intervention practice scores	32	.422	.016*
Attitude	Pre- intervention attitude vs post intervention attitude scores	32	.479	.006*

Table 7: A paired samples difference between pre- and post-intervention knowledge, attitude and practice scores of the healthcare workers

	Variable	Mean	N	SD	S. E	T-test	df	P-value
Knowledge	Pre-intervention knowledge vs post intervention knowledge scores	-0.144	32	0.254	0.045	-3.2	31	.003*
Practice	Pre-intervention practice vs post intervention practice scores	-0.109	32	0.13	0.023	-4.74	31	.000***
Attitude	Pre- intervention attitude vs post intervention attitude scores	-0.034	32	0.087	0.015	-2.25	31	.032*

***Significance at <5%, **<1 %, ***< 0.1%**

4.6 Association between socio demographic characteristics and knowledge, practice and attitude mean score (pre- and post-intervention) about brucellosis in treatment and control pastoral communities

There was a significant difference in knowledge about brucellosis among HWs with work experience ranged between 0 and 20 years than those with more years of experience *(p=0.004)*. A significant difference in knowledge was also found in HWs with college education compare to those with secondary education (*p=0.004)* and with those with less

than a year to five years' experience in working station than those with more than five years *(p=0.002)* (Table 8).

Table 8: Association between HWs' socio demographic characteristics and knowledge, practice and attitude mean scores in pre and post intervention about brucellosis in pastoral communities

	Knowledge score		Practice score		Attitude score	
Variable	**Pre intervention**	**Post intervention**	**Pre intervention**	**Post-intervention**	**Pre intervention**	**Post intervention**
Sex	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
Female	0.73±0.13	0.84±0.1	0.1±0	0.19±0.15	0.95±0.08	0.98±0.05
Male	0.74±0.24	0.91±0.09	0.1±0.06	0.23±0.13	0.95±0.11	0.97±0.05
P-value	0.854	0.053*	0.834	0.503	0.919	0.684
Age in years						
21-30	0.77±0.09	0.89±0.01	0.12±0.04	0.3±0.1	0.99±0.04	0.95±0.09
31-40	0.67±0.26	0.89±0.09	0.09±0.03	0.2±0.13	0.92±0.1	0.98±0.03
41-50	0.86±0.05	0.89±0.12	0.12±0.04	0.2±0.17	0.94±0.09	1±0
>50	0.6±0.52	0.9±0.14	0.1±0.06	0.2±0.14	0.87±0.23	1±0
P-value	0.255	0.988	0.011*	0.446	0.175	0.254
Education level						
Secondary	0.52±0.43	0.97±0.05	0.1±0.04	0.2±0.14	0.97±0.08	1±0
College	0.79±0.09	0.87±0.1	0.1±0.1	0.2±0.21	0.94±0.1	0.98±0.05
P-value	0.004**	.121	0.907	0.569	0.593	0.533
Position						
Medical doctor	0.8±0	0.85±0.07	0.1±0	0.4±0.07	0.95±0.07	1±0
Medical officer	0.67±0.06	0.1±0.06	0.1±0	0.2±0.12	0.9±0.1	0.9±0.1
Medical Assistant	0.74±0.21	0.88±0.09	0.1±0.02	0.2±0.12	0.94±0.09	0.98±0.05
Nurse	0.71±0.32	0.87±0.15	0.1±0.08	0.2±0.19	0.94±0.15	1±0
Laboratory technicians	0.83±0.12	0.87±0.06	0.2±0.06	0.3±0.17	1±0	1±0
P-value	0.900	0.660	0.194	0.408	0.835	0.065
Length of stay in position(years)						
0-10	0.78±0.09	0.89±0.09	0.1±0.03	0.2±0.12	0.97±0.07	0.98±0.06
11-20	0.5±0.41	0.88±0.08	0.06±0.05	0.1±0.14	0.92±0.1	0.98±0.04
21-30	0.9±0	0.77±0.15	0.1±0.1	0.3±0.2	0.87±0.23	1±0
P-value	0.004**	.107	0.099	0.081	0.189	0.809
Working experience in workstation(years)						
Less than a year	0.4±0.46	0.88±0.13	0.05±0.06	0.25±0.17	1±0	0.9±0.12
1-5 years	0.79±0.11	0.89±0.11	0.11±0.04	0.21±0.15	0.93±0.1	0.99±0.03
>5 years	0.8±0	0.86±0.07	0.1±0	0.2±0.12	1±0	1±0
P-value	0.002**	0.634	0.048*	0.849	0.352	0.002**

*** ANOVA test Significant difference at p. value<5 %, **< 1%**

4.7 Community health workers' knowledge regarding brucellosis in pastoral communities

Knowledge of community health workers on transmission, clinical signs in human and animals and preventive measures regarding brucellosis increased significantly in treatment group after intervention (Table 9). The main source of knowledge reported by majority of CHWs before and after intervention in both communities was friends (Figure 3).

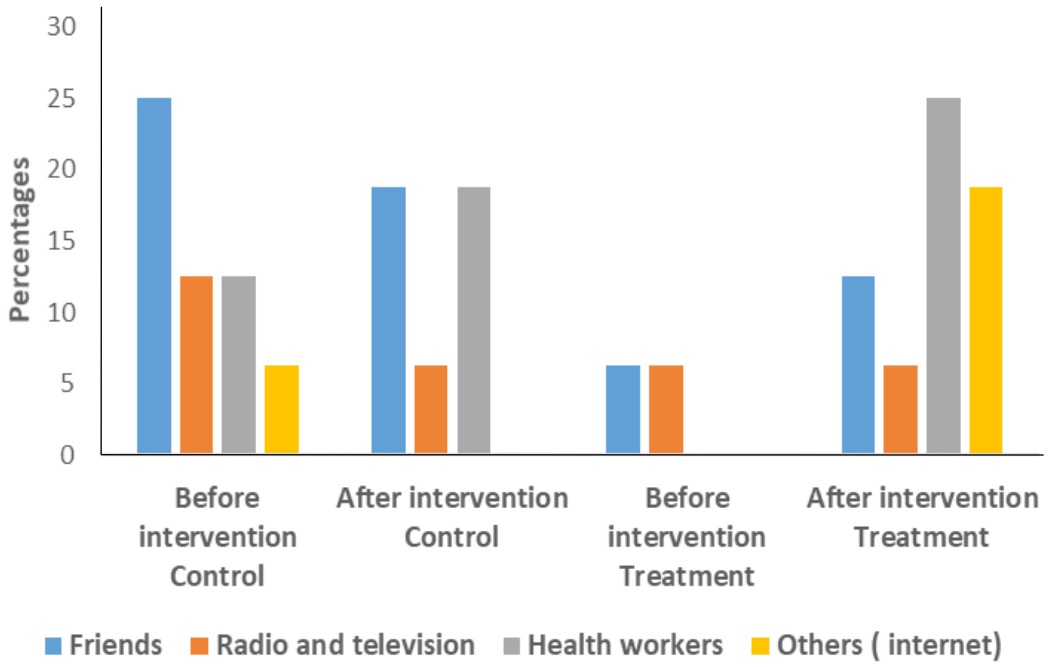

Figure 3: Sources of knowledge regarding brucellosis among community health workers before and after intervention in control and treatment pastoral communities

Table 9: Community health workers in knowledge regarding brucellosis in treatment and control pastoral communities

