SAFETY KNOWLEDGE AND PRACTICES OF CONSUMERS AND VENDORS OF MILK SOLD IN MILK DISPENSERS AND BARS AT EMBAKASI WEST SUB-COUNTY, NAIROBI.

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2023

DECLARATION

This dissertation is my original work and has not been submitted for award of a degree in any other University

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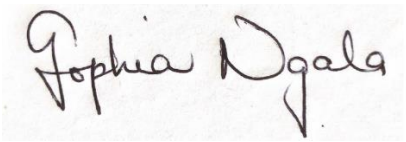

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LIST OF ABBREVIATIONS AND ACRONYMS

ATM……. Automatic teller machine

ANOVA……...Analysis of variance

CDC……. Centre for Disease Control

DNA……. Deoxyribonucleic acids

ELISA……. Enzyme-linked immunosorbent assay

GDP……. gross domestic product

IREC……. Institutional Research and Ethics Committee

KBS……...Kenya Bureau of Statistics

KDB……. Kenya Dairy Board

KNBS……Kenya National Bureau of Statistics

MRT……milk ring test

ODK……Open data kit

PCR……. Polymerase chain reaction

SD……Standard deviation

SE……. Standard error

SPSS……. Statistical package for social sciences

WHO……...World Health Organization

OPERATIONAL DEFINITION OF TERMS

Acute brucellosis- This occurs when there is an onset of symptoms from a period of 1-2 days to a course of some few weeks in some cases.

Autophagy- is the process by which the body destroys damaged cells to pave way for generation of new cells that are healthy.

Brucellosis- this is a bacterial disease that is transmitted to humans from animals mainly through the ingestion of unpasteurized milk and milk products.

Chronic brucellosis- This is the form of brucellosis which has lasted more than one year and occurs mainly when the disease is undiagnosed and untreated.

Conjunctiva- This is the mucous membrane that lines the inside of the eye.

Endemic- A disease is said to be endemic if it has a constant prevalence in a particular geographical area.

Endosome- are a heterogeneous collection of organelles that function in the sorting and delivery of internalized material from the cell surface and the transport of materials from the Golgi to the lysosome or vacuole.

Febrile illness- It is used to describe an instant fever in the body.

Fomites- These are objects that can transmit diseases, such as furniture, utensils, and clothes.

Household- These are a group of people that live within the same compound and share meals.

Pandemic- This is an epidemic affecting several countries and huge number of people.

Zoonosis- is an infection that can be transmitted from animals to humans.

ABSTRACT

Brucellosis is a significant zoonotic disease that is widespread worldwide and can cause adverse economic losses in case of an outbreak. The prevalence of brucellosis in Sub-Saharan Africa in humans is estimated to vary between 5–55% in different African countries whereas for domestic ruminants it varies from 8–46%. This study examined the consumer and vendor Brucella milk safety knowledge, handling practices and Brucella prevalence in milk sold in milk dispensers and bars in Embakasi West sub-county. A cross sectional study design was used to collect information on demographic characteristics, food safety knowledge, Self-reported Brucellosis infections, Consumers gave information on milk quantities sourced and usage while vendors were asked characteristics of the milk they sell, Microbiological analysis was done on fresh and fermented (mala and yoghurt) milk samples that were collected from the milk vendor machines and milk bars. SPSS analysis was used to do Descriptive statistics for means and proportions while inferential statistics was used for determining associations with chi- square, correlation and regression. A random sample of 229 consumers and 18 vendors from each of the 18-milk sample collection point were interviewed with 37 samples from the 18-sample collection point collected for analysis. Results show that there were more females respondents interviewed (59.8%) than male respondents (40.9%) (P-value=0.0656) for consumers and equal distribution for vendors (males-50% and females – 50%). The proportion of consumer respondents self-employed were 36.2 %, salaried employees 31.4%, students were 14.8% while the remaining percentage were distributed amongst casual labourers (9.2%), house wife (4.8%) and unemployed (3.5%) (P-value =0.685). While half (54.2 %) of the vendors, were self-employed, 41.7% salaried employees, students were 4.2% (p-value =0.365). The income of consumers respondents ranged between KES 1, 000 and KES 50 000 with a half of them (57.6%) earning an income between KES1, 000 and KES10, 000 (p-value =0.045). The vendor respondents, income ranged from KES 1,000 to KES 50,000 with that majority (83.4%) of respondents earning between KES 1000 – KES 20,000 (p-value =0.855). A majority of the consumer respondents (91.7%) had an education level of secondary school and above with only 7.4% having completed primary school education p-value=0.254). Whereas for vendors, 91.7% had completed a minimum secondary school education whereby those with primary school education were 8.3%, secondary school education were 45.8% and 16.7% for each category with college certificate and university degree (p-value =0.0354). Vendor respondents with college diploma were 12.5% (p-value =0.0354). It was observed that the majority of consumers had the knowledge of the mode of Brucella transmission and control

with 96.1% of the consumers (p-value =0.012) and 91.7% of vendors (p-value =0.033) had the knowledge that Brucella is transmitted via milk, whereas 94.8% of consumers (p-value =0.018) and 91.7% of vendors (p-value =0.294) had the knowledge that pasteurization eliminates Brucella in milk. 82.1% of consumers (p-value =0.025) and 75% of vendors (p-value =0.013) had the knowledge that fermentation has no impact on Brucella in milk. Slightly less than half (48.9%) of consumers (p-value =0.069) and 91.7% of vendors (p-value =0.026) had the knowledge that the milk they purchased and sold was pasteurized, while 94.8% of consumers boiled the milk they purchased prior to consumption (p-value =0.045). According to the study results, 3.5% of consumers (p-value =0.012) and 8.3% of vendors (p-value =0.021) had been diagnosed with Brucellosis within the last one year. An analysis of all fresh and fermented (mala and yoghurt) milk samples obtained from each of the 18 milk sampling points showed negative results for Brucella presence test. A Chi-Square Test done to assess the relationship between the three variables (demographic characteristics, level of knowledge of Brucella milk safety, and milk handling practices) and self-reported infections showed that there was not a significant relationship between the variables (P=1.969, P=0.659 and P=0.593 respectively). Consumers and vendors had knowledge of milk safety and handling practices, however, they did not have knowledge in hygiene, cleanliness and fermentation as a way of controlling transmission of Brucella. There was low infection by brucellosis disease on both consumers and vendors at Embakasi West. There was no presence of Brucella in the fresh and fermented milk samples collected from Embakasi West. Respondents should be encouraged to obtain further education on appropriate food safety practices, further trained on effective control methods of Brucella in milk and also the regulatory agencies should continue enforcing the measures put in place to ensure that all marketed milk within Embakasi West are pasteurized.

CHAPTER ONE: INTRODUCTION

1.1 Background

Brucellosis is regarded as one of the most widespread zoonotic infections across the globe whose public health implications are enormous (McDermott *et al.*, 2013). The World Health Organization (WHO) classifies it as a neglected zoonotic infection together with seven other diseases (WHO, 2005). There are estimated worldwide brucellosis cases of more than 500,000, however this figure is probably an underestimation as many of the affected countries lack effective infrastructure for diagnosis and besides brucellosis shares a wide range of symptoms with other diseases (O'Callaghan, 2020). Even though the infection has been completely eradicated in majority of the developed countries, it stills remain a public health issue in Latin America, middle east, Africa, and Central Asia.

