PREVALENCE AND FACTORS ASSOCIATED WITH BRUCELLOSIS AMONG COMMUNITY MEMBERS IN MANDERA COUNTY, KENYA

ABDIRAHMAN S. ABDALLA (BVM)
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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University or any other award.

Signature …… Date……

AbdirahmanS. Abdalla
(Q57/CTY/PT/25167/2011)
Department of Community Health

SUPERVISORS

We confirm that the work reported in this thesis was carried out by candidate under our supervision as University Supervisors.

Signature…….. Date……

Dr. Justus O. S. Osero
Department of Community Health
Kenyatta University

Signature……Date……

Dr. Peterson N. Warutere
Department of Environment and Population Health
Kenyatta University

DEDICATION

I dedicate this work to my wife Bishara Abdi Hussein and my two children Abdikhaliq Abdalla and Ayan Abdalla

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OPERATIONAL DEFINITION OF TERMS

Associated factors: are variables that can be linked to an increased risk of disease infection.

Disability weight: is measure of the relative valuations of a health state on an interval scale.

Endemic: a disease restricted or occurring continuously in a particular area

Fulminant: illness that comes suddenly and with severe symptoms over a short time

Incidence: is a measurement of the number of new individuals who contract a disease during a particular period of time.

Local farming communities: are people living in a particular region with similar economic and social activities

Prevalence: is the proportion of a population that has the condition at some time during a given period and includes people who already have the condition at the start of the study period as well as those who acquire it during that period.

Rose Bengal Plate Test (RBPT): test done to confirm if antigens used consist of brucella cells. It is usually a screening test. The Rose Bengal Test (RBT) is usually used as a screening test, and if a serum sample is classified RBT positive, the result is usually confirmed by performing a Complement Fixation Test (CFT, which is a test difficult to standardize and perform)or preferably an ELISA

Serum Slow Agglutination Test (SSAT): This is the confirmatory test to indicate presence of *Brucella* infection.

Zoonoses: diseases that animals pass to humans

ABBREVIATIONS AND ACRONYMS

CFT	Complement Fixation Test
CNS	Central Nervous System
ELISA	Enzyme Linked Immunosorbent Assay
EU	European Union
GDP	Gross Domestic Product
GI	Gastro Intestinal
LPS	Lipopolysaccharide
MRT	Milk Ring Test
PMN	Polymorphonuclear Neutrophil
SPSS	Statistical Package for Social Sciences
SSAT	Serum Slow Agglutination Test
TNF	Tumour Necrosis Factor
WHO	World Health Organization

ABSTRACT

Brucellosis is an infectious debilitating, acute or sub-acute febrile illness usually marked by an intermittent or remittent fever accompanied by malaise, anorexia and prostration, and which, in the absence of specific treatment, may persist for weeks or months. The aim of this study was to determine the prevalence and factors associated with brucellosis among community members in Mandera East Sub-County, Mandera County. The study was descriptive cross sectional study which collected both qualitative and quantitative data from where a sample of 420 respondents was systematically selected from heads of 2,617 households form Mandera East Sub-county. The study instruments included questionnaire, Focus Group Discussion guide and Interview Guide. Blood samples were screened for brucellosis using Rose Bengal Plate Test (RBPT) and the positive sera were subjected through Serum Slow Agglutination Test (SSAT) which acted as a confirmatory test. Data was analyzed using SPSS Version 20 and results of the study presented in frequencies and percentages in Tables and Figures. Ethical clearance was sought from Kenyatta University Ethical Clearance Committee, permit to carry out the study was sought from NACOSTI and consent sought from the respondents. Rose Bengal Plate Test (RBPT) indicated a prevalence of 24.8% (95% CI: 20.0–29.6) and Serum Slow Agglutination Test (SSAT) indicated that the prevalence was at 14.3% (95% CI: 8.7–19.9) among the respondents. The study showed that the seroprevalence was higher among the male respondents (98%; n=103) as detected through RBPT and (98%; n=57) confirmed through SSAT. There was significant relationship between the gender and seroprevalence as tested through RBPT ($P<0.001$) and through SSAT ($P<0.001$). It further showed that the majority of the respondents (69%) was aware of the disease and that 31% (n=130) took fermented milk without boiling, while only a few (6%; n=25) of respondents pasteurized it. There was a significant relationship between the respondents' milk preparation practices before consuming and brucellosis status using RBPT ($\chi^2=17.115$; df=4; p=0.002) but not when tests were done through SSAT ($\chi2=8.737$; df=4; p=0.068).Factors associated with the spread of brucellosis among the community members in Mandera East Sub-county included directly getting into contact with animals such as goats, cows, wild animals dogs, camels, and sheep and taking poorly prepared milk; consuming raw blood from livestock; taking raw or poorly cooked meat and getting involved in various activities touching on livestock. Scaling up of awareness of brucellosis among the community members was required. This can be done by the relevant Ministries in County government of Mandera and the Ministry of Health and of Livestock should evaluate a possibility of undertaking brucellosis campaign.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Brucellosis is an infectious debilitating, acute or sub-acute febrile illness usually marked by an intermittent or remittent fever accompanied by malaise, anorexia and prostration, and which, in the absence of specific treatment, may persist for weeks or months (Kaufmann, 2006).It is a zoonotic infection caused by the bacterial genus *Brucella* that are transmitted from animals to humans by ingestion through infected food products, direct contact with an infected animal. Other common routes of infection include direct inoculation through cuts and abrasions in the skin, inoculation via the conjunctival sac of the eyes, or inhalation of aerosols. Humans are accidental hosts, but brucellosis continues to be a major public health concern worldwide and is the most common zoonotic infection (*Pappas et al.,* 2006). *Brucella* are small aerobic intracellular coccobacilli, localize in the reproductive organs of host animals, causing abortions and sterility. They are shed in large numbers in the animal's urine, milk, placental fluid, and other fluids (Gul *et al.*, 2007).

The main domestic animals that are affected include cattle, sheep, goats, pigs and dogs with the principal manifestations of reproductive failure; abortion or birth of unthrifty offspring in females, orchitis and epididymitis in males (Young, 1995). Six major *Brucella* species are known to cause disease in humans:*Brucellaabortus, B. melitensis, B.* s*uis, B.* c*anis, B. ovis* and *B. neotomae* (Glynn *et al*., 2008) all of which circulate in animals. Susceptibility to brucellosis in humans depends on various factors, includingthe immune status, routes of infection, size of the inoculum and, to someextent, the species of *Brucella*. In general, *B.melitensis*and *B.suis*are more

virulent for humans than *B.abortus* and *B.canis*, although serious complications can occur with any species of *Brucella*.

The global burden of human Brucellosis remains enormous with the infection causing more than 500,000 infections per year worldwide (Godfroid, 2013). However it has been, or is close to being eradicated from a number of developed countries although it is more of a problem in countries with poorly standardized animal and public health programs. It is widely spread in the countries of Europe, North and East Africa, the Middle East, South and Central Asia, Central and South America and is a major cause of morbidity to both humans and animals in these countries(Robert *et al.,* 2010). It is also considered a potential biological weapon (Jovanka *et al*., 2010).The annual number of reported cases has dropped significantly because of aggressive animal vaccination programs and milk pasteurization, familiarity with the manifestations of brucellosis and knowledge of the optimal laboratory studies which have been essential for the recognition of this re-emerging zoonosis (Glynn and Lynn, 2008).

As with other public-sector animal health services, the surveillance and control of brucellosis in sub-Saharan Africa is rarely implemented outside southern Africa (McDermott *et al.,* 2012). International trade in animals and animal products poses a major risk of international spread of animal and human pathogens. The African Continent faces unique problems and obstacles to enter international world markets for animals and animal products, the most important being the continued presence of most of the trade-sensitive animal diseases in Africa and the inability of many African countries to guarantee the sanitary measures for safe trade required by trading partners. Studies done in Kampala revealed a prevalence of 12.6% in informally

marketed milk as well as a total of 652 cases of human brucellosis from the Kampala based regional referral hospital over a period of three years (Matika *et al*., 2010).

In Kenya, the distribution of brucellosis cases by 2010 was Central 24%, Coast 20%, Nairobi 17%, North Eastern 11%, Rift Valley 23%, Eastern 5%, Western 0%,Nyanza 0%. On 17th June of 2011 (Legal notice No. 68), brucellosis was gazetted as a notifiable disease in Kenya under the animal diseases act (Cap. 364) (DVS, 2011).With this act, all identified cases of brucellosis must be reported to the department of veterinary services. However, in Mandera, in the former North Eastern Kenya the available data on brucellosis is not adequate enough to inform an effective control processes. The cultures of some community that encourages consumption of raw livestock products such as whole blood and raw milk, the free range production system practiced in most parts of the county helps to maintain the disease in both animal and human populations. Livestock-wildlife interaction especially during free grazing cattle rustling, porous borders limiting control efforts in adequate diagnostic technique do not give a true picture of Brucellosis presence/absence (Augustine *et al*., 2012).

1.2 Problem statement

Zoonotic diseases especially brucellosis remain a serious obstacle to public health. Brucellosis is even more ignored in humans and most cases go undiagnosed and untreated, leading to considerable suffering for those affected (McDermott *et al.*, 2002). Currently, about half a million human brucellosis cases are annually reported worldwide but the estimated number of unreported cases due to the unspecific clinical symptoms of the disease is supposed to be 10 times higher. In endemic countries prevalence rates often exceed 10 cases per 100,000 populations(Godfroid, 2013).

Local families in Mandera East Sub-county incur losses on medication of brucellosis besides costs incurred by livestock producers through abortion in infected livestock; social and economic progress and food security losses from young livestock that are born weak and die within 7 days of birth (Robert, 2013).Infected young livestock that live, but are hindered in their growth; loss of milking ability of infected livestock; decreased reproductive efficiency through the livestock either breeding back late or not at all; loss of genetic potential due to involuntary culling of infected animals that would have contributed to the herds genetic makeup (Donald et al., 2007). The losses have increased poverty levels, social conflicts, malnutrition, morbidity and mortality rates. This study investigated the prevalence and factors associated with Brucellosis among community members in Mandera East Sub-county, Mandera County where livestock represents an important factor in the economy and livelihood.

1.3 Justification for the study

Zoonotic diseases continue to be a serious impediment to public health, to social and economic progress and food security in most African countries and especially those where suitable prevention and control procedures are not taken in time. Thorough health education especially on the mode of spread of brucellosis and the main risk factors such as consumption of raw milk, consumption of animal blood and failure to seek treatment from health institutions needs to be emphasized. Decision-making to determine the importance of brucellosis control relative to other public concerns and what brucellosis control strategies should be applied is urgently required (McDermott et al., 2002). Clear knowledge of the prevalence of brucellosis and the associated factors will empower the government and the community in the fight against

incidence and spread of Brucellosis and provide a ground for further research by scholars.

1.4Null Hypotheses

i. There is no relationship between the prevalence of brucellosis and level of awareness on brucellosis among community members in Mandera East Sub-county
ii. There is no relationship between the prevalence of brucellosis and factors associated with the it among the community members in Mandera Sub-county

1.5 Research questions

i. What is the prevalence of brucellosis among the community members in Mandera East Sub-county?
ii. What is the level of awareness on brucellosis among community members in Mandera East Sub-county?
iii. What factors are associated with the spread of brucellosis among the community members in Mandera East Sub-county?

1.6 Objectives of the study

1.6.1 Main objective

To evaluate the prevalence and factors associated with brucellosis among community members in Mandera East Sub-county, Mandera County.

1.6.2 Specific objectives

i. To determine the prevalence of brucellosis among community members in Mandera East Sub-county, Mandera County.
ii. To determine level of awareness on brucellosis among community members in Mandera East Sub-county.

iii. To establish factors associated with spread of brucellosis among the community members in Mandera East Sub-county.