	Control, n=16			Treatment, n=16		
Parameter	**Before, (n%)**	**After, (n%)**	**P-value**	**Before, (n%)**	**After, (n%)**	**P-value**
Heard of brucellosis	7(43.8)	7(43.8)	1.000	2(12.5)	8(50.0)	0.054
Don't know of brucellosis	9(56.2)	9(56.2)	1.000	14(87.5)	8(50.0)	0.054
Transmission						
Brucellosis can affect ruminants	3(18.8)	4(25.0)	1.000	1(6.3)	9(56.2)	0.006
Brucellosis can affect human	3(18.8)	4(25.0)	1.000	1(6.3)	8(50.0)	0.015
Brucellosis can be transmitted from cattle to human	3(18.8)	4(25.0)	1.000	2(12.5)	8(50.0)	0.054
Brucellosis can be transmitted from sheep/goat to human	4(25.0)	4(25.0)	1.000	1(6.3)	8(50.0)	0.015
Drinking unpasturalized/raw milk can lead to brucellosis	3(18.8)	4(25.0)	1.000	2(12.5)	8(50.0)	0.054
Contact with aborted fetus/placenta can lead to brucellosis	2(12.5)	5(31.2)	0.394	2(12.5)	8(50.0)	0.054
Eating not well-cooked meat can lead to brucellosis	3(18.8)	5(31.2)	0.685	1(6.3)	8(50.0)	0.015
Sexual transmission in human can lead to brucellosis	1(6.2)	1(6.2)	1.000	1(6.3)	8(50.0)	0.015
Brucellosis can be transmitted through inhaling aerosolized bacteria	3(18.8)	4(25.0)	1.000	0(0.0)	3(18.8)	0.226
Brucellosis can be transmitted through skin breaks/ mucous membranes	2(12.5)	4(25.0)	0.654	1(6.2)	4(25.0)	0.333
Clinical features in human						
Undulant fever	1(6.3)	5(31.2)	0.172	2(12.5)	6(37.5)	0.22
fatigue	2(12.5)	3(18.8)	1.000	1(6.3)	8(50.0)	0.015
sweating	3(18.8)	5(31.2)	0.685	2(12.5)	8(50.0)	0.054
Appetite loss	2(12.5)	3(18.8)	1.000	1(6.3)	6(37.5)	0.083
Joint pain	3(18.8)	3(18.8)	1.000	1(6.3)	6(37.5)	0.083
Back pain	3(18.8)	4(25.0)	1.000	1(6.3)	8(50.0)	0.015
Weight loss	3(18.8)	3(18.8)	1.000	0(0.0)	8(50.0)	0.002
Abortion	3(18.8)	3(18.8)	1.000	2(12.5)	6(37.5)	0.22
Swollen lymph nodes	3(18.8)	3(18.8)	1.000	0(0.0)	7(43.8)	0.007
Clinical features in animals						
Abortion	2(12.5)	5(31.2)	0.394	2(12.5)	9(56.2)	0.023
Stillbirth	0(0.0)	3(18.8)	0.226	2(12.5)	9(56.2)	0.023
Retained placenta	3(18.8)	5(31.2)	0.685	1(6.2)	7(43.8)	0.037
Swelling mammary glands	3(18.8)	3(18.8)	1.000	1(6.2)	7(43.8)	0.037
Reduced milk production	2(12.5)	4(25.0)	0.654	1(6.3)	9(56.2)	0.006
Death of young animal	3(18.8)	4(25.0)	1.000	2(12.5)	7(43.8)	0.113
Loss of appetite	3(18.8)	6(37.5)	0.433	2(12.5)	8(50.0)	0.054
Weight loss	2(12.5)	5(31.2)	0.394	2(12.5)	8(50.0)	0.054
Fever	2(12.5)	5(31.2)	1.394	1(6.2)	7(43.8)	0.037
Swollen lymph nodes	2(12.5)	2(12.5)	1.000	0(0.0)	7(43.8)	0.007
Brucellosis prevention						
Drinking boiled milk	2(12.5)	5(31.2)	1.394	2(12.5)	6(37.5)	0.22
Eating Cooked meat	3(18.8)	3(18.8)	1.000	0(0.0)	7(43.8)	0.007
Control brucellosis in Human depend on controlling in animals	3(18.8)	5(31.2)	0.685	2(12.5)	8(50.0)	0.054
Wearing gloves when handling aborted materials	3(18.8)	5(31.2)	0.685	2(12.5)	8(50.0)	0.054
Hands wash after close contact with animals and/their products	2(12.5)	2(12.5)	1.000	1(6.3)	5(31.2)	0.172
Proper disposal of infected materials	2(12.5)	5(31.2)	1.394	2(12.5)	8(50.0)	0.054

4.8 Community health workers' practices in detection and reporting of brucellosis in treatment and control pastoral communities

Significant increase was found in community health workers from treatment group who were providing advice for farmers/livestock keepers on testing for brucellosis (p=0.018) and those who were keeping records of brucellosis cases in human after intervention (p=0.018) (Table 10).

Table 10: Community health workers' pre and post practices in reporting and detection of brucellosis in treatment and control pastoral communities

Community health workers		Control, N=16			Treatment, N=16		
	Response	Before (n%)	After (n%)	p-value	Before (n %)	After (n%)	p-value
Do you provide advice for farmers for testing brucellosis	yes	2(12.5)	4(25.0)	0.654	0(0.0)	6(37.5)	0.018
Do you keep records for brucellosis cases in human	yes	0(0.0)	1(6.3)	1.000	0(0.0)	5(31.5)	0.018
*If yes which materials used for recording							
	Phone	0(0.0)	1(6.3)		0(0.0)	0(0.0)	
	Recording form	0(0.0)	1(6.3)		0(0.0)	3(18.8)	
	Notebook	0(0.0)	0(0.0)		0(0.0)	2(12.5)	
Do you submit report	yes	1(6.3)	2(12.5)	1.000	0(0.0)	2(12.5)	0.484
Frequency of report submission of human cases to higher level	weekly	0(0.0)	1(6.3)	0.484	0(0.0)	2(12.5)	0.484
	monthly	0(0.0)	2(12.5)		0(0.0)	0(0.0)	
Which means you use to submit report to higher level	digital technology	0(0.0)	1(6.3)	1.000	0(0.0)	1(6.3)	0.226
	Physical visitation	1(6.3)	0(0.0)		0(0.0)	1(6.3)	
	Special form	1(6.3)	1(6.3)		0(0.0)	1(6.3)	
How long it takes to receive feedback from the higher levels	within a day	0(0.0)	1(6.3)	1.000	0(0.0)	0(0.0)	0.226
	2to 3 days	0(0.0)	0(0.0)		0(0.0)	1(6.3)	
	2 to 2 weeks	0(0.0)	1(6.3)		0(0.0)	0(0.0)	
	more than a month	0(0.0)	0(0.0)		0(0.0)	2(12.5)	
Which means are used to transmit feedback from higher level	physical visitation	0(0.0)	2(12.5)	0.484	0(0.0)	2(12.5)	0.484
	phone call	0(0.0)	0(0.0)		0(0.0)	1(6.3)	
How do you communicate feedback to the patients	phone call	0(0.0)	0(0.0)	1.000	0(0.0)	0(0.0)	0.484
	physical visitation	1(6.3)	2(12.5)		0(0.0)	2(12.5)	

***Response based on multiple choice**

4.9 Community health workers' attitude on brucellosis prevention and control in treatment and control pastoral communities

A significant increase in attitude level was found in treatment group after intervention. In control group there was an increase of attitude level after the intervention but it was not significant (Table 11).