In Sub-Saharan Africa, diagnosis is usually a challenge because of the wide range of signs, symptoms and inadequate effective diagnostic apparatus and equipment. This often leads to misdiagnosis such as with malaria or other febrile diseases. Therefore, brucellosis is most likely underreported and it becomes a burden in developing countries. The infection does not receive the adequate health systems' attention in these countries. For this and other reasons, the WHO classifies brucellosis as one of the top neglected zoonotic diseases. The prevalence of brucellosis in Sub-Saharan Africa in humans is estimated to vary between 5–55% in different African countries whereas for domestic ruminants it varies from 8–46% (Skalsky *et al.*, 2008). The disease is caused by *Brucella species* and is known by many names such as Bang's disease, Gibraltar fever, Mediterranean fever, contagious abortion, or infectious abortion. It affects many animal species across the globe. The genus *Brucella* has 12 different species, with those of concern to livestock and humans being *B suis, B. abortus* and *B melitensis*. However, those known to cause most of human infections are *B. abortus* and *B. melitensis* (Godfroid *et al.*, 2011).

In animals, it localizes more in the udder and reproductive organs where the retro mammary lymph nodes may become permanently infected. The frequent discharge of the microorganism into the milk poses a risk to those who consume unpasteurized milk and milk products. Brucellosis affects are number of animals resulting in abortions, infertility and decreased milk yield thus causing tremendous enormous losses in livestock farming (Corbel, 2006).

Human brucellosis causes systemic disease which can lead to either acute or chronic relapsing course. Signs and symptoms are highly variable and nonspecific. Infection can either be acute or chronic. If acute phase is not treated, it may lead to the chronic phase which will last as long as the host is alive without treatment and can lead to permanent disability (Dean *et al*., 2012). Patients usually experience a variety of symptoms that includes headache, undulant fever, myalgia, arthralgia and chills. It is also linked with other symptoms such as acute renal failure, abortion, endocarditis, orchitis, encephalitis, arthritis, spondylitis and splenic abscess. Transmission to humans is mainly through direct or indirect exposure to an infected animal or by consuming milk or its products (Corbel, 2006). It is also an occupational disease where individuals that work closely with infected herds such as abattoir workers, veterinarians, laboratory personnel and farmers may be get infected. Consequently, consuming raw milk and their products is arguably one of the most important factors in brucellosis transmission. This is as due to the form in which milk and milk products are consumed which varies according to cultural habits and unhygienic, unhealthy factors in the preparation process of these products (Sam *et al*., 2012; Lindahl *et al*., 2015; Taiwan CDC, 2011). Many pathogenic organisms, such as *Brucella*, may remain viable if milk is raw or the pasteurization temperature is not achieved (Lindahl *et al*., 2015).

Kenya has implemented a number of measures to ensure safety of milk marketed to consumers. One effective measure was recommended in the National Dairy Development policy of 2013 and it proposed to educate and certify small scale milk vendors on proper and safe milk handling practices. This led to improvements on general hygiene and microbial qualities of milk. The government of Kenya also, through the Kenya Bureau of Standards, developed relevant policies in the code of hygienic practice for milk and milk products (KS1552:2016) which included the policy prohibiting the marketing of raw milk to consumers within municipalities. This in effect means that all milk offered for sale within Embakasi West have been subjected to a form of pasteurization adequate to eliminate Brucella in milk (Delia *et al.*, 2018).

This study aimed to examine the milk vendor and consumer *Brucella* milk safety knowledge and milk handling practices and the prevalence of *Brucella* species in fresh and fermented milk sold in milk dispensers and milk bars in Embakasi West sub-county, Nairobi, Kenya.

1.2 Statement of the problem

In the recent past, cases of brucellosis infections have been reported across the country, despite several efforts put in place by Kenya Dairy Board and Kenya Bureau of Standards to reduce these cases. A research done by Martin W. *et al*. in the year 2019, in a study done in Isiolo and Marsabit counties, the prevalence of brucellosis was 26% at 95% confidence level in individual animal samples when determined using ELISA. The study returned 2.4% positive results at 95% confidence level when determined using qPCR (Wainaina *et ai*., 2019). Despite brucellosis being widely distributed and having adverse effects on both livestock and humans, prevalence of brucellosis estimates is still not provided (Njeru *et al., 2016)* and this can be attributed to misdiagnosis and lack of effective diagnostic tools s (Jennings *et al*., 2007).

According to recent reports and studies, the per capita milk consumption is anticipated to have increased to a figure double the current estimate of 110 litres by 2030 (KDB 2016; Rademaker *et al*., 2016). Thus, in order to fill this gap and to address the safety concerns, milk vendors have come up with innovations such as the milk dispensers otherwise known as milk ATMs and milk bars to supply pasteurized milk to consumers (Kosgey *et al*., 2018; Bebe *et al*., 2018). At Embakasi West (like most parts of Nairobi) the nature of operations where milk is sold unpackaged, exposed and also the potential intentional non-compliance to policies laid out in the code of hygienic practice for milk and milk products (KS1552:2016) and possible neglect of quality standards required for milk safety compromises the safety of milk offered to customers. Therefore, this creates serious limitations for quality control and surveillance of milk sold in milk dispensers otherwise known as milk ATMs and milk bars. It is not known whether the consumers and vendors of milk form ATMS and bars are aware of the safety needs that are necessary when handing the milk. The vending machines cleanliness is also left to the vendors who might not be informed of the risks that might be encountered if it is not well handled. Thus, to facilitate any form of intervention it is necessary to research on the consumer and vendor Brucella milk safety knowledge, and handling practices and Brucella prevalence in milk sold in milk dispensers and bars in Embakasi West sub-county.

1.3 Justification of the study

Approximately up to 80% of milk produced in Kenya are traded in the informal segment of the sector (KDB, 2020). The milk ATMs and milk bars does away with processing and packaging costs and thus offer affordable milk and milk products to its customers. However, there exist a knowledge gap with regards to information on operations of these businesses coupled with regulatory gaps that have increased doubts about the safety of the products the businesses are offering (Bebe, 2018).

This study aimed to benefit consumers to obtain information on the distribution of *Brucella species* in the milk they consume for better decision making and on the association between the risk of infection of *Brucella species* with the level of knowledge of *Brucella* milk safety of milk vendors and consumers and their milk handling practices. It will provide relevant departments in the ministry of Health with information on the spread of brucellosis within Embakasi West (and Nairobi at large) for targeted interventions. It was also to help regulatory agencies to develop policies and regulations that target specific areas and actors in the milk supply chain. Furthermore, the Universities and training institutions will benefit from this research by obtaining information on the prevalence of Brucella in Embakasi West and thus adding to the pool of reference available for future. Finally, the community health worker will benefit with information that assist them on adding more to their training content for communities within Embakasi West.

1.4 Aim and purpose of the study

1.4.1 Aim of the study

To contribute towards the reduction of cases of brucellosis infections arising from ingestion of fresh and fermented milk sold in milk dispensers and milk bars.

1.4.2 Purpose of the study

To produce information on the milk vendor and consumer *Brucella* milk safety knowledge and the prevalence of *Brucella* species in Embakasi West sub-county, Nairobi Kenya that can be used by the stakeholders in the milk value chain towards the reduction of transmission through milk consumed on a daily basis.