1.7 Limitations of the study

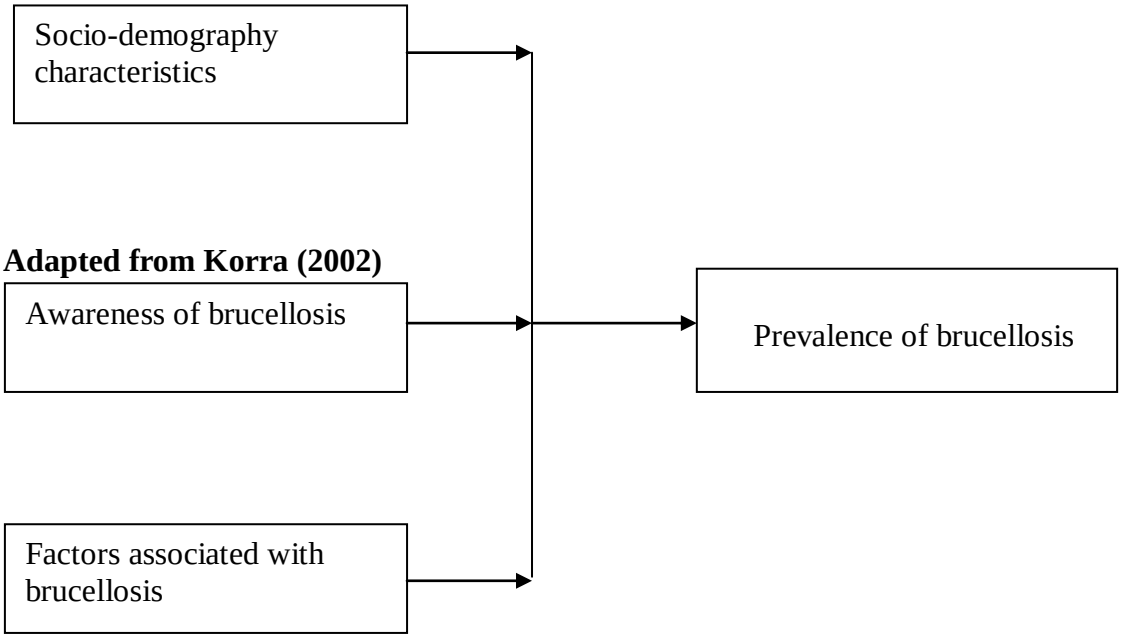
Endemic zoonoses such as brucellosis pose considerable challenges for clinicians in both human and animal health. They frequently present with general symptoms that are shared with a wide range of infectious diseases common in the tropics, and are hard to identify or differentiate clinically. In humans, non-specific symptoms such as fever, headache, fatigue, and joint or muscle aches are commonly associated with many endemic zoonoses. These symptoms also occur with common non-zoonotic diseases, such as malaria and typhoid fever, which are likely to be considered more readily by clinicians (Crump, 2014). Considerable social influences, such as training context, the influence of peers, and pressure to meet patient expectations, can also contribute to the overdiagnosis of diseases such as malaria, and thus to the relative underdiagnosis of other diseases including many zoonoses (Chandleret al., 2008). More specific symptoms may occur with some zoonotic diseases, but these lack sensitivity or specificity, so cannot be relied upon for a clinical diagnosis. For example, hepatomegaly and splenomegaly are often reported in cases of human brucellosis and others(WHO, 2006). Illiteracy among locals may have compromised the information obtained through the questionnaires; however the study endeavoured to use local language which was understood by all. The locals may have resisted tests on the Brucellosis but were persuaded to accept. The study area was volatile and highly associated with inter clan wars and Al-Shaabab threat.

1.8 Delimitations of the study

The study was delimited to adults among community members in Mandera East Sub-county in Mandera County in Kenya. Only the culture and serological outcomes and information provided by the respondents in the field were analyzed along with prevalent cases recorded in the hospitals.

1.9 Conceptual framework

Independent Variables **Dependent variables**



Adapted from Korra (2002)

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature related to the study on prevalence and factors associated to brucellosis. The literature review is based on the study objectives

2.2 Epidemiology of brucellosis

Brucellosis is primarily an infection of animals but can be transmitted to man. Different species of *Brucella* bacteria mostly infect domestic livestock: cattle (B. *abortus*), sheep and goats (B. *melitensis*) and pigs (B. *suis*). Dogs can also be infected with B. *canis*. This can all infect humans with B. *melitensis* thought to cause the most serious disease. *Brucella* possesses a unique ability to invade both phagocytic and nonphagocytic cells and to survive in the intracellular environment by finding ways to avoid the immune system. This ability helps explain why brucellosis is a systemic disease and can involve almost every organ system. The apparent prevalence of brucellosis from milk is high among the dairy farming households (Kangethe, et al. 2007). The prevention of brucellosis infection in humans is a major reason for the advocacy of milk pasteurization worldwide (Staal, 2000). The informal milk markets thrive because they provide social and economic benefits to smallholder producers. In Kenya, over 85% of marketed milk is not pasteurized and is sold through informal market pathways (Omoreetet al., 1999). Concerns about human health risks from these market pathways need to be addressed in the context of consumer practices, such as boiling, to reduce or eliminate potential infection by milk-borne health hazards, without discouraging the smallholders milk markets (Kang'ethe, 2000). One of the most effective interventions for primary prevention of brucellosis is health promotion, promotion of a healthy lifestyle from the hygiene aspect, food safety, risk

estimation, and application of adequate measures adjusted to the local needs and etiological factors (Docho et al., 2010)

2.3 Categorization and symptoms of brucellosis

2.3.1 Symptoms of brucellosis

Symptoms of brucellosis usually appear within five days and can appear after several months of infection. In early stage, symptoms may include: malaise, lethargy, headache, muscle pain, fever, chills, severe headache and backache, nausea, vomiting and diarrhoea. As brucellosis progresses it causes a severe fever (104° F to 105° F). This fever occurs in the evening along with severe sweating becoming normal or near normal in the morning, and begins again at night. This intermittent fever lasts 1 to 5 weeks, after which symptoms usually subside or disappear for two days to two weeks. Then the fever recurs. In some patients, this fever recurs only once. In others, the disease becomes chronic, and the fever recurs, subsides, and then recurs again repeatedly over months or years.

In later stages, brucellosis can cause: Loss of appetite, weight loss, abdominal pains, headache, backache, joint pain, weakness, irritability and insomnia. Patients usually recover within 2 to 5 weeks. Brucellosis is also believed to cause a high rate of Miscarriage during early pregnancy in infected women.

2.3.2 Subclinical brucellosis

Disease is usually asymptomatic, and the diagnosis is usually established incidentally after serologic screening of persons at high risk of exposure. Culture data are usually unrevealing.

2.3.4Acute and sub-acute brucellosis

Disease can be mild and self-limited in B *abortus* or fulminant with severe complications in B *melitensis*. Associated symptoms can develop 2-3 months before diagnosis in mild cases and 3-12 months before diagnosis in severe cases. Acute brucellosis occurs without focal abnormalities. Nonfocal weakness may be noted. The tissues overlying the spine or peripheral nerves may be tender to percussion. Tenderness, swelling, or effusion of joints may be evident. In some instances, orchitis appears after a few days of illness. Testicular swelling and tenderness in the wake of chills and high fever thus resemble mumps orchitis. Some patients manifest constipation (Gerberding, et al.,2008).

2.3.5 Chronic brucellosis

The diagnosis of chronic brucellosis is typically made after symptoms have persisted for one year or more. Low-grade fevers and neuropsychiatric symptoms predominate. Results of serologic studies and cultures are often negative; without confirmatory evidence, many authorities doubt the existence of chronic disease (Gerberding, et al.,2008).

2.3.6Localized and relapsing brucellosis

Localized complications of brucellosis are typically observed in patients with acute disease or chronic untreated infection. Cultures of involved tissue sites and serology can be diagnostic. Relapsing brucellosis may be difficult to distinguish from re-infection. Symptoms are more severe reflecting the initial disease. Symptoms typically develop 2-3 months after therapy completion. Culture results are typically positive, and serology may be difficult to interpret, but enzyme-linked immunoassay (ELISA) testing may be more helpful.

2.4 History on spread of brucellosis

Brucellosis causes more than 500,000 infections per year worldwide. Its geographic distribution is limited by effective public and animal health programs, and the prevalence of the disease varies widely from country to country (Pappas, et al.,2006). Overall, the frequency of brucellosis is higher in more agrarian societies and in places where handling of animal products and dairy products is less stringent. European Union (EU) data suggest that there is a clear (though nonlinear) association between gross domestic product (GDP) and rates of brucellosis. According to these data, no countries with a GDP above 90% of the mean had an annual incidence of brucellosis higher than 10 cases per million populations. Because of variable reporting, true estimates in endemic areas are unknown. Incidence rates of 1.2-70 cases per 100,000 people are reported. In very resource-poor countries (such as some African countries) in which brucellosis is endemic, control through animal slaughter is a poor option because of the fragile nature of the food supply.

In a systematic review was commissioned by the World Health Organization (WHO) with the goal of determining a disability weight for clinical manifestations of human brucellosis, the investigators proposed a disability weight of 0.150 for chronic localized brucellosis and 0.190 for acute brucellosis (Dean, et al.2012). These estimates were based on disability weights from the 2004 Global Burden of Disease Study. However, throughout the developing world, the true incidence of disease is considered likely to be at least 10 to 25 times higher than that reported. In East Africa, estimation of the true incidence in humans is also constrained by lack of a validated serological test, particularly in rural areas. For example, in both Tanzania and Kenya, there has generally been a poor agreement between results of diagnostic serological tests carried out in rural dispensaries and at veterinary research laboratories.

In addition to its significance as a direct cause of human disease, brucellosis in livestock is of considerable concern to the sustainable economy and food security of farming communities in Tanzania. In cattle and small ruminants, brucellosis causes severe economic losses as a result of abortion, sterility and reduced milk production. Little information is currently available for more extensive farming systems where more than 97% of livestock are kept. Little is also known about brucellosis in sheep and goats, which are considered a major source of infection for people. The role of wildlife in the epidemiology of brucellosis also warrants attention, given the fact that *Brucella* seropositives have been detected in 41/103 (39.8%) buffalo sampled in the Arusha region, an area where livestock-wildlife interactions are common. In other parts of the world, wild ungulates have been identified as important sources of infection for livestock. The nature and magnitude of the zoonotic risk of brucellosis is likely to differ between pastoralist and smallholder systems, due to differences in management practices, contact with animals and consumption of animal products. In Sub-Saharan Africa, approximately 16% of livestock harbour the disease yet its treatment in animals is not recommended. Instead animals should be culled and this practice is not possible in the developing countries due to economic implications and poor compensation rates by the governments. This therefore has resulted to endemicity of the disease and continued source of infection to humans. Although human mortality due to brucellosis is only about 2%, the disease causes severe disabling sequel like rheumatism, infertility in males, spontaneous abortion and also results to wastage of resources through prolonged treatment, up to six weeks, and loss of income through loss of working hours. *Brucella* organisms are also considered potential biological weapon which could be cheaper to produce but more devastating than chemical weapons (Kambi, 2012).

2.5 Transmission of brucellosis

Brucellosis can be transmitted from one animal to another, animal to humans and also from humans to humans through various ways.

2.5.1 Transmission to humans

Brucellosis is a worldwide infection traditionally associated with farm workers, veterinarians and persons whose occupation includes packing of meat or dairy products. Ingestion of unpasteurized goat milk and related dairy products is the main route by which B *melitensis* is transmitted to humans. Slaughterhouse workers, primarily those in the kill areas are inoculated with *Brucella*e through aerosolization of fluids, contamination of skin abrasions, and splashing of mucous membranes. Farmers and shepherds have similar exposure risks, and they also have exposure to aborted animals. Veterinarians are usually infected by inadvertent inoculation of animal vaccines against B *abortus*and B *melitensis*. Laboratory workers (microbiologists) are exposed by processing specimens (aerosols) without special precautions. Transmission to infants is via breastfeeding.