Table 11: Community health workers before and after intervention attitude on brucellosis in treatment and control pastoral communities

CHWs' Attitude	Control, N=16			Treatment, N=16		
	Before, n(%)	After, n(%)	P-value	Before, n(%)	After, n(%)	P-value
Brucellosis is important in Tanzania	4(25.0)	7(43.8)	0.458	2(12.5)	7(43.8)	0.113
Brucellosis affect pastoral mostly communities	5(31.3)	7(43.8)	0.716	2(12.5)	8(50.0)	0.054
Brucellosis can be cured	4(25.0)	4(25.0)	1.000	2(12.5)	8(50.0)	0.054
Inadequate knowledge led to misdiagnosis of brucellosis	5(31.3)	7(43.8)	0.716	2(12.5)	8(50.0)	0.054
Collaboration strategy with both sectors can prevent brucellosis	5(31.3)	7(43.8)	0.716	2(12.5)	8(50.0)	0.054
Use of guidelines/references materials enhance proper diagnosis and management of brucellosis	6(37.5)	8(50.0)	0.722	2(12.5)	8(50.0)	0.054
Engage CHW enhances quick detection	6(37.5)	7(43.8)	1.000	2(12.5)	7(43.8)	0.113
Public awareness is important for prevention of disease	6(37.5)	8(50.0)	0.722	2(12.5)	8(50.0)	0.054
Mobile phone enhances early detection and quick reporting of results	6(37.5)	7(43.8)	1.000	2(12.5)	8(50.0)	0.054

4.10 Correlation between pre- and post-intervention knowledge, attitude and practice for the community health workers

A paired-samples t-test was conducted to compare the mean score of knowledge, attitude and practice of the treatment group and control group of the CHWs, before the

intervention and after the intervention. A significant correlation was found between means of knowledge (p=0.003), practice (p=0.004) and attitude (p=0.000) scores (Table 12). There was a significant increase in knowledge (p=0.000), practice (p=0.001) and attitude (p=0.000) scores after the intervention (Table 13).

Table 12: Paired samples correlations between pre- and post-intervention knowledge, attitude and practice scores of the community health workers

	Variable	N	Correlation	P-value
Knowledge	pre-intervention knowledge vs post intervention knowledge scores	32	.505	.003**
Practice	pre-intervention practice vs post intervention practice scores	32	.491	.004**
Attitude	pre-intervention attitude vs post intervention attitude scores	32	.442	.011*

Table 13: Paired samples difference between pre- and post-intervention knowledge, attitude and practice scores of the community health workers

Variable	N	Mean	SD	S. E	t-test	df	P-value
Pre-intervention knowledge vs post intervention knowledge scores	32	-0.441	0.282	0.05	-8.85	31	.000***
Pre-intervention practice vs post intervention practice scores	32	-0.163	0.26	0.046	-3.54	31	.001***
Pre- intervention attitude vs post intervention attitude scores	32	-0.216	0.167	0.029	-7.31	31	.000***

***Significance at <5 %, **< 1%, ***<0.1%**

4.11 Association between CHWs' socio demographic characteristics and knowledge, practice and attitude mean scores in pre and post intervention regarding brucellosis in treatment and control pastoral communities

There was significant increase in knowledge in CHWs with less than a year compared to those with more than one year experience in working station (p=0.006). A significant

difference in attitude was observed in CHWs with age group between 21-30 and 31-40 years than other age groups (p=0.031) (Table 14).

Table 14: Association between community health workers' socio demographic characteristics and knowledge, practice and attitude mean scores in pre and post intervention regarding brucellosis in treatment and control pastoral communities

	Knowledge score		Practice score		Attitude score	
Variable	**Pre intervention**	**Post intervention**	**Pre intervention**	**Post-intervention**	**Pre intervention**	**Post intervention**
Sex	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
Female	0.39±0.35	0.71±0.18	0.09±0.24	0.3±0.39	0.51±0.03	0.75±0.18
male	0.21±0.31	0.7±0.15	0.01±0.04	0.15±0.23	0.53±0.15	0.73±0.18
P-value	0.209	0.880	0.135	0.174	0.679	0.859
Age in years						
21-30	0.65±0.07	0.74±0.21	0±0	0.2±0.28	0.3±0.42	0.8±0.28
31-40	0.36±0.34	0.74±0.2	0.02±0.06	0.13±0.15	0.54±0.1	0.78±0.19
41-50	0.16±0.28	0.7±0.15	0.01±0.03	0.25±0.29	0.56±0.09	0.75±0.18
>50	0.21±0.34	0.66±0.13	0.09±0.25	0.21±0.42	0.5±0	0.68±0.17
P-value	0.185	0.691	0.602	0.881	0.031*	0.647
Education level						
No formal education	0.26±0.46	0.7±0.17	0.27±0.46	0.33±0.49	0.5±0	0.73±0.23
Incomplete primary	0.7±	0.9±	0±0	0.4±	0.6±	1±
Primary	0.24±0.31	0.69±0.15	0.02±0.05	0.2±0.3	0.51±0.14	0.71±0.17
Secondary	0.28±0.38	0.74±0.19	0±0	0.08±0.17	0.58±0.08	0.8±0.2
P-value	0.607	0.577	0.031*	0.624	0.624	0.378
Length of stay in position (years)						
0-10	0.4±0.33	0.72±0.16	0.02±0.06	0.19±0.23	0.49±0.18	0.8±0.19
11-20	0.1±0.26	0.7±0.17	0.01±0.04	0.2±0.4	0.5±0	0.67±0.15
21-30	0.21±0.29	0.67±0.15	0±0	0.16±0.29	0.59±0.13	0.71±0.16
31-40	0.25±0.39	0.72±0.18	0.15±0.32	0.27±0.36	0.52±0.04	0.73±0.21
P-value	0.25	0.946	0.215	0.939	0.381	0.504
Working experience in workstation(years)						
Less than a year	0.4±0.35	0.97±0.06	0±0	0.3±0.26	0.5±0	0.9±0.17
1-5 years	0.25±0.33	0.68±0.16	0.02±0.06	0.19±0.33	0.55±0.08	0.74±0.19
>5 years	0.25±0.34	0.67±0.13	0.06±0.2	0.19±0.29	0.51±0.16	0.71±0.17
P-value	0.757	0.006**	0.63	0.839	0.668	0.234

*** ANOVA test Significant difference at p. value<0.05, **<1%**

4.12Awareness on other zoonotic diseases

4.12.1 Healthcare workers' awareness on other zoonotic diseases in treatment and control pastoral communities

All HWs (100%) were found to have heard about Rabies in all communities. Good awareness was reported on other zoonoses except for Echinococcosis and Cryptosporidiosis (Figure 4).

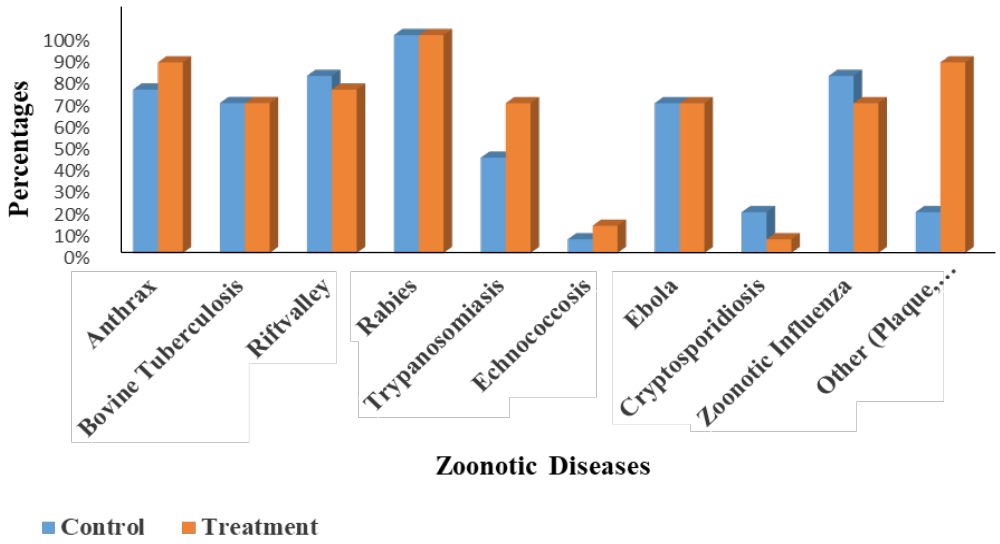

Figure 4: Awareness of healthcare workers on other zoonotic diseases in treatment and control pastoral communities

4.13.2 Community health workers' awareness on other zoonotic diseases

All CHWs (100%) and 14(87.5%) in control and treatment communities reported to have heard about Rabies respectively. None of the CHWs in both communities reported to have heard or seen cases of Echinococcosis and Cryptosporidiosis (Figure 5).