1.5 Objectives of the study

1.5.1 General objective

To determine the safety knowledge and practices of milk consumers and vendors and to assess the prevalence of Brucella species in fresh and fermented milk sold in in Embakasi West sub-county, Nairobi Kenya.

1.5.2 Specific objectives

1. To determine the demographic characteristics milk vendors and consumers in Embakasi West sub-county, Nairobi Kenya.
2. To assess the level knowledge of *Brucella* milk safety and milk handling practices among milk vendors and consumers in Embakasi West sub-county, Nairobi Kenya.
3. To establish the prevalence of self-reported *Brucella* species infection among milk vendors and consumers in Embakasi West sub-county, Nairobi Kenya.
4. To analyse the pH and prevalence of *Brucella* species in milk sold in milk dispensers and milk bars in Embakasi West sub-county, Nairobi Kenya.

1.6 Research hypotheses

1. There exist no positive association between demographic characteristics of milk vendors and consumers and prevalence of self-reported *Brucella* infections.
2. Inadequate knowledge and milk handling practices by milk vendors and consumers does not lead to *Brucella* infection.
3. The inadequate milk safety knowledge and handling practices has led to a high number of self-reported Brucella infections among milk vendors and milk consumers.
4. The inadequate milk safety knowledge and handling practices led to milk sold at milk dispensers and bars to contain a high level of *Brucella* species on analyse and a high ph.

1.7 Assumptions of the study

The current laws in Kenya prohibits the marketing of unpasteurized milk directly to consumers with the exception of milk sold by producers to consumers within two

kilometres of each other. Due to this therefore, it was assumed that the milk marketed within the study area have been subjected to pasteurization and thus return zero positive results in the samples tested for *Brucella*.

1.8 Limitations of the study

The nature of this study and the type of questions respondents are required to respond to may prompt them to be unwilling to be interviewed.

1.9 Delimitations of the study

This study was confined to Embakasi West sub-county in Nairobi County.

1.10 Risks and potential adverse effects of the study

There were no foreseen risks or potential adverse effects of this study.

CHAPTER TWO: LITERATURE REVIEW

2.1 The dairy industry in Kenya

The Kenya dairy industry contributes an estimated value of 4% of the national gross domestic product (GDP), 12% of the Agricultural gross domestic product (GDP) and 44% of the livestock GDP. It has over 4.5 million heads of cattle with over 1.8 million farmers practicing smallholder dairy farming. The dairy industry is a significant socio-economic activity in Kenya, creating 1.8 million direct or indirect jobs. It also provides income and a steady source of nutritious food in the rural areas (KDB, 2020).

Kenya's dairy industry is one of the biggest in Africa in terms of milk production with a high of 5.2 billion litres in 2016 (KDB, 2020). The country is also leading in per capita consumption in sub-Saharan at 120 which is expected to double by the year 2030 (The dairy industry in Kenya, 2020). Milk demand is increasing due to urban development, middle class that is steadily increasing and opportunities for export in the region. Formally marketed milk is over 600 million litres of every year (KDB, 2020) which is attracting private investors both internal and international to exploit this market for local and export business. The industry is expected to make a significant contribution to the big four agenda as envisioned by the Government of Kenya owing to its estimated GDP contribution. According to KDB, the country's milk production crossed the 5 billion mark in the 2016 when a total of 5,275,345,000 billion litters was produced, as compared to 4,550,558,000 billion in 2015 and 4,759,526,000 billion litres in 2017 (KDB, 2020).

2.2 History and general overview of *Brucella*

Brucella species are small, Gram-negative, facultative coccobacilli, having a microscopic appearance of 'fine sand', most of which lack a native plasmids, capsule, or endospores (Ramos and Ramalho, 2008). They are intracellular inside the host organism and show persistence in the environment outside the host organism. Their intracellular trafficking includes two to three steps, beginning with endosomal vacuoles, followed by deriving of compartments in the endoplasmic reticulum and then vacuoles that have various markers of atypical autophagy (He, 2012). They are able to survive extreme pH, humidity, temperature, and also in aborted materials that have been frozen. There are 9 distinct species of *Brucella* but the ones that are of pathogenic importance are *B. suis, B. canis, B. melitensis, B. ovis* , and *B. abortus*, whereas

B. neotomae has not been associated with any specific disease. Those that are responsible for human diseases are *B. abortus*, *B. suis* and *B. melitensis* (Corbel and Thomas, 2006).

Brucella cultures usually occur either as smooth and non-smooth forms of smooth cells or rough forms. However, they are usually classified either as rough or smooth when identified on selective or basal media (Ramos, 2008). They have a periplasmic space under the cell wall that is thought to be the location for different kinds of hydrolytic enzymes (Aminzadeh *et al*., 2010). Regardless of the particular technique, Brucella have the ability to quickly cross the obstruction within mucosa with little activation of the defense mechanism in the host. Furthermore, Brucella most likely influence and utilize the immune system of the host for its benefit the as shown by the down regulation of cytokine expression inside the intestine immediately after infection (Rossetti *et al*., 2013).

Brucella organisms in their vegetative form may be killed by temperatures of sixty degrees Celsius (60^0C) for ten minutes, however more extreme heat treatment may be required to destroy dense suspensions including laboratory cultures (Gerald and Faaem 2009). They are also highly sensitive to exposure to sunlight and fairly sensitive to acid, and therefore appear to be killed by milk products that have been subjected to lactic acid fermentation such as sour milk and in cheese. (Ramos, 2008). The organisms can remain alive outside the animal body for different time periods after being removed. This is usually dependent on the storage conditions and the environment. It survives longer when kept under cold temperatures. *B. abortus* is capable of surviving in the uterine excretions for up to 7 months when kept inside an ice chest. It also survives for up to 30 days when kept in ice cream chilled at 0◦ Celsius as well as in butter for a period 142 days kept at 8◦C. However, it is rapidly killed in fresh milk kept at room temperature and remain alive for long at refrigeration temperatures (Jovanka *et al*., 2010).

In 1897 *Brucella species* was first isolated by a Danish veterinarian, Bernard Bang (Bang, 1897) from a dying soldier's liver caused by a febrile infection in Malta. The disease had brought about considerable mortality and morbidity in a number of British soldiers. The origin was discovered to be connected to goats and sheep's milk (Kim, 2015). Later, in 1897 *Brucella abortus* was isolated from aborted fetus in cattle by Fredrick Bang who also was a Danish Veterinary professor (McMahan, 1944). And in 1914 *Brucella suis* was isolated by Traum from infected pigs' fetuses (Kim, 2015). *Brucella species* confine in the genital organs of the animal

leading to sterility and abortions. Furthermore, they are discharged in substantial quantities in the animal's milk, urine, and placental fluid.

2.3 Pathogenicity of *Brucella* organism

Brucella usually penetrate the epithelial cells in the mucosa after which they are transferred either as free bacterial cells or within phagocytes to regional lymph nodes. After they localize in the lymph nodes, it leads to lymph node inflammation, hypertrophy and reticulo-endothelial and lymphatic hyperplasia. If the bacterial cells are not confined and destroyed inside these regional lymph nodes emptying the area with the infection, then they reproduce and spread through lymph or blood to a number of other tissues and organs including the reproductive organ, mammary gland and spleen (Olsen, 2014), after which they can spread via the lymph nodes to preferred tissues in the reproductive organ (Rossetti *et al*., 2014; Gorvel and Moreno, 2002; Kim, 2015). Once in the preferred tissue, *Brucella* causes acute and sometimes chronic disease of reproductive tract that can lead to abortion and other severe genital tract infections (He, 2012).