Nearly every case of human brucellosis has an animal origin *(*Nicoletti, 1992; Tzaneva et al.,2007*)*. Large quantities of the bacteria are excreted with the foetus, placenta and the uterine fluid, mainly at the time of calving. After an abortion or parturition, the organism continues to be excreted mainly via milk of infected cows serving as continued source of infection to humans (Mangen et al., 2002). Human to human transmission and congenital infection have also been documented (Oded et al., 2007; Frank et al., 1993). Exposure through breaks in the skin, following direct contact with tissues, blood, urine, vaginal discharges, aborted foetuses or placentas are also possible routes of transmission of the disease (Gerald et al., 2009).

2.5.2 Transmission between animals

Transmission occurs as in B. *abortus* mainly through materials excreted by the female genital tract. The primary organ of dissemination is the placenta after abortion or full term parturition. Infection may be direct through contact with contaminated material or aerosol infection, or indirectly by grazing on contaminated pastures or through other materials. Dogs may be vectors mechanically or biologically. Lambs and kids can become infected in utero. B *melitensis* causes disease only in adult animals. Male and female animals are equally susceptible. The husbandry system, as well as environmental conditions, affects the spread of infection. Dogs and some wild carnivores may carry the infection to other places.

2.6 Safety measures and management of spread of brucellosis

A careful history is the most helpful tool in the diagnosis of brucellosis. The history should include both assessment of any risk factors present and evaluation of any symptoms reported (Greenfield, et al., 2002).

2.6.1 Risk factors

The risk factors for brucellosis differ somewhat, depending upon whether a given individual resides in or has recently visited a region of endemic disease.

2.6.1.1 Endemic exposure

Brucellosis should be considered in any patient whose place of residence or dietary, travel, or occupational history suggests a risk for the infection and who is experiencing any of the various complications of brucellosis. The threshold for consideration of brucellosis is low in regions of endemic disease, where diagnostic testing is undertaken for any of the many atypical presentations or unusual

complications. Unpasteurized daily products, raw or poorly cooked meats are sources of infection in regions of endemic disease. Laboratory transmission of brucellosis may occur, especially in regions of endemic disease (Bouza, et al. 2005).

2.6.1.2 Non-endemic exposure

Brucellosis poses a particular diagnostic challenge in persons from non-endemic regions. A dietary history is important in evaluating for the possibility of brucellosis among individuals who live in non-endemic regions because the disease may be acquired through ingestion of infected foods shipped from regions of endemic disease. Ingestion of unpasteurized milk from cows or goats enhances risk of infection in both disease endemic and non-endemic regions. Physicians, veterinarians, pathologists and laboratory persons are exposed to tissues from infected animals are at particular risk (Bouz,et al.2005). Herders, hunters, farmers, dairy workers, veterinarians and meatpackers exposed to goats, sheep, cows, camels, pigs, reindeer, rabbits, or hares in areas where the disease is not endemic are at greatest risk.

2.6.2 Vaccination

Brucellosis is a zoonosis and requires control programmes aimed at the final eradication in affected regions. Mass vaccination accompanied by a strict surveillance scheme is a first step to reduce the number of infected animals hence the infection pressure. At a low level of infection a test-and-slaughter programme can be applied in order to attain brucellosis free flocks and zones. Prevention of re-infection and availability of sufficient young animals for replacement is essential.

2.7 Levels of training and sensitization on brucellosis

Patient education should include efforts to address the nature of the disease and the routes by which it can be transmitted; the symptoms, complications, and treatment of

the disease, as well as the risk of relapse if it is not adequately treated. In addition, the potential adverse effects of the medications administered; the need for strict compliance with the antibiotic regimen; in soma case, reassurance concerning recurrent symptoms that are not associated with clinical or laboratory evidence of acute brucellosis; the need to avoid potential sources of infection as by avoiding infected animals, using stricter precautions when dealing with a potentially infected animal, or avoiding potentially contaminated foods. For farmers and ranchers, immunization of their cattle against the disease as necessary and for laboratory workers, maintenance of the appropriate level of containment.

2.8 Social demographic characteristics associated with prevalence

These characteristics include age, sex, education level and social-economic status and others.

2.8.1 Age-related demographics

Brucellosis in the Mediterranean, chiefly due to B *melitensis*, has the highest age/sex-related incidence in males in their mid-20s. A report from northern Saudi Arabia found that cases of brucellosis occurred mainly in individuals aged 13-40 years with younger than 13 years and less in those aged 40-60 years (Fallatah, et al., 2005). The predilection is not universal, given that 60% of cases in Jordan occur in individuals younger than 24 years. Elderly individuals with acute localized brucellosis are particularly likely to manifest destructive localized brucellosis of the spine (Alp and Doganay 2008). Brucellosis is generally uncommon in infants. Brucellosis may be more common in children in developing countries because of lack of pasteurization and working in an agrarian society (Calebi,et al., 2007).

2.8.2 Sex-related demographics

Brucellosis is more common in males than in females. Young adult males predominate in most series of patients with brucellosis compiled in areas of endemic disease but the reasons for increased risk are not known. Food-borne brucellosis is not limited according to age or sex and is found in women and men in equal numbers (Fallatah, et al., 2005).

2.9 Clinico-epidemiological diagnosis

Given that symptoms and signs of brucellosis are nonspecific, cultures and serology are usually necessary for diagnosis.

2.9.1 Culture

Diagnosis of brucellosis is definitive when *Brucella* organisms are recovered from blood, bone marrow, or other tissue. Some *Brucella* species require 5-10% carbon dioxide for primary isolation. Because of the ease of aerosol transmission, any potential *Brucella* specimens should be handled under a biohazard hood. The sensitivity of blood cultures with improved techniques such as the Castaneda bottles is further improved by the lysis-centrifugation technique. With these methods, the sensitivity is approximately 60%. Subcultures are still advised for at least 4 weeks.

2.9.2 Serology

Serologic testing is the most commonly used method of diagnosing brucellosis. It includes;

i) Milk Ring Test (MRT)

The MRT is used to screen for Brucellosis in herds of dairy cattle. If applied to test milk from individual cows, the milk should be diluted in already negative milk before testing. The use of MRT is such that an intense blue colour in the cream layer and a

mild blue coloration in the skim milk layer indicate a positive result. A negative result is indicated by equal intensity in colour in both layers or, the blue coloration is more intensive in the skin milk layer.

ii) Milk Plate Test (MPT) in goat milk

This test is a modification of MRT also used in goat milk. The test is highly sensitive and the equipment used in the serum agglutination plate method may be used (Grant et al., 1952).

iii) Rose Bengal Plate Test (RBPT)

In this test antigens used consist of *Brucella* cells stained with Rose Bengal suspended in a buffer at pH 3.65. Positive sera are subjected to the SSAT and CFT (Macmillan, 1985).

iv) Serum Slow Agglutination Test (SSAT)

This test is conducted by dilution of serum in phenolised saline in agglutination tubes and adding equal volumes of the standard antigen that is whole cell antigen. It is not effective in individual animals due to its deficiencies for instance, detecting non-specific antibodies as well as specific antibodies form *Brucella* infection and vaccination, during incubation it is the last test to indicate presence of infection. (Laing et al., 1988).

v) Enzyme Linked Immunosorbent Assay (ELISA)

The assay employs both whole cell and purified lipopolysaccharide antigens and a variety of immunoglobulin conjugates and its substrates (Nelson and Duncan, 1990). The conjugate consists of antibovine IgG conjugated to horseradish perioxidase while the substrate is hydrogen peroxide with donor chromogen of donor chromogen 2 (ABTS) that turns green in the presence of peroxidase (Floves et al., 1984).

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

This chapter describes the research design, target population, sample size, sampling method, data collection, ethical consideration, data analysis and data presentation techniques that was used in the study.

3.2 The study design

This was a cross sectional study to be carried out in Mandera East Sub-county, Mandera County. According to Saunders *et al*., (2007), a cross sectional study is ideal in that it provides a point in time information that captures the opinions, attitudes, preferences, prevalence and factors of interest in research.

3.3 The study area

The study was carried out in Central and Khalalio divisions in Mandera East Sub-County, Mandera County. The Sub-county borders Ethiopia to the North, Somalia Republic to the East, Mandera North and Mandera Central Sub-counties to the West and South West respectively and lies approximately 3.94^0 North latitude and 41.86^0 East longitudes (Appendix VII).

3.4 The study population

The study population was made up of 10,458 households in Mandera East Sub-County where each household had on average 6 members. The population is mainly rural and largely pastoralists keeping cattle, goats, donkeys, sheep, camels and often interact with the wildlife such as buffaloes and antelopes.

3.5 Sample size determination

The sample size was determined using this formula by Fisher et al., (1998).

$$n = \frac{z^2 \text{ x } p \text{ x} q}{d^2}$$

Where: n = desired sample size (if target population is greater than 10,000)

z = standard normal deviate (1.96) at 95% confidence interval.

p = the proportion in the target population estimated to have the characteristic being measured. (Because it was unknown, p=0.5 was used).

q = 1- p- proportion of population without the desired population

d = the level of statistical significance (0.05)

$$n = \frac{1.96 * 1.96 * 0.5 * 0.5}{0.05 * 0.05}$$

=384 households

In order to cater for the anticipated non-responses and fouled (spoilt) questionnaires, some 36 (approximately 10% more respondents) were included in the sample making a total sample size of **420**.

3.6 Sampling method

Multistage sampling technique was used to determine the study participants in this study. Mandera East Sub-county was purposively selected while Simple random sampling technique was used to select two divisions the Central and Khalalio divisions (Table 1). Simple random sampling was then used to determine two locations from each of the selected divisions. Four locations, the Central and Fiqo from Central Division and Khalalio and Bella from Khalalio Division were selected. All households were involved in the study until correct sample reached. Household heads were selected into the study and where not present, any other eldest member of the family who was mature was selected to participate in the study. Key informants included Mandera County Director of Public Health Services, Director of Veterinary services laboratory technologists pharmacists in Public and Private facilities.

Table 1: The Sample Frame

County	Sub county	Division	Location	Households in the population	Households in a Sample s
Mandera	Mandera East	Central	Central	740	118
			Fiqo	580	95
		Khalalio	Khalalio	602	97
			Bella	695	110
Total				**2617**	**420**

Adult men and women who had lived for at least six months in the area and consented to participate were selected and enrolled into the study. All study participants were interviewed using a questionnaire which included demographics, risk factors and clinical symptoms for brucellosis. The questionnaires were pre-tested at Takaba in Mandera West in October 2014 and were revised to extended study to improve understanding of questions and to eliminate overly-sensitive questions. Three nurses and a Clinical officer participated in blood samples collection and this team was directly answering to Mandera County Director of Health Services and of Veterinary services.

3.7.1 Blood sample collection and handling

A respondent with recorded or reported history of fever during the current study was a handled as a suspected case. Fever was defined as any patient whose temperature was recorded by the clinician to be above 37^0C

Every respondent was asked to donate their brachial vein's blood which was taken with 5 ml Vacutainer® tubes. The blood samples were centrifuged in 3000 rounds per minute for five minutes. Separated 1.5 ml tubes of serum were kept in a cool box and transported to the Mandera Hospital laboratories for storage and testing.

3.7.2 Serological test

Sera were tested with the RBPT for detection of antibodies to *Brucellaabortus/melitensis*. Positive sera were re-tested with using Serum Slow Agglutination Test (SSAT) according to manufacturer's instruction.

To identify risk factors, socio-demographic variables like age, sex, education level and religion were assessed. In addition, occupational factors such as use of protective gear, animal species handled whether sick or healthy and if the respondents participated in animal handling were explored. Probable cases were respondents whose blood tested positive on the rapid testing by the Rose Bengal Plate Test while all respondents whose blood tested positive for brucellosis by Serum Slow Agglutination Test (SSAT) were confirmed cases.

3.8 Inclusion criteria

The study included household heads or any eldest members of the household available at home during the study day. Only those who consented to the study were included.

3.9 Exclusion criteria

Household heads who were under treatment particularly on Antibiotic drugs or those who could not mentally stable were excluded.

3.10 Research instruments

The study used questionnaire, key informant guides and Focus group discussion guides to collect the required data for this study. These study tools were both structured and unstructured in nature. Laboratory equipment and reagents were used for serological tests.