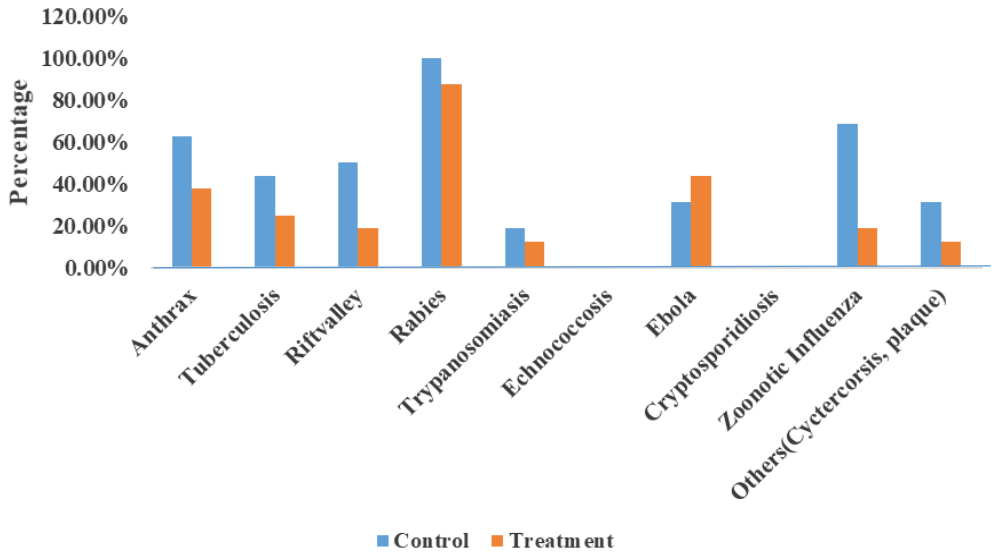

Figure 5: Community health workers' awareness on other zoonotic diseases in treatment and control pastoral communities

4.13 Brucellosis seropositivity in febrile patients in treatment pastoral communities

A total of 141 serum samples from patients with febrile symptoms were screened by RBPT, where by 17(12.1%) were positive and confirmed by c-ELISA, in which four (2.8%) were positive in the selected ward health facilities.

4.14.1 Brucellosis cases reported through electronic tool

A total of 141 brucellosis suspected cases were reported in four consecutive months in treatment group using *AfyaData app* from May to September 2020 in patients with febrile illnesses seeking health care. Only six (4.3%) cases were reported by the CHWs using referred forms. Most of the cases were from Kimamba health facility 28(19.9%). More than half, 93(66.0%) of the reported cases were from females. The age of the patients ranged from 2 to 80 years with average of 37(±1.59) years. Half of the patients who were seropositive (50.0%) were from Msowero health facility. Cases from Rudewa were more likely to be *Brucella* positive *(p=0.0003)* (Table 15).

Table 15: The proportions of subject and seropositivity status in each category of each variable investigated during the study (N=141)

Variable	Categories	Proportion (n%)	Seropositive (RBPT), n (%)	P-value	Seropositive (c-ELISA), n (%)	P-value
Sex	Male	48(34.0)	7(41.2)	0.588	1(25.0)	1.000
	Female	93(66.0)	10(58.8)		3(75.0)	
Age	1-10	15(10.6)	0(0.0)		0(0.0)	
	11-20	23(16.3)	4(23.5)	0.543	1(25.0)	0.711
	21-30	32(22.7)	5(29.4)		0(0.0)	
	31-40	34(24.1)	4(23.5)		2(50.0)	
	>40	37(26.2)	4(23.5)		1(25.0)	
Number of cases in health facility						
	Kimamba	28(19.9)	2(11.8)		0(0.0)	
	Rudewa	6(4.3)	5(29.4)	0.0003*	0(0.0)	0.336
	Msowero	19(13.5)	1(5.9)		2(50.0)	
	Tindiga	2(1.4)	0(0.0)		0(0.0)	
	Dakawa	9(6.4)	0(0.0)		0(0.0)	
	Dumila Dispensary	26(18.4)	1(5.9)		0(0.0)	
	Dumila HC	7(5.0)	1(5.9)		1(25.0)	
	Dodoma Isanga	1(0.7)	0(0.0)		0(0.0)	
	Changarawe	1(0.7)	0(0.0)		0(0.0)	
	Twatwatwa	4(2.8)	0(0.0)		0(0.0)	
	Serengeti kada	2(1.4)	0(0.0)		0(0.0)	

Agape	11(7.8)	5(29.4)	0(0.0)
Chanzuru	10(7.1)	0(0.0)	0(0.0)
China Estate	15(10.6)	2(11.8)	1(25.0)

4.14.2 Observed clinical signs in brucellosis seropositive febrile patients in treatment pastoral community

Recorded clinical signs from febrile patients attending selected health facilities were headache, fever, back pain and joint pain as presented in the (Table 16).

Table 16: Observed clinical symptoms in brucellosis seropositive patients in treatment pastoral community

Clinical signs (n =141)	Frequency	(%)
Headache	80	20.8
Fever	51	13.3
Loss of appetite	24	6.20
Joint pain	38	9.9
Coughing	22	5.7
Body weakness	25	6.5
Vomiting	26	6.8
Abortion	8	2.1
Sweating at night	22	5.7
Back pain	9	2.3
Fatigue	36	9.4
Nausea	11	2.9
Diarrhea	12	3.1
Weight loss	4	1.0
Abdominal pain	7	1.8
Bitter mouth	5	1.3
Muscle pain	4	1.0

CHAPTER FIVE

5.0 DISCUSSION

This study assessed the effect of the training and use of electronic tool *(AfyaData app)* on awareness and reporting for brucellosis to the frontline health workers who are working in the pastoral communities in Tanzania. The study findings showed clearly that the majority of participants had limited knowledge on human brucellosis before the training. But after completion of the training their awareness was improved. Based on their socio characteristics less than half of the HWs had college education while majority of the CHWs had primary education, similar results were found in KAP study for animal health and medical workers conducted in Sudan and northern Uganda (Marin *et al.,* 2017; Narbirye *et al.,* 2017). The low education level of CHWs might have contributed to the low awareness and practices towards management of brucellosis in pastoral communities.

The results revealed that majority of HWs have heard about brucellosis before training, this can be explained by their medical training background, and on job training they went

through in addition to work experience. However, few weren't aware about the causative agent of the disease which may result to misdiagnosis and mismanagement of the disease. These findings are similar to what was reported in northern Tanzania that health workers were informed about the disease but not the causative agent (Kunda *et al.,* 2008). Similarly, Chipwaza *et al.* (2014) reported low awareness to the community and healthcare workers in eastern Tanzania regarding febrile illness like brucellosis. This might be due to neglected nature of the disease hence they didn't pay required attention during their training and therefore a need of refresher workshops to improve their understanding of a disease management. The training significantly improved their understanding regarding brucellosis.

The current study also, revealed that duration at work, education and experience of the HWs had a positive impact on their knowledge about the disease. This might be due training workshops or seminars they participated during their professional work. Although the mean score of knowledge differed with position of the HWs but the difference was not significant. The medical doctors were found to be knowledgeable than nurses and midwives, this may be due to their educational background (Narbirye *et al.,* 2017).