2.4 Brucellosis

Brucellosis is caused by *Brucella species* and has been given many names over the years such as Bang's disease, Gibraltar fever, Mediterranean fever, contagious abortion, or infectious abortion. It affects many animal species across the globe. The disease causes adverse economic impacts and is also a public health hazard. It is regarded as one of the most common zoonosis around the world and causes public health problems with estimated annual reported cases of more than 500,000 globally and this is despite the fact that human are accidental hosts. It causes a significant human morbidity in areas where it is endemic (Donev *et al*. 2010).

Brucella is classified in risk group III by the WHO laboratory biosafety manual. It is an infection that can easily be acquired in the laboratory, and therefore observation of strict preventive measures is recommended during handling heavily infected animal samples that includes abortion products and cultures. Therefore, specific recommendations are established for the biosafety precautions that should be observed when handling materials suspected to be infected with *Brucella* (OIE, 2009). Transmission of Brucellosis to humans can cause acute Undifferentiated Fever, which may lead to chronic infections that usually cause far-reaching complications such as those that affect the human loco motor system, circulatory system, and

central nervous systems. Therefore, Precautionary measures should be put in place to avert human infection.

The first report on brucellosis in man in East Africa was in 1910 when a disease called "Muhinyo" in Uganda was reported in which *Brucella* organism was found to be the causative agent (WHO, 2005). Human *Brucella* infections in Kenya were reported in 1953 by Wright *et al*., who reviewed 70 cases of patients observed over a period of 10 years. Brucellosis is endemic in sub-Saharan Africa especially in those countries that practice extensive pastoral farming where implementation of surveillance and control measures is rarely done. The disease is usually ignored in humans and therefore may lead to patients suffering considerably. In Kenya, the disease has a huge impact because it affects several animal species and also humans. This is as a result of several factors such as mortality, morbidity and other losses incurred from treatment costs (Perry *et al*., 2010). It causes serious economic losses because of the effects it has on the health of several animals and can also diminish the products obtained from them (Aminzadeh *ET AL*., 2010). It may also lead to trade barrier of livestock and their products, and a hindrance to free movement of animals (Zinsstag *et al*., 2011).

2.5 Transmission of brucellosis

Transmission is mainly by coming in contact either directly or indirectly with infected animals and in most cases through ingestion and venereal routes i.e., sexually transmitted (Quinn *et al*., 2010). Even though Infection do happen due to occupational exposure, for the general public, consuming unpasteurized dairy and dairy products constitutes the main risk of transmission in regions where the disease is endemic. Veterinarians and farmers who are exposed to infected animals or aborted substances such as foetuses or placentas risk occupational exposure. Transmission may also occur via the conjunctiva, inhalation and in utero though less common (CDC, 2019). It can also occur through fomites. However, there is prove of transmission by fleas, mosquitoes or ticks from an infected animal to a healthy animal (OIE, 2009).

Transmission through consumption is becoming more recognized as compared to occupational exposure, as more and more evidence links it with ingestion of food contaminated with the bacteria (WHO, 2005; Arimi *et al.*, 2005). This, Probably, is the reason it is regarded a re-emerging food-borne illness spread through consuming infected raw dairy and dairy milk products (Zinsstag *et al*., 2011). Diseases such as E. coli, salmonellosis and brucellosis infections are frequently occurring. Brucellosis, tuberculosis and campylobacter cause the

highest number of healthy life years lost, because their impact on daily life is severe. Listeriosis, Brucellosis and *Escherichia coli* infections brings about highest direct costs.

2.6 Signs and symptoms

Clinical manifestations of brucellosis may include: joint pain, fever, chills, sweats, loss of appetite, weakness, headache and fatigue (CDC, 2012). In many patients the clinical manifestations are mild and, thus, sometimes diagnosis may not be considered. The incubation period can range from one week to two months, but in most cases between 2–4 weeks. The symptoms may disappear and then reappear after several weeks or months and later return (CDC, 2012). In some cases, people may suffer chronic brucellosis for years, even after treatment. The symptoms in chronic case include recurrent fevers, fatigue, endocarditis arthritis, and spondylitis. Brucellosis can affect any part of the body, including the liver, reproductive system, central nervous system, and heart whereby it may cause serious damage in just one organ or throughout your body (Charles Patrick Davis and Melissa Conrad Stöppler, 2021).

Some of the complications are lethal, however, death is rare with an estimated mortality rate of 2 percent, and thus majority of those infected with the disease get to survive the disease, and more so if they don't have complications. Brucellosis has been reported globally and is a reportable disease in most countries and affects people of all ages and both sexes (CDC, 2012).

2.7 Treatment of Brucellosis

Treatment is done after positive diagnosis and is done by the doctor prescribing antibiotics such as doxycycline. Treatment is often difficult and the patients may take several weeks to months (usually 6-8 weeks) to compete the dose before they can fully recover from the illness. In order to improve the chance of full recovery, commencement of treatment plan within the first of month of occurrence of symptoms is advised. Treatment of brucellosis is usually with antibiotics which usually takes several weeks to months, and even after treatment (Corbel, 2006) the disease can recur. The medication must be taken for several weeks to avoid recurrence of the disease which normally occurs within the initial six months after treatment (CDC, 2012).

2.8 Prevention and vaccination

Brucellosis Prevention is dependent on surveillance and also the prevention of risk factors with the most effective strategy being the elimination of the disease in animals (CDC, 2019).

Vaccination of cattle, sheep and goats is recommended in enzootic regions with high prevalence rates. In countries where prevention through vaccination of healthy animals or elimination of those infected with the disease is not practical or achievable, prevention of human infection is recommended through implementing measures such as food-safety programs, raising awareness, laboratory safety and occupational hygiene. However, there's no vaccine for brucellosis in humans. That's why it's important to take other steps to protect individuals from infection by the bacteria. In agricultural and meat-processing work, correct handling, protective barriers and disposal of afterbirths, animal carcasses and internal organs is an effective prevention strategy. Pasteurization of milk meant for direct consumption and for use in production derivatives such as cheese is also important in preventing transmission from animals to humans. Furthermore, use of education campaigns about avoiding unpasteurized milk products can be effective, as well as putting in place policies on its sale. (Corbel, 2006).

Milk contamination occurs when bacteria from the animals, or their environment, pass in to the milk because of poor hygienic practices. Handling of milk by several value chains agents when bulking and transporting raises the risk of bacterial contamination. Bacterial contamination such as with *Salmonella species* And *Escherichia coli* indicate poor hygiene and milk handling practices. In Kenya, zoonotic infections such as Q-fever and brucellosis poses a serious public health issue for milk consumers (Njenga *et al*., 2010; Arimi *et al*., 2005; Wanjala *et al*., 2017). Lactic acid bacteria contamination is also a concern in Kenya especially if not eliminated by adequate and appropriate heat treatment and subsequent cooling immediately leads to milk spoilage such as sour milk and thus reducing the shelf life of products derived from milk (Kabui *et al*., 2015; Wanjala *et al*., 2017).