3.11 Data analysis

The collected data was organized in descriptive statistics where measures of central tendency, dispersion, relative positions and measures of relations and associations were determined. In most circumstances, the data collected in descriptive survey research design are non-parametric (Brunt, 1997) thus Chi-square test was used to test the research hypotheses. Analysis was done using SPSS Version 20.

3.13 Ethical consideration

This research sought approval from the Kenyatta university department of community health and the Graduate school. Ethical clearance was sought from Kenyatta University ethics review committee (KU-ERC) and research permit from the National Commission for science, technology and innovation (NACOSTI). Authority to conduct the study was granted by Mandera County government. Informed written consent was sought from the respondents willing to participate after fully explaining to them the whole research process, benefits and risks and their rights in participation. Confidentiality was maintained and anonymity ensured.

CHAPTER FOUR: RESULTS

4.1 Introduction

This section presents results based on the objectives of the study. The results are on demographic characteristics of the study respondents, prevalence of brucellosis, awareness and factors associated with brucellosis.

4.2 Demographic characteristics

This study was carried out among 420 community members in Mandera East Sub-county. The overall mean age was 44± 13years (range 15–87) and median 44 years. About 29.3%of the respondents were aged between 35-45 years where 86.2% were males (Table 4.1).

Table 4.1: Socio-demographic characteristics of the respondents

Attribute	Category	Frequency (N)	Percent (%)
Age groups	15-25	15	3.6
	25-35	91	21.7
	35-45	123	29.3
	45-55	112	26.7
	55-65	54	12.8
	>65	25	6.0
Gender	Male	362	86.2
	Female	58	13.8
Marital status	Single	14	0.3
	Married	371	88.3
	Separated/ Divorced	24	0.6
	Widowed	11	0.3
Religion	Muslim	385	91.7
	Christian	35	8.3
Level of education	Never been to school (Informal Education)	22	5.2
	Never completed Primary school	135	32.1
	Completed Primary School	162	38.6
	Never completed Secondary school	74	17.6
	Completed Secondary School	21	5
	Post-Secondary School Education	6	1.4
Occupation	Pastoralist	210	50
	Agro-pastoralist	27	6.4
	Farmer	14	3.3
	Formal employment	8	1.9
	Unemployed	161	38.3

The study showed that majority of the respondents (58.3%) were married, 91.7%practiced Islam faith, and 38.6% had completed primary school while half of them were pastoralists(50%) (Table 4.1).

4.3 The prevalence of brucellosis

The presence of *Brucella* antibodies was screened using Rose Bengal Plate Test (RBPT) and Serum Slow Agglutination Test (SSAT) and the results were presented in Table 4.2.

Table 4.2: Respondents RBPT and SSAT status

Location	**RBPT**		**SSAT**	
	Negative cases	**Positive cases**	**Negative cases**	**Positive cases**
Central	99 (69.7%)	43 (30.3%)	14 (44%)	27 (66.0%)
Khalalio	105 (66.1%)	33 (23.9%)	15 (54%)	13 (46%)
Fiqo	75 (79.8%)	19 (20.2%)	10 (38.0%)	16 (62.0%)
Bella	37 (80.4%)	9 (19.6%)	5 (56%)	4 (44%)
Total	**316(75.2%)**	**104(24.8%)**	**44(42.3%)**	**60(57.7%)**
Significance	$\chi2$=4.087; df=3; p=0.252		$\chi2$=7.009; df=3; p=0.072	

Rose Bengal Plate Test (RBPT) indicated a prevalence of 24.8% (95% CI: 20.0–29.6) and Serum Slow Agglutination Test (SSAT) indicated that the prevalence was at 14.3% (95% CI: 8.7–19.9) among the respondents. Respondents from Central location had the highest seroprevalence of 30.3% as detected through RBPT while SSAT detected 66.0%. However respondents from Bella location had the least seroprevalence of 19.6% and 44% as detected through RBPT and SSAT tests respectively. However there was no significant statistical difference between the location of the respondent and his/her seroprevalence as detected through RBPT ($\chi2$=4.087; df=3; p=0.252) and as detected through SSAT ($\chi2$=7.009; df=3; p=0.072)

4.3.1 The prevalence of brucellosis relation to marital status

The study examined the relationship between the respondents' seroprevalence to brucellosis and their marital status and the results were presented in table 4.3.

Table 4.3: Relationship of marital status of the respondents and sero-prevalence of brucellosis

Variable	RBPT			SSAT		
	Negative	**Positive**	**Significance**	**Negative**	**Positive**	**Significance**
Marital status						
Single	10(71%)	4(29%)	$\chi 2$=4.203; p=0.235*	1(25%)	3(75%)	$\chi 2$=6.080; p=0.092*
Married	282(76%)	89(24%)		39(43%)	51(57%)	
Separated	16(67%)	8(33%)		3(43%)	4(57%)	
Widowed	8(73%)	3(27%)		1(33%)	2(67%)	
Total	**316(75%)**	**104(25%)**		**44 (42%)**	**60(58%)**	

The study showed that highest brucellosis seroprevalence was among separated respondents (33%) as detected through RBPT and among widowed (67%) as confirmed through SSAT. However there was no significant statistical relationship between the marital status of the respondent and his/her seroprevalence as detected through RBPT (χ^2=4.203; df=3; p=0.235) and as detected through SSAT ($\chi 2$=6.08; df=3; p=0.092)

4.3.2 The prevalence of brucellosis in relation to gender and age of the respondents

The study examined the relationship between the respondents' seroprevalence to brucellosis with their gender and with age and the results were presented in table 4.4 below.

Table 4.4: Relationship of gender and age of the respondent with sero-prevalence of Brucellosis

Variable	RBPT			SSAT		
	Negative	**Positive**	**Significance**	**Negative**	**Positive**	**Significance**
Gender						
Female	57 (98%)	1(2%)	P<0.001*	7(87%)	1(13%)	$\chi 2$=11.215; df=1; p<0.001
Male	259(72%)	103(28%)		37(38%)	59 (62%)	
Total	**316(75%)**	**104(25%)**		**44 (42%)**	**60(58%)**	
Age						
15-25	13 (87%)	2(13%)	$\chi 2$=1.7546; df=5; p=0.418	2(50%)	2(50%)	$\chi 2$=1.4211; df=5; p=0.652
25-35	72(85%)	19(15%)		10(53%)	9(47%)	
35-45	82(71%)	41(29%)		12(32%)	25(68%)	
45-55	86 (77%)	26 (23%)		12(43%)	16(57%)	
55-65	44 (81%)	10 (19%)		6(60%)	4 (40%)	
>65	17 (68%)	8(32%)		2(33%)	4(67%)	
Total	**316(75%)**	**104(25%)**		**44 (42%)**	**60(58%)**	

The study showed that the seroprevalence was higher among the male respondents (28%;n=103) as detected through RBPT and (62%; n=59) confirmed through SSAT. There was high significant association between respondents' gender and his\ her seroprevalence as tested through RBPT (P<0.001) and through SSAT (P<0.001). The respondents whose age was between 35-45 years (29%, n=41) and (68%, n=25) as tested through RBPT and SSAT respectively. However the study did not show any significant statistical association between respondents' age and seroprevalence as tested through RBPT ($\chi 2$=1.7546; df=5; p=0.418) and through SSAT ($\chi 2$=1.4211; df=5; p=0.652)

4.3.3 The prevalence of brucellosis in relation education level and occupation of the respondents

The study compared the number of respondents' seroprevalence to brucellosis with their education level and occupation and the results are presented in table 4.3.

Table 4.5: Relationship of education level and occupation of the respondent with sero-prevalence of brucellosis

Variable	RBPT			SSAT		
	Negative	**Positive**	**Significance**	**Negative**	**Positive**	**Significance**
Level of Education						
No school	19(86%)	3(14%)	$\chi2$=4.160; df=5 p=0.519	2(40%)	3(60%)	$\chi2$=2.427; p=0.781*
Incomplete Primary	98(73%)	37(27%)		14(37%)	24(63%)	
Completed primary	123(76%)	39(24%)		17(46%)	20(54%)	
Incomplete secondary	53(72%)	21(28%)		8(42%)	11(58%)	
Complete secondary	17(81%)	4(19%)		2(50%)	2(50%)	
College/ University	6(100%)	0(0%)		1(100%)	0(0%)	
Total	**316(75%)**	**104(25%)**		**44 (42%)**	**60(58%)**	
Occupation						
Pastoralist	153(73%)	57(27%)	$\chi2$=5.202; df=4; p=0.268	21(35%)	39(65%)	$\chi2$=6.463; p=0.138*
Agro-pastoralist	19(70%)	8(30%)		3(60%)	2(40%)	
Farmer	9(64%)	5(36%)		1(33%)	2(67%)	
Formal employment	5(62%)	3(38%)		1(50%)	1(50%)	
Unemployed	130(81%)	31(19%)		18(53%)	16(47%)	
Total	**316(75%)**	**104(25%)**		**44 (42%)**	**60(58%)**	

The study showed that the highest brucellosis seroprevalence was least among those respondents with complete secondary and college education level. This observation was made among the unemployed too who had the least seroprevalence to the disease (19%, n=31)in tests carried out through RBPT and (47%, n=16) as confirmed through SSAT. However the study did not show any significant statistical association between respondents' level of education and seroprevalence as tested through RBPT ($\chi2$=4.160; df= 5, p=0.519) and through SSAT (χ^2=5.202; df=4; p=0.268)

4.4 Factors influencing prevalence of brucellosis

4.4.1 Knowledge and past experience with brucellosis

Past experience with brucellosis or having known or heard of someone who had suffered from brucellosis was referred to as knowledge of the disease. The majority of the respondents, 69% (n = 290) reported to have heard of brucellosis (Figure 4.1)

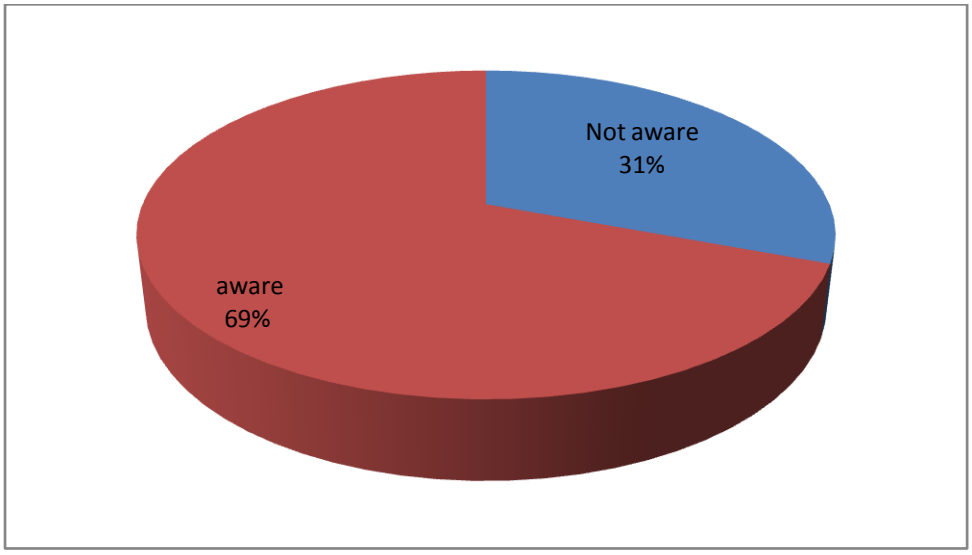


Figure 4.1: proportion of respondents who were either or not aware of brucellosis

Among those who alleged to have known the disease, 72% (n = 209) said they knew how the disease was transmitted. The most commonly cited modes of brucellosis transmission were interacting with dogs 32% (n = 67), handling meat 27% (n = 56), eating meat that is not well prepared 21% (n = 44) and drinking raw milk 11% (n = 23) and assisting animals to deliver (9%, n = 19).

4.4.2 History of human brucellosis and knowledge on clinical symptoms

The respondents in the study who had knowledge of brucellosis were asked to state what they knew to be the clinical symptoms of the disease and the results are presented in Figure 4.2.