This study revealed good knowledge of HWs on transmission routes, clinical signs, diagnosis, prevention and control of brucellosis before the training intervention, probably acquired through formal training they went through. Majority of HWs correctly mentioned boiling of milk, consumption of well-cooked meat and proper disposal of aborted materials as important means of disease prevention. Furthermore, they pointed out that fever plus history of exposure to animals and animal products can suggest the patient with febrile illness for brucellosis testing. This implies that HWs were aware on the importance of the disease in the area but due to limited access to appropriate tools and

reagents they were unable to perform the brucellosis diagnosis test. These findings are contrary with the KAP study conducted in Sudan which reported participants being unaware of the symptoms and transmission routes of brucellosis in human (Marin *et al.,* 2017).

The main sources of brucellosis knowledge reported among the HWs in this study were learning programs. Other sources mentioned included newspapers, television, radio, veterinarians and health workers. The main source of knowledge of brucellosis for CHWs was the health workers working in the respective village dispensaries and health centers. Also, media and friends were another source of information. As a result, the knowledge of brucellosis did not differ significantly at the community level. These findings were similar to those reported in other studies conducted in different places such as in South Africa and Kenya which found main knowledge sources were veterinarians and health workers (Obonyo, 2015; Cloete *et al.,* 2019), radio, television and newspapers in West and Central Africa (Musallam *et al.,* 2019), and friends or coworkers in Tajikistan and Pakistan (Lindahl *et al.,* 2015; Zhang *et al.,* 2019). The increasing number of local radios and television stations reaching the remote areas could be an opportunity to reach the CHWs and community with information regarding zoonoses as pointed out by some of the participants in this study.

On the other hand, the study revealed low awareness in CHWs regarding brucellosis in both communities before the training intervention. The poor knowledge among CHWs could be attributed to their low level of education and inadequate public health promotion regarding zoonotic diseases. This observation might have affected the detection and management of brucellosis in communities they serve. Similarly low knowledge about the disease and risky practices among the community health workers have been reported in

China and South Africa (Arif *et al.,* 2017; Cloete *et al.,* 2019). Contrary the results on KAP studies of CHWs about brucellosis conducted in Kenya and Uganda (Obonyo, 2015; Kansiime *et al.,* 2015) and Tajikistani (Lindahl *et al.,* 2015) reported higher awareness of CHWs awareness of brucellosis. The mean score of knowledge in pretest and post intervention was high in CHWs with age ranged 21-30 and 31-40 years and also, for women CHWs but the difference was not significant.

The present study also reports improved CHWs knowledge following training intervention. Prior to the training, majority of CHWs were not aware on recommended disease prevention measures like milk boiling, wearing gloves when handling animals and proper disposal of aborted materials. This indicates that the risk of acquiring *Brucella* infection in the community they serve is high due to the fact that the reliable personnel to communicate about the disease were not aware. Similar findings were reported by other studies in Tanzania and Kenya (Karimuribo *et al.,* 2005; Obonyo and Gufu, 2015). Also, in China and South Africa which also reported poor understanding regarding brucellosis and risky practices among the CHWs (Arif *et al.,* 2017; Cloete *et al.,* 2019). Although CHWs plays important role in pastoral communities' health promotion, the findings of this study underscore the importance of training them on zoonotic diseases which in most cases are neglected.

The findings of the present study revealed that the reporting practices of brucellosis before the intervention were very poor in both communities. Participants were not reporting the cases of brucellosis to higher official levels and this may be attributed to the fact that they didn't consider it during diagnosis due to lack of awareness about the disease and required diagnostic facilities. Therefore, it is likely that brucellosis cases were not diagnosed. The absence of disease diagnostic kits at health facilities may

further indicate brucellosis to be neglected in Tanzania as also reported by Chipwaza *et al.* (2014). This observation also can be explained by the reason that health workers are likely concentrating on endemic diseases in their area like malaria as also reported in other studies (Kunda *et al.*, 2008). It was found that mean score of pre practice was significant with HWs age, this means that HWs with age group between 21-30 and 41-50 were found to have high mean score of practice compared to other age groups.

Poor practices were also recorded by the CHWs, majority were found not advising the community/farmers to notify the veterinary unit when their livestock are sick. These findings are contrary to a study conducted in Sweden by Rajala (2016) who found that less than half of participants notify veterinarian about animal health issues. After the intervention the participant's practices were good in treatment pastoral community. The difference between treatment and control pastoral community was significant in almost all practice items. Also, the findings of the current study reported that the mean score of practice was statistically significant with CHWs education in pre-intervention, CHWs with primary education were found to have high mean practice score compare to those with secondary and incomplete primary education, this may be due to the fact CHWs were livestock keepers and they use their local knowledge in brucellosis control. These results are contrary to Narbirye *et al.* (2017) who reported good practice in participants with higher education level.

The results of this study also revealed that the attitude of HWs towards brucellosis control was good before and after the intervention in both communities. It was reported that majority of participants agreed on the fact that inadequate knowledge of the health workers led to misdiagnosis of the disease. Attitude towards use of the brucellosis

guidelines/reference materials to enhance management of brucellosis and engagement of CHWs to improve early detection had showed a great opportunity in improving management of brucellosis in human. The current study found participants to have positive attitude regarding brucellosis before and after the intervention. Similar findings were observed in the studies conducted in Northern Uganda and Sri Lanka for medical and community health workers who reported positive attitude towards brucellosis control (Nabirye *et al.,* 2017; Kothalawala *et al.,* 2018). Contrary, studies in Kenya and South Western Uganda reported community health workers to have poor attitude towards brucellosis control (Obonyo, 2015; Kansiime *et al.,* 2015). It was also observed that CHWs mean score for attitude in pre-intervention viz post-intervention was statistically significant with CHWs' age, CHWs age ranged between 31-40 and 41-50 years were found to have good attitude regarding brucellosis control compare to the youngest and eldest. Also, HWs mean score in post attitude was found to be significant with years of experience in working station. HWs with more years in their working station were found to have high mean score of attitudes after the intervention. Similar findings were found in a study conducted in Egypt on study the effect of teaching program for nurses on quality of care for brucellosis among children who reported an increase in attitude after the intervention to the participants (Afify *et al*., 2020).

Furthermore, this study found that participants' knowledge on other zoonotic diseases was poor. Most of the respondents in both pastoral communities reported to be more aware on Rabies, Anthrax and Rift Valley fever, but poor on Echinococcosis, Cryptosporidiosis and Ebola. Similar observation was made by a study conducted in northern Tanzania (Kunda *et al.,* 2008). This indicates that limited knowledge in any aspect of the disease is the contributing factor for misdiagnosis. Lack of knowledge by

health personnel in any disease manifestation or on how to investigate it may lead to high chances of misdiagnosis.

The results of the current study indicate that the mobile phone reporting application has in revitalized reporting of brucellosis cases in selected wards in Kilosa district. By using this electronic based system (*AfyaData app*), a total of 141 brucellosis suspected cases in human were reported in the first four months in treatment pastoral community. This may be due to the fact that the app was easy to navigate and quick to learn for the HWs. The average time needed for training a HWs to run the system on a mobile phone was less than half an hour and the fact that recording of reports from patients does not require internet connection this makes the process easier and less time consuming. In all the suspected cases presented few patients were referred by CHWs through referral forms. This may due to the majority of CHWs didn't receive the training.

Due to the uncertainty nature of brucellosis clinical signs, diagnosis requires laboratory testing of blood samples using special equipment and trained staffs that are often limited or unavailable in pastoral communities, delaying chances for patient's treatment. The conducted training using One Health approach in the current study to HWs on diagnosis and reporting of brucellosis increased the ability of the participants to diagnose patients with brucellosis and reporting cases via a mobile technology. This has enhanced quick reporting of brucellosis cases which have significant positive impact on brucellosis diagnosis and management. Similar findings were reported in the study conducted in Western Kenya on animals' surveillance, which reported mobile phone-based animal health surveillance system to be an effective tool for reporting of disease events by communities in a rural setting in Africa (Thumbi *et al.,* 2019).