2.9 General overview of milk dispensing business in Kenya

Milk vending machines are innovative enterprises that have come up to supply consumers with cheaper pasteurized milk and milk products and particularly in urban centers. In Kenya, they are popularly known as milk ATMs and they sell unpackaged ready-to-drink milk that are pasteurized and chilled. These businesses manage to reduce the price of their products by doing away with processing and packaging costs and also having the ability to offer quality products at any preferred volume to match varying customers' expectation (Kosgey *et al*., 2018). The milk vending machines are spread across different business that includes supermarket ATM s and also located in standalone businesses. They are also owned by different groups of entities such as sole proprietorship, partnership, company-owned and cooperatives (Ayuya *et al.,*

2020). The milk ATMs are imported from countries such as Italy, China and The Netherlands at a cost which range from KES 150,000-700,000 depending on the capacity and the country of origin. The average yearly operating costs is KES 123,200 with the average daily sale being 140 liters.

On average, ATM vendors sell milk at half the price of packaged pasteurized milk which present an economic incentive for consumers to purchase milk from the vendors. (Bebe *et al.*, 2018). It is for this reason and the fact that milk vending machines have a high sales margin to entrepreneurs who sell large volume of milk (KES 10 POSITIVE) that have made the business lucrative and thus the number of milk dispensers have been on the increase with a peak in the year 2018. According to data supplied by the KDB, registered milk vending machines in 2018 were 1550 with the majority of them concentrated in Nairobi and Kiambu counties owing to higher demand because of dense populations in these counties (Ayuya *et al.*, 2020) (Bebe *et al.*, 2018). The major concerns in these businesses are regulatory gaps which leads to potential compliance issues that increases concerns for safety and quality of products on offer as well as milk vending machines that sell raw milk against the existing regulations.

The reasons for choice of ATM milk over other sources vary and include affordability, availability and flexibility in volume purchased. This sector has also contributed in job creation with an estimated national employment of 3550 operators 59% being male and 41% being female and an average age of 28 years which shows that the bulk of those employed are youth. The operators have varying level of education from primary to tertiary with a majority having secondary education as the highest level of education, and each business is estimated to employ between 6-20 employees. The sector also generates other job opportunities such as milk pasteurization, vending machines maintenance, sell of spare parts as well as milk transportation (Ayuya *et al.*, 2020).

This study aimed to evaluate the prevalence of *Brucella* species in fresh and fermented milk sold in milk dispensers and milk bars and to determine the knowledge of milk consumers and milk vendors on *Brucella* milk safety in the study area. The information obtained may be used to develop strategies that can be used to prevent *Brucella* infection.

2.10 Review on relevant research methodologies

2.10.1 Cross-sectional surveys

These are used to gather data so as to make conclusions about a study population at a particular point in time. This design may be repeated regularly, however once respondents are sampled at a particular point in time, they should not be intentionally resampled, even though a respondent previously selected can be randomly picked at another point in time (Paul, 2008). In this study, the investigator measures both the exposures and outcome in the selected participants at the same time. Furthermore, the participants are also chosen using the inclusion and exclusion criteria established for the research study (Study design 101, 2019).

2.10.2 Techniques for Detection of *Brucella* species

2.10.2.1 Polymerase chain reaction (PCR)

PCR were developed to identify *Brucella* with relatively high analytical sensitivity and has less hazard. It uses closed-tube systems and this reduces the possibility of cross-contamination that sometimes lead to false results. PCR uses two conventional methods for detection. The fist is sequence-specific DNA probes that comprise oligonucleotides marked using a fluorescent reporter, and this permits identification only after hybridization of the probe with its complementary sequence. The second is non-specific fluorescent dyes. This method minimize contamination because it does not require extensive manipulation (Yu and Nielsen 2010).

2.10.2.2 Enzyme-linked immunosorbent assay (ELISA)

ELISA as described by Michael Moore in 2021, utilizes a kind of enzyme immunoassay that is solid phased to identify a ligand (protein) presence in a liquid sample by the use of antibodies that are aimed against the protein that is to be quantified. ELISA is often used in analytical biochemistry assay and in various fields such as medicine, plant pathology, quality control checks in various industries and biotechnology. This method is used to measure glycoproteins, proteins, antigens and antibodies in samples such as in pregnancy test. There are different kinds of ELISA differentiated by the antigen-antibody used and they include competitive ELISA, sandwich ELISA, Indirect ELISA and direct ELISA (Michael, 2021).

2.11 Gaps in Knowledge

The growing urbanization, expanding income levels and a population that is on the increase has caused a surge in demand for milk that is of good quality and safe for consumption. Latest statistics indicate that the sale of processed dairy milk products has had a continuous growth

and is expected to continue with the trend (KNBS, 2016). According to recent reports and studies, the per capita milk consumption is anticipated to have increased to a figure double the current estimate of 110 litres by 2030. (KDB 2016; Rademaker *et al*. 2016). For these reasons, therefore, the demand for milk that is safe and affordable to consumers is higher, and especially in urban setting where incomes are higher and also have experienced changes in dietary patterns. Thus, in order to fill this gap and to address the safety concerns, milk vendors have come up with innovations such as the milk dispensers otherwise known as milk dispensers to supply pasteurized milk to consumers (Kosgey *et al*. 2018; Bebe *et al*. 2018). This has enabled the sale of unpackaged milk to penetrate traditional formal markets segments for processed milk, and are now located in a number of retail outlets that's include supermarket, milk bars and retail shops (Kosgey *et al*. 2018). The milk dispensers and milk bars does away with processing and packaging costs and thus offer affordable milk and milk products to its customers. However, there exist a knowledge gap with regards to information on operations of these businesses coupled with regulatory gaps that have increased doubts about the safety of the products the businesses are offering (Ayuya *et al.,* 2020). The nature of operations where milk is sold unpackaged and exposed and also potential intentional non-compliance and possible neglect of quality standards required for milk safety compromises the safety of milk offered to customers. Therefore, this creates serious limitations for quality control and surveillance of milk sold in milk dispensers and milk bars (Bebe *et al., 2018).*

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Research design

3.1.1 Study setting

The county of Nairobi was created by the 2010 constitution as a successor of city council of Nairobi which is now defunct and is one of the 47 counties in Kenya. It consists of the county government of Nairobi, Nairobi County assembly and the county public service that are charged with managing the resources in the county. Nairobi County is the capital city and headquarters of the republic of Kenya. It is led by elected and appointed leaders that include the Director General of the Nairobi metropolitan services, Deputy Governor and 123 members of county assembly. It is spit into 17 administrative sub-counties with 85 wards. The sub-counties include Embakasi West, Embakasi East, Embakasi North, Embakasi Central, Embakasi south, Kibra, Langata, Dagoretti South, Dagoretti North, Westlands, mathare, Ruaraka, Kasarani, Roysambu, Starehe, Kamukunji and Makadara.