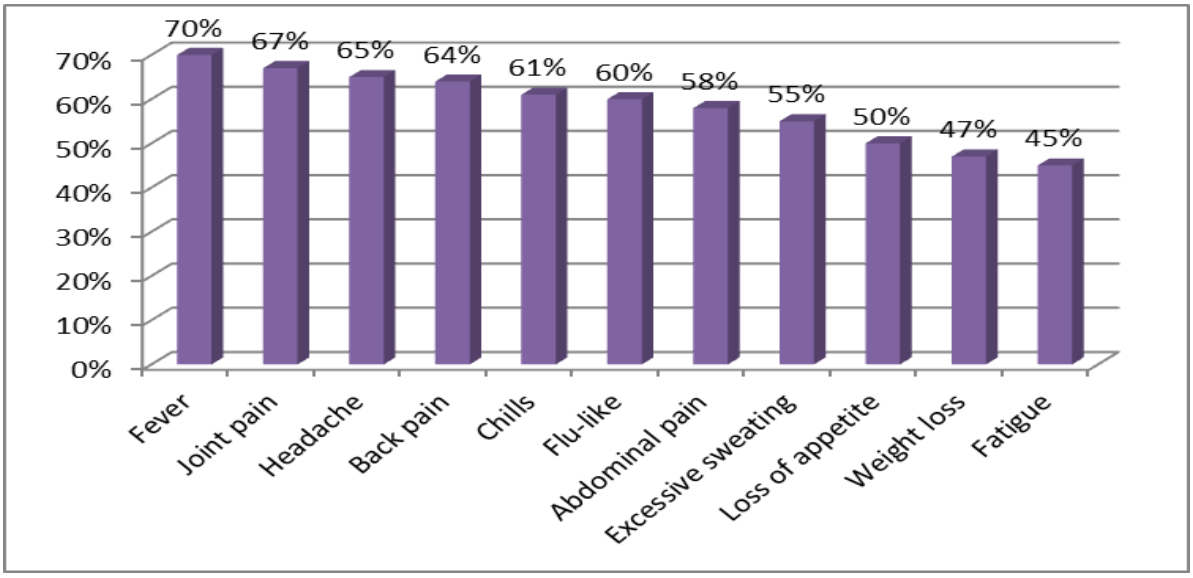


Figure 4.2: Proportion of respondents who gave various signs and symptoms of brucellosis

The most cited sign and symptom was fever70% (n = 146), while fatigue45% (n = 94) was the least stated. The knowledge of signs and symptoms of the disease were compared with gender, marital status, education level, age and occupation of the respondents and the results were presented in table 4.6

The male respondents were seen to be more aware (31%) of the signs and symptoms of the disease than females (27%). About two-thirds of those with tertiary education had knowledge.

There was no significant relationship between awareness status and respondents' gender ($\chi 2$=0.309; df=1; p=0.578), marital status ($\chi 2$=3.670;df=4, p=0.293), and age ($\chi 2$=14.231; df=5; p=0.651). However there was a significant relationship between the respondents' level of education and their awareness of brucellosis ($\chi 2$=15.597; p=0.007 (Table 4.6).

Table 4.6: Relationship of knowledge of brucellosis with gender, marital status, education level, age and occupation of the respondents

Variable	Not aware	Aware	Significance
Gender			
Male	113(31.2%)	249(68.8%)	$\chi 2$=0.309; df=1; p=0.578
Female	16(27.6%)	42(72.4%)	
Marital Status			
Single	72(29.4%)	173(70.6%)	$\chi 2$=3.670; p=0.293*
Married	49(35%)	91(65%)	
Separated	7(29.2%)	17(70.8%)	
Widowed	1(9.1%)	10(90.9%)	
Age			
15-25	3(20%)	12(80%)	$\chi 2$=14.231; df=5; p=0.651
25-35	19(21%)	72(79%)	
35-45	38(29%)	85(71%)	
45-55	44(39%)	68(61 %)	
55-65	17(31%)	37(69%)	
>65	8(32%)	17(68%)	
Total	129(31%)	291(69%)	
Level of Education			
No school	3(13.6%)	19(86.4%)	$\chi 2$=15.597; p=0.007*
Incomplete Primary	50(37%)	85(63%)	
Completed primary	53(32.7%)	109(67.3%)	
Incomplete secondary	13(17.6%)	61(82.4%)	
Complete secondary	6(28.6%)	15(71.4%)	
College/University	2(33%)	2(67%)	

4.4.3 History of infection with the disease

Diagnosis of brucellosis based on the clinical picture alone is difficult due to similarity with clinical presentations of other infections. It is even more difficult to confirm the diagnosis if it was not reported to a health facility. However the study inquired on if the respondents had a known history of the infection with brucellosis which included the perceived, clinically diagnosed cases or cases serologically diagnosed and the response was presented in Figure 4.3.Slightly more than a third (37%, n= 155) of the respondents confirmed of having had an earlier infection.

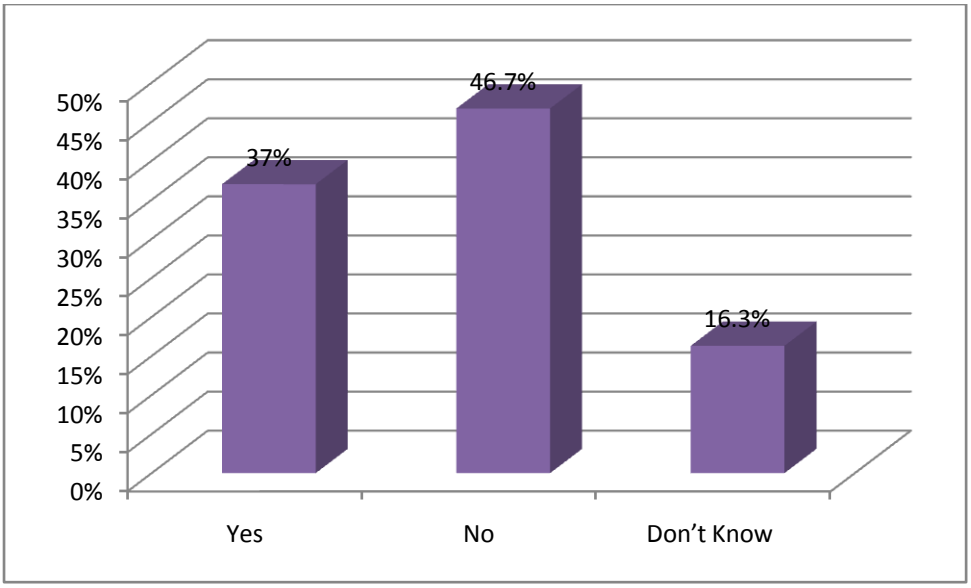


Figure 4.3: History of known infection with Brucellosis

All the 37% of the respondents indicated that they sort for medication and that is how they became aware of their brucellosis infection status. When they were asked on how they sort for treatment, the responses are presented in figure 4.4. Most of the patients were treated either at private or public health facilities (78.8%, n=115) while the rest sort traditional healing practices.

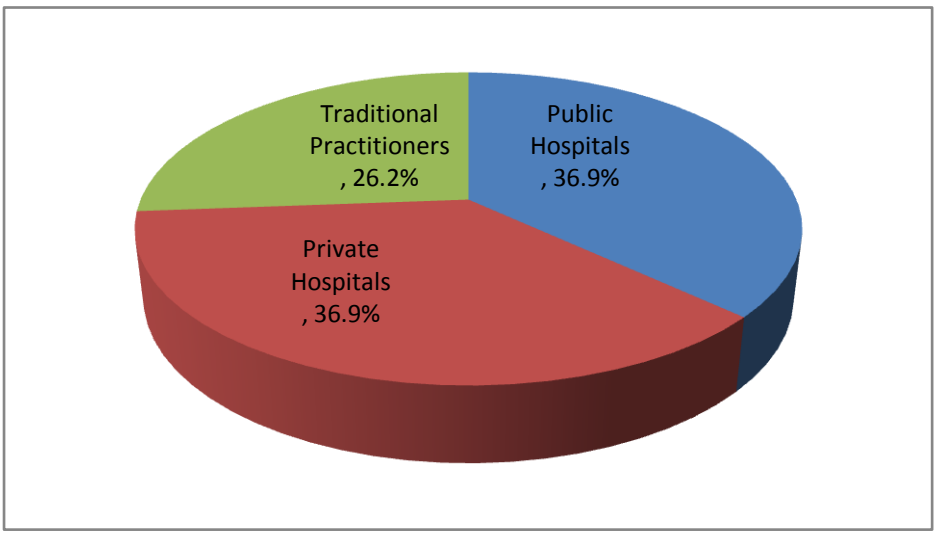


Figure 4.4: Places where respondents went for treatment of Brucellosis

4.4.4 Association of awareness of brucellosis and seroprevalence

The study sort to compare the seroprevalence status and the awareness of the disease

Table 4.7: Relationship between respondents test status and awareness.

Variable	Not Aware	Aware	Significance
RBPT			
Negative	96(30%)	220(70%)	$\chi2$=0.067; df=1; p=0.796
Positive	33(32%)	71(68%)	
SSAT			
Negative	109(30%)	251(70%)	$\chi2$=0.226; df=1; p=0.635
Positive	20(33%)	40(67%)	

Among those that were seropositive for RBPT and SSAT, about a third (32%, n=33) and (33%, n=20) respectively were not aware of the disease. However there was no significant statistical association between awareness and seropositivity ($\chi2$=0.067; df=1; p=0.796; and$\chi2$=0.226; df=1; p=0.635).

4.5Factors associated with spread of Brucellosis among the community members

4.5.1 Animals respondents directly get contact with

The respondents were asked to state the animals they were most in contact with and the results are presented in figure 4.5. Almost all respondents 99% (n= 414) were in contact with goats while other contact animals included wild animals such as antelopes. Some of these animals if infected with Brucellosis are likely to transmit it to the residents in the study area. However there was no significant association between getting into direct contact with animals and respondents' RBPT status ($\chi2$=10.576; df=6; p=0.102) or SSAT status ($\chi2$=5.159; df=6; p=0.524).

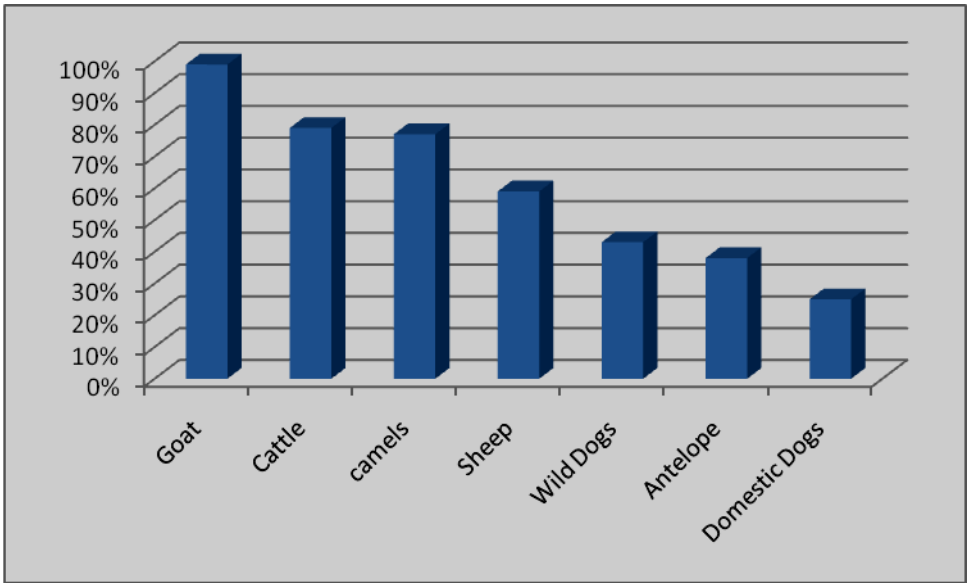


Figure 4.5: Proportion of respondents who directly get into contact with various animals

4.5.2 Milk handling and preparation practices

Milk handling is an important risk factor in transmission of brucellosis hence milk handling practices were explored among the respondents and the results presented in figure 4.6.