Application of mobile phones and ICT technologies to improve disease reporting and surveillance in public health has been reported in Tanzania for other zoonotic diseases like rabies (Mtema *et al.,* 2016). Also, it has been used in other countries such as, China (Yang *et al.,* 2009), Sri Lanka (Robertson *et al.,* 2010), Zambia, Uganda and Madagascar (Zurovac *et al.,* 2012), and Kenya (Smith *et al.,* 2019). Combining the participatory community based approaches with mobile technology has the potential to support not only early detection of disease events that are happening at the community level but also actual response (Freifeld *et al.,* 2010).

In this study no association was demonstrated in age of the patients and brucellosis positivity, this may be due to small number of febrile patients recruited and majority of them being female of similar age. These findings are similar to other studies which reported lack of association between age with brucellosis positivity (Nguna *et al.,* 2019). Significant association was found in relation to location (ward health facilities) (*p=0.0003*). This clearly indicates that the number of patients with seropositivity in *Brucella* infection was concentrated in certain wards. The high exposure rate was found in Rudewa ward, this may be attributed by the fact that the ward is inhabited with high number of Maasai community whose livelihood depend much on livestock keeping increasing the risk of acquiring brucellosis.

During screening of febrile patients in the selected health facilities it was found that higher seropositive rate/clinical rate was from female patients but the difference was not statistically significant. This can be explained by the fact that in pastoral and most agro-pastoral setup, females do most of the work associated with harvesting of livestock products such as milking, cleaning of livestock houses, and handling of the newly borne calves, which may predispose them to the infection. Furthermore, in African settings, most women attend health facilities and hence possibilities of being diagnosed with

different diseases which may be the case for them having high number of diagnosed brucellosis cases (James, 2013). Similar findings were found in Ngorongoro district in northern Tanzania (Nonga and Mwakapeje, 2017) and also, in Kampala, Uganda (Makita *et al*., 2011). These findings are contrary with the study conducted in Mbeya by Sagamiko *et al.* (2018) who reported zero (0%) seropositivity in females and higher in males, also in Rwanda Nguna *et al.* (2019) reported higher rate in males compared to females. Differences in prevalence rates between the sexes may be attributed to different behavioral attitudes towards livestock handling and preparation of food of animal origin in those communities (Nonga and Mwakapeje, 2017).

The current study also reported major clinical symptoms showed by the patients were headache, fever, joint pain and fatigue. These clinical symptoms are most common in many febrile diseases and they concur with the *Brucella* positive patients who were reported in other studies (James, 2013; Migisha *et al.,* 2018).

Most of the seropositive patients were in age range of 31-40 and above 40 years, these are considered as adults who were associated with livestock keeping hence longer exposure time and higher risk of acquiring brucellosis. Similar results for age were reported in Uganda and Kenya (Makita *et al.,* 2011; Maiyo and Obey, 2016). Another group which was found affected ranged from 11-20 years; these are teenagers who in the pastoralist communities are more associated with herding animals, milking and also assisting animals during delivery. They lack protective gears in handling animals and aborted materials subjecting them in higher risk of contracting brucellosis. Similar results were found in the study conducted in febrile patients in Kenya and northern Tanzania by (Njeru *et al.,* 2016; Bodenham *et al.,* 2020).

The current study also revealed a highly significant correlation between HWs mean scores in pre and post intervention in practice and attitude. Also, a highly significant increase between mean score of pre and post intervention in knowledge, practice and attitude. This indicates that the intervention conducted was effective in improving the knowledge, practices and attitude of the FHWs. Majority of HWs practices improved after intervention, they were found to consider brucellosis during diagnosis, also report the disease cases using the electronic technology and also receive the feedback and communicate them to the patients. This has enabled the quick reporting of the disease cases in the treatment pastoral community and also raised awareness of disease diagnosis while improving their attitude regarding brucellosis prevention and control measures. Increased knowledge, practices and attitudes were similarly observed in studies conducted in Egypt to the nurses and slaughterhouse workers when assessed the effectiveness of health educational program (Abd El-fattah *et al.,* 2017; Afify *et al*., 2020).

Also, mean score of knowledge and attitude regarding brucellosis for CHWs was found to increase significantly after the training. The CHWs were found more knowledgeable on transmission, symptoms and preventive measures of brucellosis. The mean score of practices was reported to increase significantly after the intervention, this implies that CHWs from treatment pastoral communities were advising the farmers to screen their animals for brucellosis and also, they were found to provide referral form to patients with symptoms suggestive of brucellosis. Similar findings were found in the study conducted in Brazil for CHWs, who found participants knowledge, attitude and practice increasing after the intervention (Meloe Lima *et al.*, 2018). The results could provide guidance on formulation of strategies to improve early detection and management of brucellosis in the study districts and other similar settings.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Based on the findings of the present study it is concluded that before the intervention the participants knowledge and practices on brucellosis were low, although they showed good attitude. Meanwhile, training intervention improved participant's knowledge, attitude and practices significantly. Brucellosis was diagnosed in some febrile patients in treatment pastoral community but the prevalence was low. A noted limitation of this study was in the limited and purposively selection of study sites based on brucellosis risk, suggesting that an attempt to generalize the findings should be made with caution.

6.2 Recommendation

i. Refresher programs and seminars should be given to the frontline health workers to raise their awareness on brucellosis and should be monitored and evaluated after being given seminars or new technology.

ii. Frontline health workers should be encouraged to buy and use android powered smartphones where they can access AfyaData app for reporting of infectious diseases and to enable quick response and management of the diseases.

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APPENDICES

Appendix 1: Questionnaire

District name……. Date of interview ……

1. **Facility Details**
   - **1.1.** Name of the facility…….
   - **1.2.** Type of health facility
     - Dispensary
     - Health center
     - Hospital
   - **1.3.** Ward name …….

2. **Participants Details**
   - **2.1.** Name of participant……...
   - **2.2.** Education
     - Primary
     - Secondary
     - College/university
     - No formal education
     - Incomplete primary education
   - **2.3.** Profession
     - Medical assistant (clinical officer)
     - Medical officer
     - Assistant medical officer
     - Medical doctor
     - Other
   - **2.4.** Position
     - Officer in charge
     - Clinician
     - Other
   - **2.5.** Number of months in your position…….
   - **2.6.** Number of months in your work station……

2.7. Sex

- Female
- Male

2.6. Age (years)……

3. General Knowledge On Brucellosis

3.1. Have you heard of a disease called brucellosis?

- Yes
- No

3.2. What organism causes brucellosis ……...

3.3. Where did you get informed about brucellosis?

- Training program
- Co-worker
- Veterinary officials
- Friends
- Radio/Television/newspaper
- Other

4. Brucellosis transmission: On the scale shown, how much do you agree /disagree with the following statements

4.1. Brucellosis affects domestic ruminants (cattle, sheep, and goats)

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.2. brucellosis affects humans

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.3. brucellosis can be transmitted from cattle to humans

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.4. Brucellosis can be transmitted from sheep/goats to humans

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.5. A person could acquire brucellosis by drinking raw/unpasteurized milk

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.6. A person could acquire brucellosis by contact with aborted foetus or placenta

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.7. A person could acquire brucellosis by eating meat, liver or spleen not well cooked

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.8. Sexual transmission of brucellosis can occur in humans

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.9. A person can acquire brucellosis by inhaling aerosolized bacteria

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.10. A person can acquire brucellosis through breaks in the skin or mucous membrane

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.11. A person can acquire brucellosis through blood transfusion from infected person