This study was conducted in Embakasi West sub-county, which has five electoral wards namely: Maringo/Hamza, Kariobangi South, Mowlem, Umoja I and Umoja II. The county is more of a milk consuming area, and is a suitable location for sale of fresh and fermented milk. Both small and large-scale milk businesses contribute to income generation within the county. In 2019, Nairobi city had an area of 696.1 km^2 with a population of 4,397,073, according to the 2019 population census, with a population growth rate of 2.3%. However, to conduct this research study, Nairobi County population is approximated to be 4,498,205 in the year 2021, calculated using the estimated yearly population growth rate of 2.3% determined by the Kenya Bureau of Statistics (KBS) during the 2019 population census. However, this figure could be higher than the actual population considering the covid-19 pandemic that had an effect on people's livelihood. This led to the closure (temporary or permanently) of several industries and businesses, which provided employment for the residents and this may have had an impact on the population level at the time of this study. This is probably because many industry personnel may have been laid off may and have migrated out of the city as most of the city inhabitants are people who originally came from different parts of the country in search of employment and other opportunities. The map of Embakasi West sub-county is shown in Figure 1 and the map of Embakasi West sub-county is shown in Figure 2.

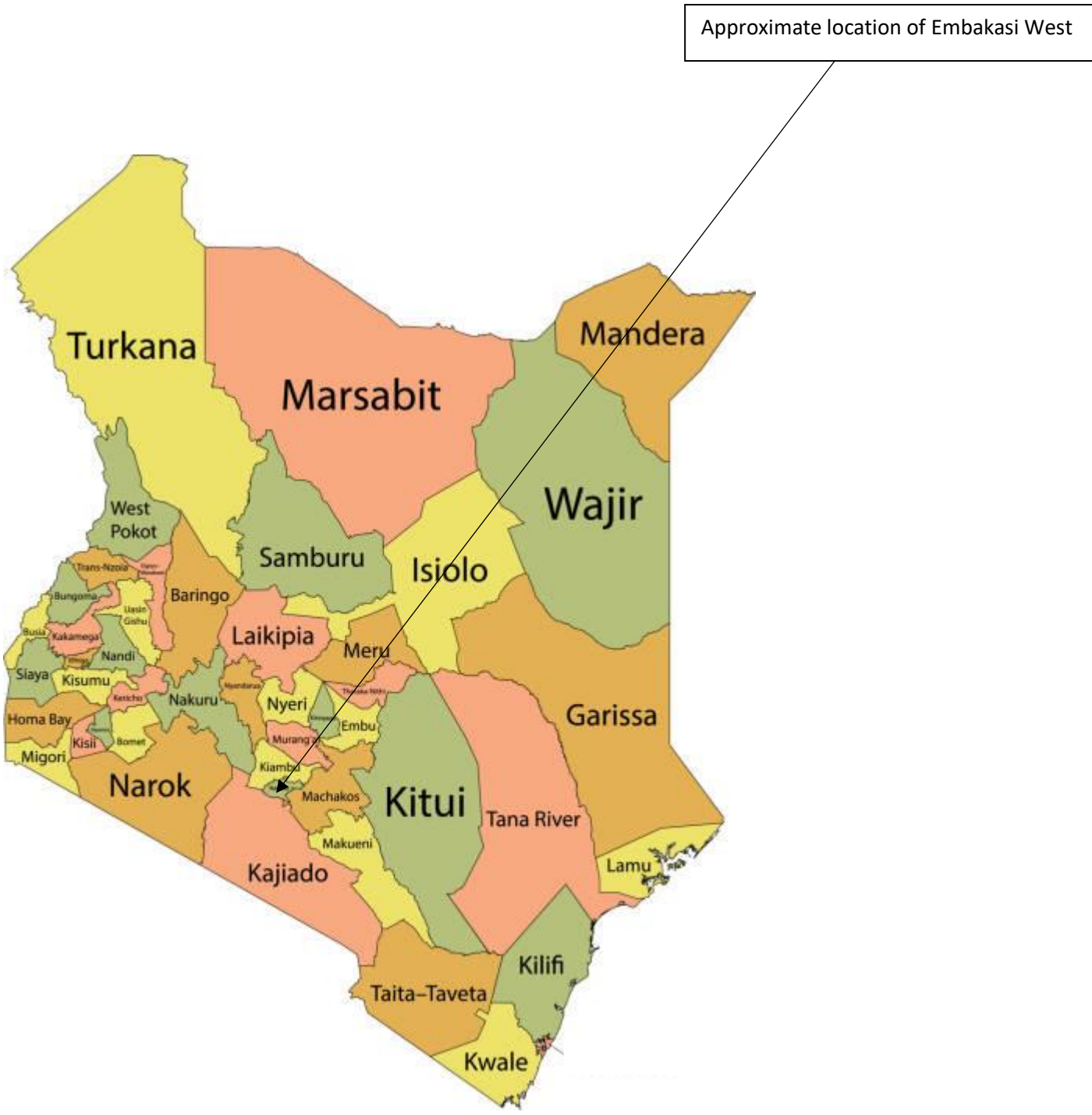

Figure 1: The map of Kenya (Wikipedia, 2022. sourced from https://en.wikipedia.org/wiki/Counties_of_Kenya)