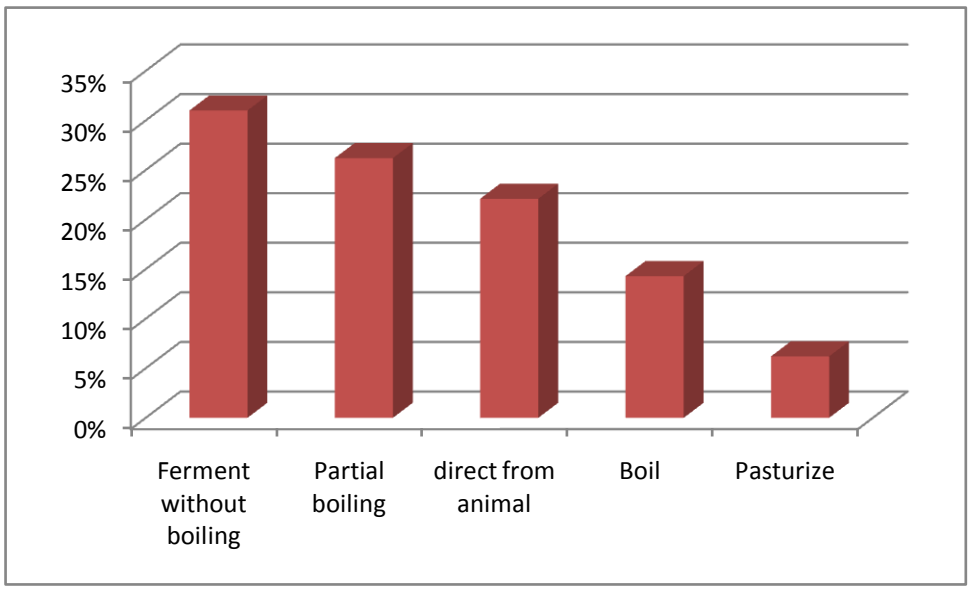


Figure 4.6: Milk handling and preparation practices

The study showed that 31% (n=130) fermented milk without boiling, while only a few (6%; n=25) respondents pasteurized. There was a significant relationship between the respondents' milk preparation practices before consuming and brucellosis status using RBPT (χ^2=17.115; df=4; p=0.002) but not when tests were done through SSAT (χ2=8.737; df=4; p=0.068).

Table 4.8: Relationship between proportion respondents affected by various factors and RBPT or SSAT status

Variable	RBPT			SSAT		
	Negative	Positive	Significance	Negative	Positive	Significance
Animals in direct contact						
Goats	84(84.8%)	15(15.2%)	χ2=10.576; df=6; p=0.102	11(90.9%)	9(9.1%)	χ2=5.159; df=6; p=0.524
Cattle	52(65.8%)	27(34.2%)		8(81%)	15(19%)	
Camel	56(73.7%)	20(26.3%)		8(82.9%)	13(17.1%)	
Sheep	43(72.9%)	16(27.1%)		6(88.1%)	7(11.9%)	
Wild dogs	33(76.7%)	10(23.3%)		4(81.4%)	8(18.6%)	
Antelopes	27(69.2%)	12(30.8%)		4(87.2%)	5(12.8%)	
Domestic dogs	20(83.3%)	4(16.7%)		3(87.5%)	3(12.5%)	
Total	316(75%)	104(25%)		44 (42%)	60(58%)	
Milk preparation before consuming						
Ferment without boiling	104(80%)	26(20%)	χ2=17.115; df=4; p=0.002	14(44%)	18(56%)	χ2=8.737; df=4; p=0.068
Partially heating milk	93(84.5%)	17(15.5%)		12(57%)	9(43%)	
Consume without boiling	60(64.5%)	33(35.5%)		10(36%)	18(64%)	
Thoroughly boiling	43(71.7%)	17(28.3%)		6(43%)	8(57%)	
Pasteurization of milk	15(57.7%)	11(42.3%)		2(22%)	7(78%)	
Total	316(75%)	104(25%)		44 (42%)	60(58%)	
Preparation of meat before consuming						
Taken raw	132(77.6%)	38(22.4%)	χ2=2.899; df=2; p=0.235	18(44%)	23(56%)	χ2=1.426; df=2; p=0.490
Roasted	125(71%)	51(29%)		18(38%)	29(62%)	
Thoroughly Cooked	58(79.5%)	15(20.5%)		8(50%)	8(50%)	
Total	316(75%)	104(25%)		44 (42%)	60(58%)	

4.5.4 Meat Preparation practices before consumption

Meat preparation practices before consumption is an important risk factor in the infection of brucellosis and the results are presented in figure 4.7. The study showed that most of the residents 42%,(n=176) took roasted meat while 17%, (n=71) took raw meat, a practice that is socially acceptable in the community.

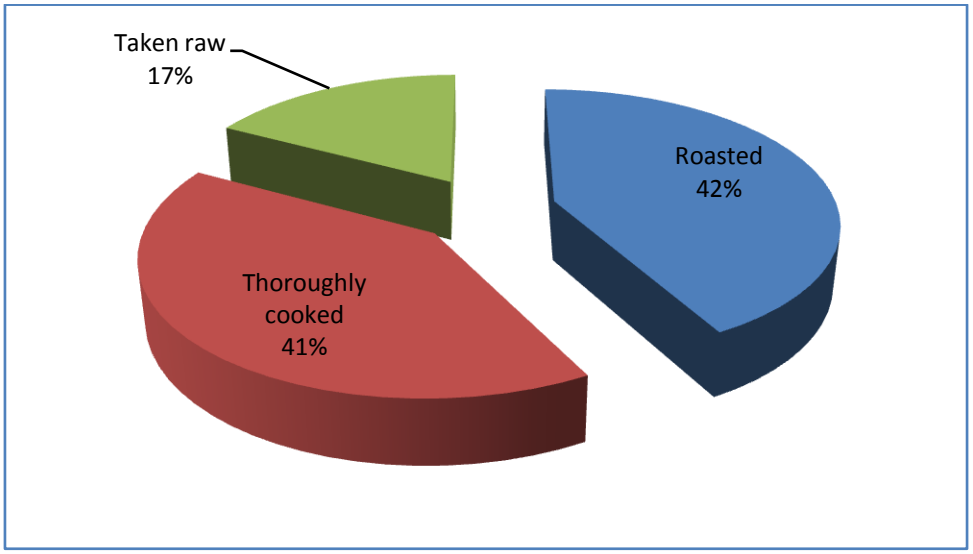


Figure 4.7: Proportion of respondents who prepared meat variously before consuming

However there was no significant relationship between respondents' method of meat preparation and RBPT status ($\chi 2=2.899$; df=2; p=0.235), or SSAT status ($\chi 2=1.426$; df=2; p=0.490).

4.5.5 Livestock Losses experienced by respondents

The respondents were asked the types of losses they experience with their livestock in order of priority and the results presented in figure 4.9. Majority (44.8%, n=188) stated that sterility was the lead cause of livestock losses. Other losses were experienced through abortion (34.5%, n=146) and reduced milk production (20.4%, n= 86). However, the type of livestock loss experienced by respondents was not

associated with their Brucellosis test status using RBPT χ^2=5.435; df=3; p=0.143) or SSAT (χ^2=0.651; df=3; p=0.885)

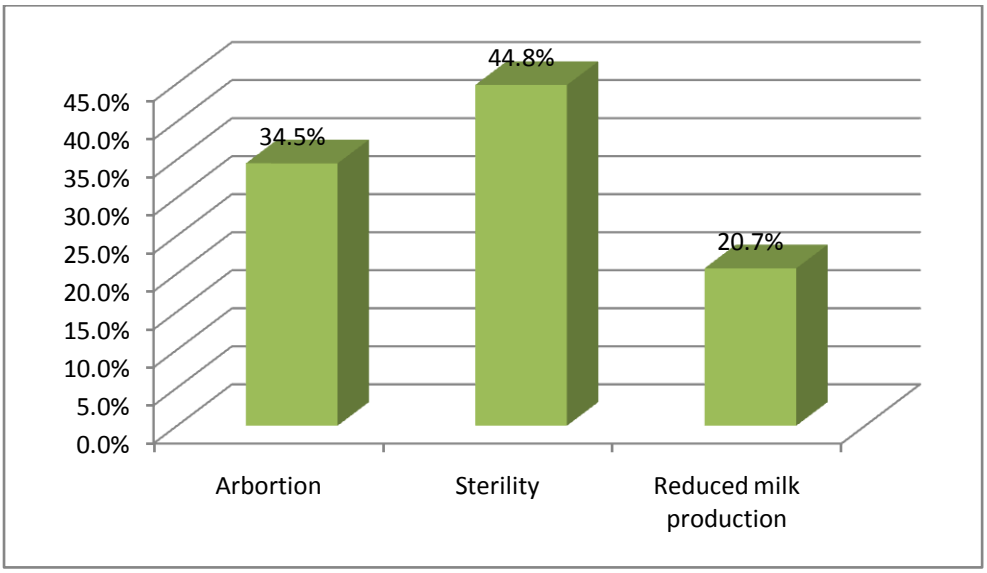


Figure 4.8:Proportion of respondents who experienced various types of Losses of their Livestock

4.5.6 Perception of respondents on control measures of brucellosis

Respondents were asked to state the methods they would suggest as control of brucellosis and their responses are presented in figure 4.9. The majority of the respondents who were aware of Brucellosis said that it could be controlled by avoiding the taking of unpasteurized milk and products (85%, n=247) while others suggested avoiding handling sick or dead animal bodies (70%, n= 203); cook meat thoroughly (65%, n=189) among other methods.

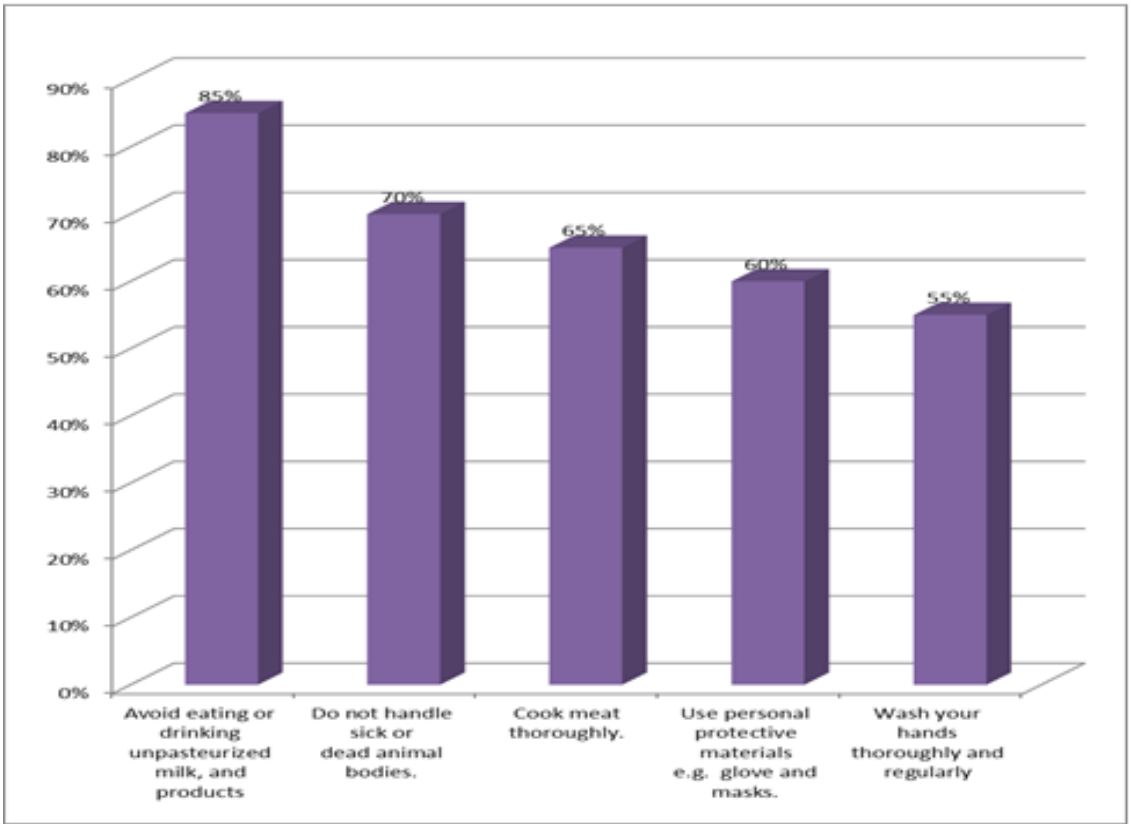


Figure 4.9: Proportion of respondents who cited various types of control

CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussion

In this chapter is a presentation of discussion of results in relation to literature review. The discussion is guided by the research questions and objectives of the study and the results obtained in the study.