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

4.12. A person can acquire brucellosis through contact with menstrual blood from the infected person

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5. **Clinical sign and symptoms of brucellosis in human: on the scale shown, how much do you agree /disagree with the following statements. The common clinical signs and symptoms of brucellosis include**

5.1. Continuous or intermittent fever

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.2. fatigue

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.3. sweating

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.4. Loss of appetite

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.5. Muscular and joint pain

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.6. Pain in the back

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.7. Weight loss

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.8. Headache

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.9. coughing

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.10. Swollen lymph nodes

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

5.11. Abortion

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree

- Strongly disagree

5.12. Inflammation of the epididymis and/testicles

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

6. Awareness on Diagnosis of brucellosis: on the scale shown, how much do you agree /disagree with the following statements. Diagnosis of brucellosis can be made through

6.1 history of prolonged at least a week by presence of clinical signs like repeated fever

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

6.2 patient's history of exposure to likely sources of the diseases

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

6.3 serological test

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

6.4 culture technique

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree

- Strongly disagree

7.1 Diagnosis and reporting practices in healthcare workers

7.2 Do you advice clients/patients to get tested for brucellosis

- Yes
- No

7.3 Do you provide any test that can be used to diagnose brucellosis in humans in this facility?

- Yes
- No

7.4 If yes to Qn 7.2 mention the test……

7.5 What human samples do you take for diagnosis of brucellosis?

- Blood
- Cerebrospinal fluid
- Others

7.6 How many cases of brucellosis have you ever suspected in patients who attended this facility during the past 1 month? ……..

7.7 How many cases of brucellosis have you ever confirmed in patients who attended this facility during the past 1 month? …….

7.8 How frequently do you consider brucellosis diagnosis for patients attending this facility?

- Frequently
- Rarely
- None at all

7.9 Do you have test reagents for brucellosis in this facility?

- Yes
- No

7.10 If yes to Qn 7.8, what reagent do you have in place……

7.11 Do you refer samples elsewhere for brucellosis testing?

- Yes
- No

7.12 If you yes to Qn. 7.10, where do you refer …….

7.13 If you refer sample to testing elsewhere, do you get feedback on results

- Yes
- No
- NA

7.14 How long it usually takes to receive resulting from referral point

- Within a day
- 2-3 days
- 4-7 days
- `1-2 weeks
- 3-4 weeks
- >month
- NA

7.15 How do you receive results from referral point?

- Phone calls/sms
- Collected physically on paper
- Digital technology
- Not applicable

7.16 Do you communicate results from referral point to patients?

- Yes
- No

7.17 How do you communicate test result to patients? (1mark)

- Phone calls/sms
- Collected physically on paper
- Digital technology
- Not applicable

7.18 Do you have guidelines for diagnosis and management of brucellosis?

- Yes
- No

7.19 If yes to Qn 7.17, ask to see the guidelines: guidelines seen?

- Yes
- No

8 Detection and Reporting practices in community health workers

8.1. Do you advice /refer patients to visit health facilities when they experience clinical manifestation suggestive of brucellosis?

- Yes
- No

8.2 How do you provide referral to health facility?

- Verbal
- Written
- Do not provide referral

8.3 Do you advise farmers to consult veterinary officers when their animals experience clinical manifestation suggestive of brucellosis?

- Yes
- No

8.4 Do you keep record of suspected brucellosis cases in animals?

- Yes
- No

8.5 Do you keep record of suspected brucellosis cases in human?

- Yes
- No

8.6 Where do you keep record?

- Note book
- Records forms
- Phone
- NA

8.7 How frequently do you submit reports for human cases to higher levels?

- Daily
- Weekly
- Monthly
- Quarterly
- Other
- Not submitting

8.8 How frequently do you submit reports for animal cases to higher levels?

- Daily
- Weekly
- Monthly

- Quarterly
- Other
- Not submitting

8.9 How do you submit reports to higher levels?

- Phone call/sms
- Physical visitation
- Digital technology
- Other

8.10 How long it usually takes to receive feedback from higher level?

- Within a day
- 2-3 days
- 4-7 days
- 1-2 weeks
- 3-4 weeks
- >month
- Never receive feedback

8.11 How do you receive feedback from higher level?

- Phone call/sms
- Physical visitation
- Digital technology
- Other

8.12 How do you communicate feedback to patients/community members?

- Phone call/sms
- Physical visitation
- Digital technology
- Gathering/meeting
- Not communicating

8.13 Have ever receive training on the detection of diseases transmissible between animals and humans?

- Yes
- No

8.14 Do you have guidelines or references materials for detection, recording and submission of clinical manifestation suggestive of brucellosis?

- Yes

- No

8.15 If yes to last Qn; ask to see guidelines/references materials: seen

- Yes
- No

9 **Prevention and control of brucellosis**: **on the scale shown, how much do you agree /disagree with the following statements. Brucellosis can be prevented by:**

9.1. Drinking boiled/pastoralized milk

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

9.2 Eating meat, liver or spleen well cooked

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

9.3 Control of brucellosis in human depends much on control of the disease in animals

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

9.4 Wearing gloves when handling aborted fetuses or placenta

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

9.5 Washing hands after close contact with animals and/their products

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

9.6 Proper disposal of infected materials

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

10 Attitude: on the scale shown, how much do you agree /disagree with the following statements

10.1. **Brucellosis** is an important public health disease in Tanzania

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

10.2 Brucellosis affects mostly the pastoral communities

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

10.3 Brucellosis can be successfully cured

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

10.4 Inadequate knowledge and awareness of brucellosis amongst the FHWs contribute to misdiagnosis of the disease

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

10.5 Brucellosis can be prevented and controlled through collaborative strategy between animal and human sectors

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

10.6 Use of guidelines or references materials can be enhanced appropriate diagnosis and management of brucellosis

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

10.7 Engagement of community health workers in event-based surveillance can enhanced early detection and reporting of brucellosis suspected cases

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

10.8 Public awareness is important for disease prevention and control

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

10.9 Use of mobile phone-based technology can enhance early detection and communication of test results compared with paper-based system

- Strongly agree
- Agree
- Neither agree nor disagree (neutral)
- Disagree
- Strongly disagree

11 What other disease transmissible between animals and humans: are u aware of?

11.1 Anthrax: Awareness

- Yes
- No

11.2 Bovine tuberculosis: awareness

- Yes
- No

11.3 Rift valley: awareness

- Yes
- No

11.4 Rabies: awareness

- Yes
- No

11.5 Trypanosomiasis

- Yes
- No

11.6 Echinococcosis: awareness

- Yes
- No

11.7 Ebola: awareness

- Yes
- No

11.8 Cryptosporidiosis: awareness

- Yes
- No

11.9 Zoonotic influenza: awareness

- Yes
- No
-

Other zoonotic diseases: ……

Appendix 2: Patient questionnaire

Questionnaire number……... Date ……

1. Patient barcode _____Patient name _____
2. Patient age_____ Patient sex_____
3. Ward name_____ Village name_____
4. Patient phone number_____

5. Clinical manifestations

- 1st manifestation_____
- 2nd manifestation_____
- 3rd manifestation_____

6. Do you keep animals? Yes/No

   Which animals do you keep?