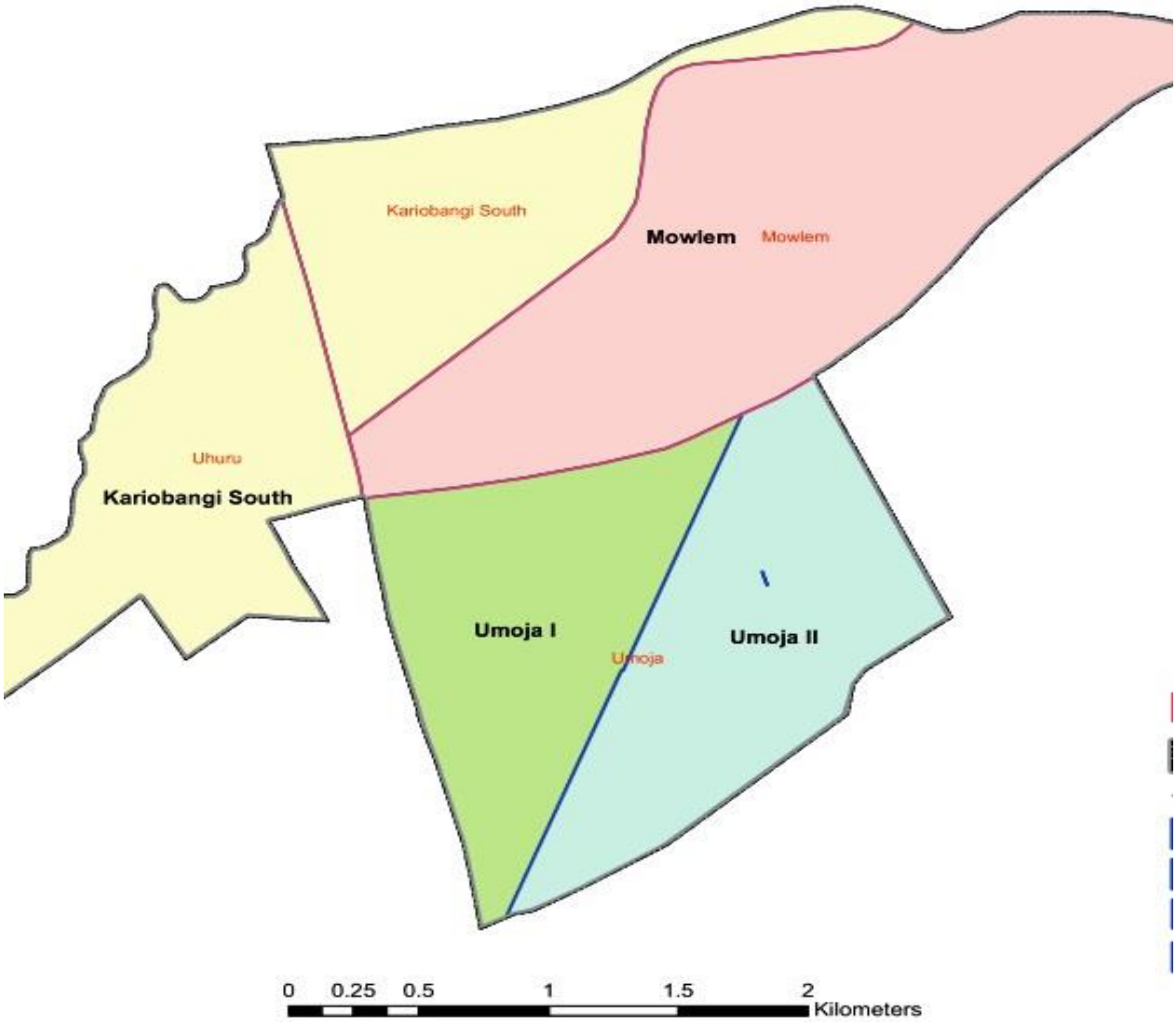

Figure 2: Map of Embakasi West sub-county (Facebook- Embakasi-West, 2021. Sourced from https://web.facebook.com/Embakasi-West-Constituency-255601571227194/about/)

3.1.2 Conceptual design

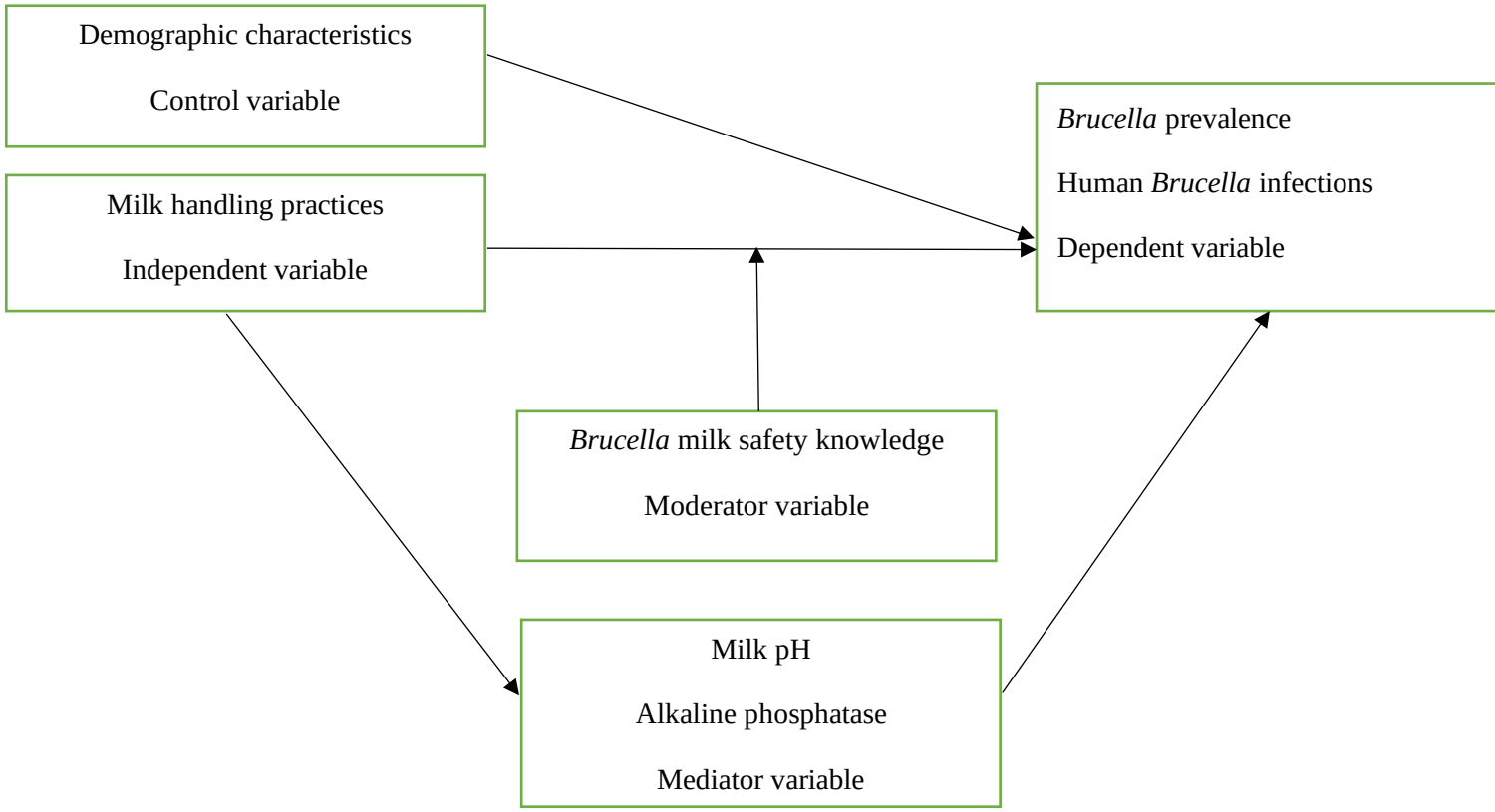

Figure 3: conceptual design of variables relevant in the current study

Vendor and consumer milk handling practices is an important factor in determining the *Brucella* prevalence and consequently *Brucella* human infections. Furthermore, the knowledge they have acquired on *Brucella* milk safety affects the relationship between these factors as more knowledge leads to better handling practices which results in less prevalence and infections. Milk pH and alkaline phosphatase tests asses for adequacy of processing factors that eliminates *Brucella* species in milk.

3.1.3 Study design

This research study used cross-sectional study design based on samples of fresh and fermented milk sold in milk ATMs and milk bars with the inclusion of questionnaires administered on milk vendors and milk consumers of the fresh and fermented milk.

3.2 Study methodology

3.2.1 Study population

The population for this study included milk vendors and consumers in Embakasi West sub-county in Nairobi County.

3.2.2 Sampling of milk dispensers and milk bars

Sampling was conducted between the months of October and December 2021. Only the samples that satisfied the inclusion criteria were included. A total of 18 milk shops were identified using simple random selection within the sub-county and they became the point of sample collection, identification of milk consumers and also the vendors became respondents for the vendor questionnaire. The 18 were distributed such that six were supermarkets ATMS, 6 milk shops with ATMs and 6 milk shops without ATMs. Figure 2 shows how the sample size was arrived at.