5.1.1 Prevalence of brucellosis among community members in Mandera East Sub-county, Mandera County

The study established a high prevalence of brucellosis (24.8%) for Rose Bengal Plate Test (RBPT) and 14.3% for Serum Slow Agglutination Test (SSAT) among community members in Mandera East Sub-County. This was probably because the communities here are pastoralists who are in constant contact with animals. The findings of this study are consistent with Racloz *et al.,* (2013) who studied the persistency of brucellosis in pastoral systems. Very high prevalence (24.5%) has been reported in the Northern Sudan and 6.9% in Tanzania (Angara, *et al* 2004). Studies done by Muriuki *et al*., (1997) and Richards *et al*.,(2010) in Kenya showed that human brucellosis is more common where extensive cattle production systems predominate with almost a prevalence of 14% to 21%. However the result from the study was higher than the 0.1% to 10.1% reported among high-risk people in other countries Zinsstag et al., (2007).

The study showed that people of age between 15-45 years of age were affected more, this was consistent with report from northern Saudi Arabia which found that cases of brucellosis occurred mainly in individuals aged 13-40 years with younger than 13 years and less in those aged 40-60 years (Fallatah, et al., 2005). This age group plays

an important role in livestock herding and birthing and have direct contact with animals and aborted materials. However that seropositives were found in all age groups, this may indicate ongoing exposure and transmission of brucellosis.

The study showed a significant difference between gender and RBPT status of the respondents. Men were more infected than their women counterparts. This would be because men were much more in contact with livestock. This is consistent with study done by Mantur et al., (2007), Young et al., (2000) who showed that brucellosis may be more common in males in areas where it is an occupational hazard of farmers and shepherds, butchers or veterinarians.

Marital status, age, level of education, and occupational of the respondents didn't influence their RBPT or SSAT status. Whether married or not married, at any age, any level of education and in whichever occupation Brucellosis infection can occur provided one is in contact with infected animals or their products. The results of this study concurs with results of work done by Mantur et al., (2007) who observed that both males and females in all age groups are affected equally in particular when dairy is the most common source of infection. Likewise Zafer et al., (2005)observed that level of education did not always translate to good hygienic standards. Similar results were found in Uganda by Nakavuma and Opuda-Asibo (1999) who observed that Socio-demographic factors (age, sex, education level, religion) were all not significantly associated with *Brucella* infection unlike in other studies.

5.1.2 Awareness on brucellosis among community members in Mandera East Sub-county

The studies showed that almost a third of the respondents were not aware of Brucellosis. This was consistent with other studies which have been conducted elsewhere (Adesiji et al., 2005; Mubyazi et al., 2013).The level of awareness of the respondents was found to be significantly associated with their level of education. The number of respondents who were aware of Brucellosis increased with the level of education of the respondents. This was consistent with studies done by (Adesiji et al., 2005andMubyaziet al., 2013). Marital status, age, gender and occupational status of the respondents did not have association with their awareness on the disease.

5.1.3 Factors associated with spread of brucellosis among the community members in Mandera East Sub-county

Getting into direct contact with animals was found to be one of the risk factors of Brucellosis transmission. This is consistent with observations made by Jones et al., (2008) that nearly two-thirds of human pathogens are zoonotic and, of greater concern, nearly three-quarters of emerging and re-emerging diseases of human beings are zoonoses. It is Nicoletti(1992) who stated that nearly every case of human brucellosis has an animal origin and endemicity of the disease in animals poses a continuous risk for human infection. A study by Kenneth et al., (2009) indicated high brucellosis prevalence among the study participants who had handled animals or their products in one way or the other.

Majority of respondents who didn’t have contact with livestock tested negative implying that professions associated with livestock increased the risk of brucellosis infection. These results are consistent with studies performed in Sub-Saharan Africa

that suggest that cattle are a significant source of *Brucella spp*. for humans, if not the most important one. It remains to be known if cattle are mainly infected with B. *Melitensis*(which is documented in North Africa) or with *B. abortus* like documented in Zimbabwe or with both *Brucella* species like recently described in Kenya (Godfroid, 2013).

Respondents mostly had direct contact with goats, sheep, cows, camels and other non-food animals which increased probability of infection as indicated by Nicoletti, (1992) and Tzaneva et al.,(2007) where nearly every case of human brucellosis has an animal origin.

Results from key informant interviews indicated that animal afterbirths are not properly disposed but are just left to rot or be fed on by scavengers. Fewer respondents immediately disposed placenta after livestock abortion or full term parturition by burying or burning. This increased the risk of infection as large quantities of the bacteria are excreted with the foetus, placenta and the uterine fluid, mainly at the time of calving. After an abortion or parturition, the organism continues to be excreted mainly via milk of infected cows serving as continued source of infection to humans (Mangen et al., 2002). Human to human transmission and congenital infection have also been documented (Frank et al.,1993; Oded et al.,2007). It is usually recommended through World Animal Health Organization that those who work as veterinarian, laboratory (microbiologist) and in slaughter houses be protected from inoculation with *Brucella* through aerosolization of fluids, contamination of skin abrasions and splashing of mucous membrane by use of protective gear and gloves which is a good precaution measure as exposure through breaks in the skin, following direct contact with tissues, blood, urine, vaginal discharges, aborted foetuses or placentas are also possible routes of transmission of the disease (Gerald et al., 2009).

Another risk factor which was found among the members was consuming milk which is not properly prepared. Many respondents fermented and consumed milk without boiling or pasteurizing it. These results were consistent with previous studies Geoffrey et al., 2002; Kenneth et al., 2009; Mutanda et al., 1998) who noted that unprocessed milk from the market and consuming it raw were independently associated with brucellosis. Mode of milk preparation before consumption contributed to the prevalence where majority of the infected respondents consumed un-boiled and fermented milk. The prevention of brucellosis infection in humans is a major reason for the advocacy of milk pasteurization worldwide (Staal, 2000). This is in line with findings from Omoreet et al.,(1999) where in Kenya, over 85% of marketed milk is not pasteurized and is sold through informal market pathways. As indicated by Kang'ethe, (2000) concerns about human health risks from market pathways need to be addressed in the context of consumer practices, such as boiling, to reduce or eliminate potential infection by milk-borne health hazards, without discouraging the smallholders milk markets. Meat was mostly cooked before consumption, roasted and thoroughly cooked which reduced risk of infection.

5.2 Conclusions

i) The prevalence of brucellosis was 24.8% (95% CI: 20.0–29.6)using Rose Bengal Plate Test (RBPT) and 14.3% (95% CI: 8.7–19.9)using Serum Slow Agglutination Test (SSAT) among community members in Mandera East Sub-County.

ii) The study showed that majority of the respondents (69%) were aware of brucellosis while only 31% of the respondents were not aware of brucellosis as a disease

iii) Factors associated with spread of brucellosis among the community members in Mandera East Sub-county include directly getting into contact with animals such as goats, cows, wild animals dogs, camels, and sheep and taking poorly prepared milk; consuming raw blood from livestock; taking raw or poorly cooked meat and getting involved in various activities touching on livestock.

5.3 Recommendations

5.3.1 Operational recommendations

This study gives the following recommendations

i) Sub-county of Mandera East should find out an appropriate way of dealing with the high prevalence rate of brucellosis in the area.

ii) Scaling up of awareness of brucellosis among the community members is required. This can be done by the relevant Ministries in Sub-County government of Mandera East.

iii) The community members in Mandera East Sub-County should be sensitized on to prevent themselves from Brucellosis infection which is due to various risk factors as found in the study.

iv) The contribution of non-conventional livestock species (wildlife such as antelopes) to human brucellosis needs to be addressed by Kenya Wildlife Services.

v) Most human brucellosis cases have mainly two different origins: food borne (milk and milk products) or occupational (farmer, butcher, veterinarian,). If human cases are predominantly found in certain professional categories, it suggests that sanitary measures related to milk and milk products are well implemented, whereas control should be enhanced in the reservoir animal species

5.3.1 Recommendations for further research

i) The need for further study on the effects of Brucellosis infection among community members in Mandera East Sub-County

ii) A study is required on the appropriate and sustainable methods of dealing with high prevalence of brucellosis in Mandera East Sub-County.

iii) There is need for further study to establish the existence and prevalence of other zoonotic diseases in Mandera East Sub-County

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APPENDICES

Appendix I: General Patient Information and Consent Form

Introduction

Participation in this study is voluntary. We aim to find out the trend and factors associated to prevalence of Brucellosis.

What is Brucellosis?

Is a zoonotic infection caused by the bacterial genus *Brucella*. The bacteria are transmitted from animals to humans by ingestion through infected food products, direct contact with an infected animal, or inhalation of aerosols.

What is involved in this study?

Once you consent for your participation, we will take your age, sex, race, marital status, level of education, profession and history on exposure to Brucellosis

Are there any risks involved?

There are no risks involved filling in the questionnaire

Will I be penalized for not participating?

No, you will not be penalized for failure to participate in the study.

What benefits will I get if I participate?

Information regarding the trend and factors associated to prevalence of Brucellosis is vital for further prevention of the disease to the community at large. You can access the findings from the Veterinary Offices once the study is over.

What about confidentiality?

All the information we obtain will be kept confidential

How much will it cost me?

No extra cost will be incurred

What are my rights as a participant?

Participation in the study is voluntary. Once inducted in the study, you can choose to discontinue at any time.

What do you do with the information you get?

This information will help us understand the disease better. Like any other scientific information, we will seek to share our findings with the Ministry of Health and the rest of the world.

Are you satisfied with the information given?

If yes, fill in and sign the consent form below:

Appendix 2: Consent for the Study

I……of……
…….. Location/Hospital Study no……. I voluntarily agree to participate in this research. The nature of the study has been fully explained to me by Dr. Abdirahman S. Abdalla. I have not been promised any material gain to participate.

Signature ……

Date …….

If you want to know more or have any queries about this study you can contact the following:

DrAbdirahman S. Abdalla (Researcher)
C/o Kenyatta University
Department of Public Health
Nairobi
Mobile No.: 0721686376
Email: dr.asabdalla@gmail.com

Appendix 3: Self-Administered Questionnaire

Section A: Demographic Characteristics

1. **Age (in years)** …….
2. **Sex** Female ☐ Male ☐
3. **Marital Status**:

Single ☐ Married ☐ Separated/Divorced ☐ Widowed ☐

Other Specify…….

4. **Religion**

Christian ☐ Muslim ☐ *Other Specify*……

5. **Level of education**

a) Never been to school (Informal Education) ☐
b) Never completed Primary school ☐
c) Completed Primary School ☐
d) Never completed Secondary school ☐
e) Completed Secondary School ☐
f) Post Secondary School Education ☐

6. **For how long have been in the Mandera East District?.....years**
7. **What is your profession?**

a. Pastoralist ☐
b. Agro-pastoralist ☐
c. Farmer ☐
d. Formal employment ☐
e. Casual employee ☐
f. Unemployed ☐

g. Other, specify…….