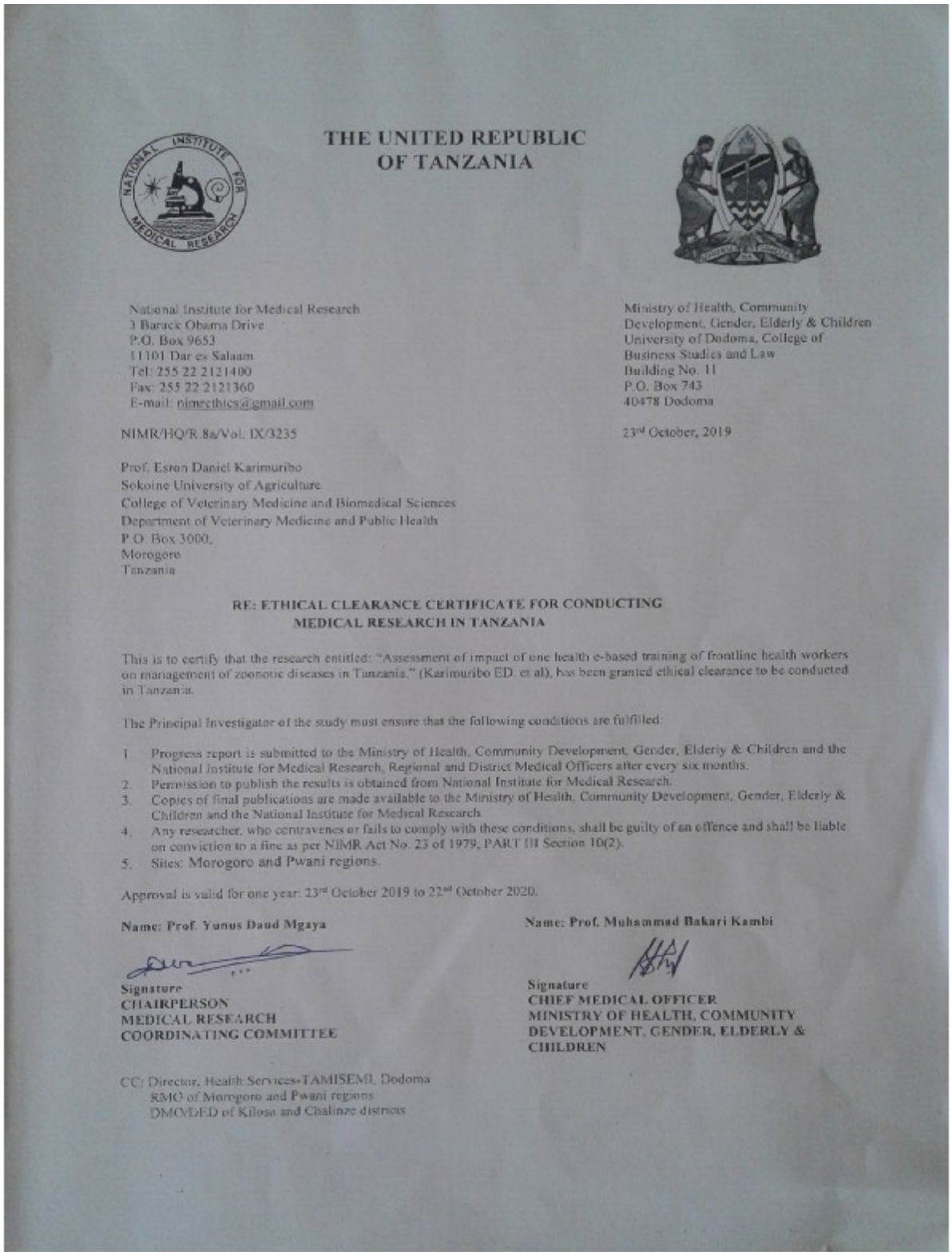
- Cattle Yes/No
- Goat Yes/No
- Sheep Yes/No

7. In the past three months did you

- Consume raw milk Yes/No
- Consume uncooked meat Yes/No
- Directly contact aborted materials Yes/No

8. Referred by CHW Yes/No

Appendix 3: Ethical consideration



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Ministry of Health, Community
Development, Gender, Elderly & Children
University of Dodoma, College of
Business Studies and Law
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40478 Dodoma

NIMR/HQ/R.8a/Vol. IX/3235

23rd October, 2019

Prof. Esron Daniel Karimuribo
Sokoine University of Agriculture
College of Veterinary Medicine and Biomedical Sciences
Department of Veterinary Medicine and Public Health
P.O. Box 3000,
Morogoro
Tanzania

RE: ETHICAL CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH IN TANZANIA

This is to certify that the research entitled: "Assessment of impact of one health e-based training of frontline health workers on management of zoonotic diseases in Tanzania." (Karimuribo ED. et al), 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 and Pwani regions.

Approval is valid for one year: 23rd October 2019 to 22nd October 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 and Pwani regions
DMO/DED of Kilosa and Chalinze districts

Appendix 4: Research permit

THE UNITED REPUBLIC OF TANZANIA

PRESIDENT'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

Telegraphic Address: "REGCOM"
Phones: 023 2604237/2604227

Fax No: 260 09 73
In Reply please quote:

Regional Commissioner's Office,
P. O. Box 650,
MOROGORO.

Ref. No: AB. 175/245/01/219

12th November, 2019

District Administrative Secretaries,
Kilosa.

Re: RESEARCH PERMIT

Please refer to the above mentioned subject.

I am introducing to you a team from Sokoine University of Agriculture (SUA), The National Institute for Medical Research (NIMR) and Southern African Centre for Infectious Diseases Surveillance (SACIDS) foundation for One Health, who are conducting research in our Region.

The names of the researchers are prof. Esron Karimuribo (SUA), Prof. Rudovick Kazwala (SUA), Dr. Leonard E.G Mboera (SACIDS Foundation for One Health), Dr. Calvin Sindato (National Institute for Medical Research), Eng. Eric Beda (SACIDS foundation for one Health), Mr. Mpoki Mwabukusi (SACIDS Foundation for One Health) and Ms. Belinda Mligo.

The title of the research project is **"Assessment of impact of One Health e-based Training of Frontline Health Workers on Management of Zoonotic Diseases in Tanzania"**

The permit is granted from **November, 2019** to **November, 2020** the research will cover Kilosa.

Please provide necessary assistance to enable the accomplishment of the research project.

Thank you for your cooperation.

Jacob A. Kayange
For; Regional Administrative Secretary

Copy: Vice Chancellor
Sokoine University of Agriculture- SUA
P.O. Box 3297
MOROGORO

'Researchers'

Appendix 5: Research permit

JAMHURI WA MUUNGANO WA TANZANIA
OFISI YA RAIS
TAWALA ZA MIKOA NA SERIKALI ZA MITAA

SIMU: "REGCOM COAST"
Simu. 02-2402500.
Fax Na. 02-2402250/2402686/24021
Barua pepe: ras@pwani.go.tz
rhmtpwani@yahoo.com

Ofisi ya Mkuu wa Mkoa,
Mkoa wa Pwani,
S.L.P 30080,
KIBAHA.

Unapojibu tafadhali taja:
Kumb. Na. DCD.128/140/01/109

19/11/2019

Mkurugenzi Mtendaji,

Halmashauri ya Wilaya ya Chalinze,

Pwani.

YAH: UTAFITI WA "ASSESSMENT OF IMPACT OF ONE HEALTH e-BASE TRAINING OF FRONTLINE HEALTH WORKERS ON MANAGEMENT OF ZOONOTIC DISEASES IN TANZANIA"

Tafadhali husika na mada tajwa hapo juu.

Tumepokea barua Kumb.EPF/Vol.1 ya tarehe 11/11/2019 kutoka Chuo Kikuu cha Sokoine Morogoro inayohusu mada hapo juu.

Kibali kimetolewa kwa Utafiti huo kufanyika katika Halmashauri yako na kimeambatanishwa na kibali kutoka NIMR na Wizara ya Afya.

Kwa barua nawatambulisha Wataalamu kutoka Taasisi mbali mbali za utafiti watakaoshiriki katika utafiti uliotajwa hapo juu, kama ilivyo katika barua yao ya maombi ilivyopokelewa.

Dr. Gunini Kamba

Kny: KATIBU TAWALA MKOA

PWANI