Section B: Brucellosis Factors

8. Do you know what Brucellosis is?

Yes ☐ No ☐

9. If yes, what is the source of Brucellosis?

……

……

10. What are the symptoms of Brucellosis?

……

……

11. Have you ever been infected with Brucellosis

Yes ☐ No ☐

If No, skip to question 10

If Yes, when were infected with Brucellosis

a) Last one week ☐

b) Last two weeks ☐

c) Last one month ☐

d) More than one month ago ☐

Did you seek medication?

Yes ☐ No ☐

If Yes, where did you get treatment

a. Public Hospital ☐

b. Private Hospital ☐

☐

c. Traditionalist

d. Other, Specify ……

Did you fully get well?

Yes ☐ No ☐

Section C: Transmission to Human Beings

12. Are lactating mothers tested for Brucellosis before and during the breastfeeding period?

Yes ☐ No ☐

13. How do you prepare milk before consuming?

a. Pasteurization before consuming ☐

b. Ferment without boiling ☐

c. Partially heating the milk ☐

d. Consume without boiling ☐

e. Thoroughly boiling ☐

14. How do you consume blood from livestock?

a. Drink uncooked ☐

b. Cook before drinking ☐

15. How do you prepare meat before consuming?

a. Roast ☐

b. Take raw ☐

c. Thoroughly cook ☐

16. Which of the following animals do you have direct contact with

a. Sheep ☐

b. Goats ☐

c. Cows ☐

☐

d. Dogs

e. Wild animals (Rabbit/ Hare/ Reindeer) ☐

f. Pigs ☐

g. Camels ☐

h. None of the above ☐

17. Which of the following have you experienced as losses in your livestock?

a. Abortion ☐

b. Sterility ☐

c. Reduced milk production ☐

d. None ☐

18. In which of the following activities have you been involved in?

a. Working in a Slaughter house ☐

b. Handling aborted anamals ☐

c. Working in a Farm ☐

d. Veterinarian services ☐

e. Packing meat of dairy products ☐

f. Travelling areas with animals infected with Brucellosis ☐

g. Physician (Veterenary department) ☐

h. Pathologist (Veterinary department) ☐

i. Working in Laboratory (Microbiologist) ☐

j. Herding ☐

k. Hunting ☐

l. Abattoir worker ☐

m. None ☐

19. If you have worked or work in a slaughter house in which of the following are you protected from?

a. Inoculated with *Brucella* through aerosolization of fluids ☐

b. Contamination of skin abrasions ☐

c. Splashing of mucous membrane ☐

d. None ☐

If protected, how?

…….....

…….....

20. If you have worked or work as a veterinarian are you protected from advertent inoculation of animal vaccines?

Yes ☐ No ☐

If protected, how?

…….....

……

21. If you have worked or work in a laboratory (microbiologist) are you protected from exposure by processing specimens (aerosols)?

Yes ☐ No ☐

If protected, how?

…….....

……

.....

22. Have you experienced a large outbreak of Brucellosis that can be linked to biologic weapon released?

Yes ☐ No ☐

If yes, how did you respond?

…….....

……

.....

Section D: Transmission between animals

23. Do you immediately dispose placenta after livestock abortion or full term parturition?

Yes ☐ No ☐

If yes, how?

……

……

…….....

24. Do your livestock have contact with material/ aerosol infection, grazing on contaminated pastures and other materials?

Yes ☐ No ☐

25. Are livestock exposed to dogs from within or other places?

Yes ☐ No ☐

26. Do you use disinfectants on the livestock?

Yes ☐ No ☐

27. In the event of outbreak of Brucellosis which of the following is conducted?

a. Mass vaccination of livestock ☐

b. Strict surveillance of Brucellosis ☐

c. Creation of Brucellosis-free flocks ☐

d. Creation of Brucellosis-free zones ☐

e. Test and slaughter program ☐

f. Mixing flock in transhumance areas ☐

g. Movement of flock to different areas ☐

h. Support from the Government (financial, training & sensitization) ☐

i. None of the above ☐

Section E: Training and Sensitization on Brucellosis

28. Have you been informed about the following issues partaining Brucellosis through training or sensitization (*Please tick appropriately*)

Trained or Sensitized	**Yes**	**No**
The nature of the disease and the routes by which it can be transmitted		
The symptoms, complications, and treatment of the disease, as well as the risk of relapse, if it is not adequately treated		
The potential adverse effects of the medications administered		
The need for strict compliance with the antibiotic regimen		
In soma case, reassurance concerning recurrent symptoms that are not associated with clinical or laboratory evidence of acute brucellotic disease		
The need to avoid potential sources of infection – This may involve avoiding infected animals, using stricter precautions (e.g., gloves and mask) when dealing with a potentially infected animal, or avoiding potentially contaminated foods		
For farmers and ranchers, immunization of their cattle against the disease as necessary		
For laboratory workers, maintenance of the appropriate level of containment		

FOR OFFICIAL USE ONLY (CULTURE AND SERELOGIC TEST OUTCOME)

The outcome of test on respondent

Positive ☐ Negative ☐

The outcome of test on dairy goat

Positive ☐ Negative ☐

Appendix 3: Key Informant/ Focus Group Guide

1. What is Brucellosis?
2. What is the source of Brucellosis?
3. What are the symptoms of Brucellosis?
4. Once infected with Brucellosis, what are the procedures to follow?
5. How do you prepare milk before consuming?
6. How do you consume blood from livestock?
7. How do you prepare meat before consuming?
8. How do you control direct contact with animals?
9. How do you immediately dispose placenta after livestock abortion or full term parturition?
10. Do your livestock have contact with material/ aerosol infection, grazing on contaminated pastures and other materials?
11. Are livestock exposed to dogs from within or other places?
12. Do you use disinfectants on the livestock?
13. In the event of outbreak of Brucellosis which are the followed procedures?
14. Have you been informed about issues partaining Brucellosis through training or sensitization?

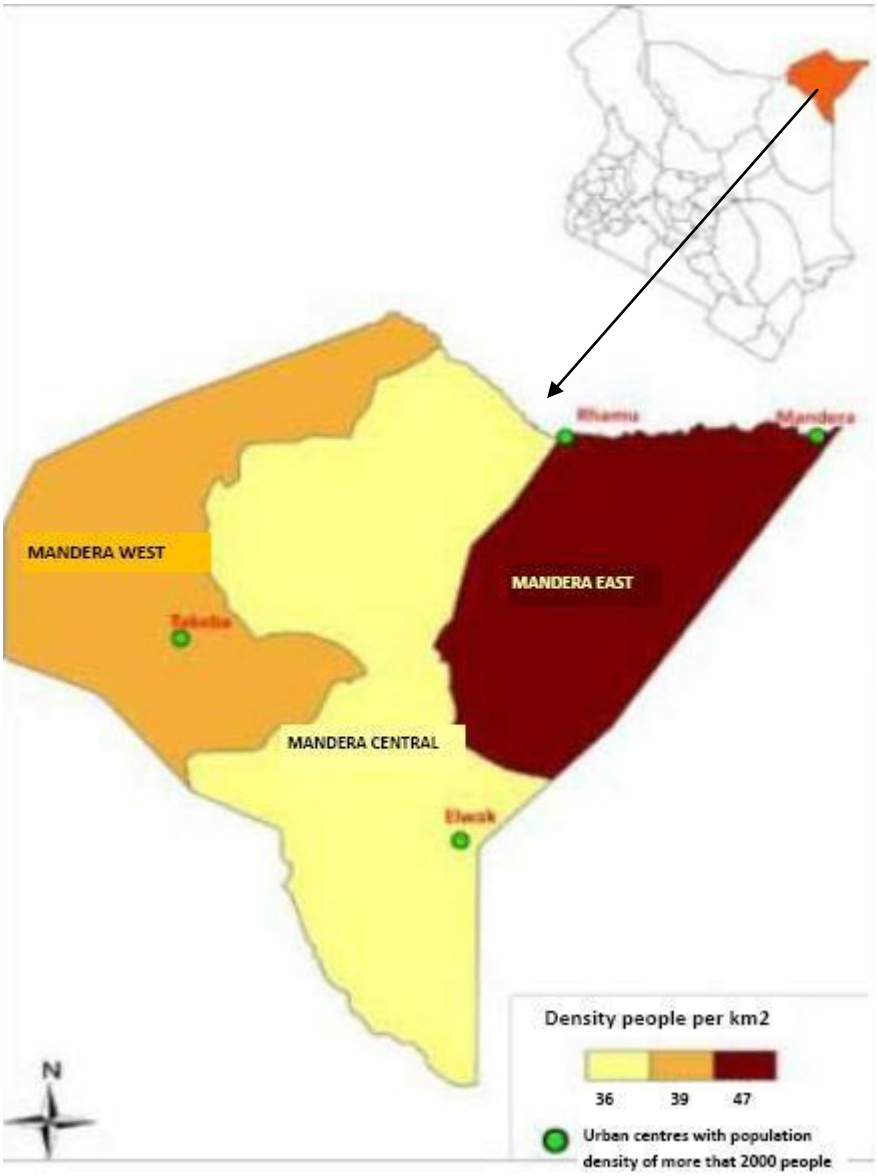
Appendix 4: Proposed Research Budget

Description	**Price per unit**	**Quantity**	**Total(kshs)**
Thesis writing	3,000	8	44,000
Questionnaire	50	420	124,000
Research assistant	2,5000	1	60,000
Stationery	1,500	1	8,500
Pilot study	20,000	1	150,000
Travelling expenses	3,000	4	140,000
Data analysis	30,000	1	70,000
Thesis writing	3,000	6	36,000
Contingency (10%)			90,150
Total			**722,650**

Appendix 5: Proposed implementation timetable

	June 2014	July 2014	August 2014	September 2014	October 2014
Thesis development and presentation in the department					
Ethical review and approval					
Data collection					
Data analysis and Presentation of results					
Submission of results					

Appendix 6: Map of Study Area



Appendix 7: Research Permit NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:

4th December, 2014

NACOSTI/P/14/5030/4415

Dr. Abdirahman Sheikh Abdalla
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Prevalence and factors associated with brucellosis among community members in Mandera East Sub County, Mandera County,"*** I am pleased to inform you that you have been authorized to undertake research in **Mandera County** for a period ending **31st December, 2015.**

You are advised to report to **the County Commissioner, the County Director of Education and the County Coordinator of Health, Mandera County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the rese.arch report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: SECRETARY/CEO

Copy to:

The County Commissioner
Mandera County.

The County Director of Education
Mandera County.

Appendix 8: Consent Letter- Ethics Committee, Kenyatta University

KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Email: chairman.kuerc@ku.ac.ke
secretary.kuerc@ku.ac.ke
ercku2004@gmail.com
Website: www.ku.ac.ke

P. O. Box 43844 - 00100 Nairobi
Tel: 8710901/12
Fax: 8711242/8711575

Our Ref: KU/R/COMM/51/379 Date: 7th November, 2014

Abdirahman S. Abdalla
Kenyatta University,
P.O Box 43844, Nairobi

Dear Abdirahman,

APPLICATION NUMBER PKU/270/I 246– "PREVALENCE AND FACTORS ASSOCIATED WITH BRUCELLOSIS AMONG COMMUNITY MEMBERS IN MANDERA EAST SUB-COUNTY, MANDERA COUNTY, KENYA." – VERSION 2.

1. IDENTIFICATION OF PROTOCOL
The application before the committee is with a research topic, "Prevalence and factors associated with Brucellosis among community members in Mandera East Sub-County, Mandera County, Kenya" version 2, received on7th November, 2014.

2. APPLICANT
Abdirahman S. Abdalla

3. SITE
Mandera East Sub-County (Central and Khalahyo Divisions).

4. DECISION
The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines AND APPROVED that the research may proceed for a period of ONE year from 7th November, 2014.

5. ADVICE/CONDITIONS
i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.
iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.
If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

PROF. NICHOLAS K. GIKONYO
CHAIRMAN, ETHICS REVIEW COMMITTEE

I DR. ABDIRAHMAN S. ABDALLA accept the advice given and will fulfill the conditions therein.

Signature..... Dated this day of 7TH NOV 2014.

cc. Vice-Chancellor