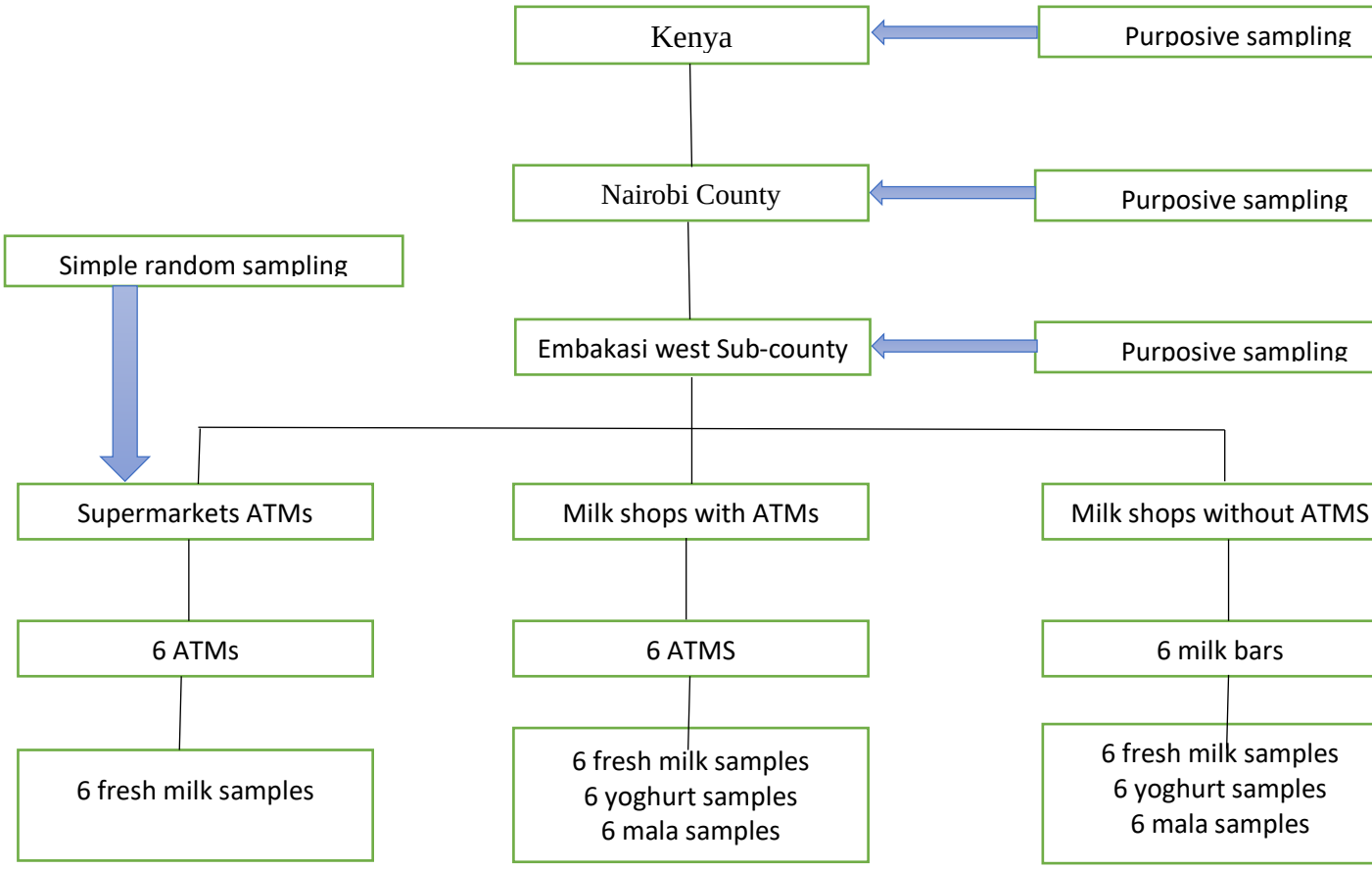

Figure 4: Determination of sample size

3.2.3 Sampling of milk vendors and consumers

3.2.3.1 Inclusion criteria

1. Milk vendors interviewed were only those from whom the milk samples were obtained from.

2. Respondents to the milk consumption questionnaire were persons aged 18 years and above.

3. Respondents were sampled from Embakasi West sub-county only.

3. Respondents were only persons who purchase milk at the sample collection dispensers.

3.2.3.2 Sample size determination of vendors

A questionnaire was also administered to the milk vendors at every milk sampling point therefore making a total of 18 vendors interviewed. The milk vendors were those who operate the milk dispensers and bars from whom the milk samples are collected. They were asked to provide information regarding their businesses including the place of origin of the milk, if they prepare the fermented, they sell, daily quantities they sell and whether they are aware if the milk they sell has been subjected to pasteurization.

3.2.3.3 Sample size determination of consumers

The sample size determination for milk consumers was computed using the Cochran's formula as shown below:

$$n = \frac{Z^2 Pq}{e^2}$$

Where:

Z= Standard deviation at the 95% confidence interval which is 1.96.

e is the precision level which is 5%.

p is the estimated fraction of the population possessing the characteristic in question, which in this case is 50% because the prevalence of *Brucella* in Nairobi is unknown.

q is 1 – p.

Thus;

$$n = \frac{1.96^2 * 0.5(0.5)}{0.05^2}$$

=384

Add 10% attrition rate:

= (384*0.1) +384

Thus: n=423

Give a reason why your sample dropped to 229; e.g., due to financial constraints for paying remunerators, or these where the people who could be reached during day hours – since most people purchase milk any time of the day

Therefore, at every one of 18-milk sampling point identified, 24 consumers were interviewed using a questionnaire that captured their demographics, knowledge of *Brucella* milk safety, and any previous infections with *Brucella* species. They will also be asked about the use of their milk, the quantities they buy and in case of previous infection with *Brucella*, if they had had any case of abortion related to the disease.

However, in the actual data collection exercise, a figure of 229 was realized. This drop was contributed to by two major factors. First, time of milk purchase by consumers whereby the majority of consumers buy their milk early in the morning between 5.30AM and 7.30AM and late in the evening between 5.30PM and 10PM whereas our data collection exercise was carried out between 8.00AM and 4.00PM. Secondly, financial constraint also could not allow for extended time of data collection as I was self-funding and therefore the budget was not elastic and could not be expanded.

3.2.4 Sampling of milk

Samples were from selected milk dispensers and milk bars within Embakasi West sub-county which were up for sale and also were handled in a similar way as presented for sale.

3.2.4.1 Milk sample size determination

This study used the cluster sampling technique whereby the population of Embakasi West sub-county was divided as per the wards. From the wards, milk dispensers and bars selling fresh and pasteurized milk were identified using the simple random selection, from whom the milk

samples were collected. Where the selected milk vendors do not have milk on the day of sample collection, the nearest milk vendor was picked as an alternative.

A total of 37 samples were collected from milk dispensers and milk bars distributed across the sub-county such that 20 samples were fresh milk and 17 samples were fermented milk. Fresh milk samples were collected from all the 18 collection points identified. However, fermented milk samples were collected only from the milk bars with dispensers and milk bars without dispensers excluding the supermarkets dispensers. More fresh milk samples were collected than the number targeted and this is due to the fact that there was difficulty in getting shops selling unpackaged yoghurt.

3.2.4.2 Milk samples collection and transportation

A half-liter of fresh and fermented milk sample was purchased from the selected milk ATMs and milk bars milk within Embakasi West sub-county. The milk samples were then placed in sterile containers, coded and transported to Analabs laboratory where they were stored in refrigerators awaiting analysis.

3.4 Definitive data collection and sample testing

3.4.2 Data collection

3.4.2.1 Establishment of the demographic characteristics

Data collection techniques

The milk vendors and consumers were interviewed where they were asked to provide information relating to their demographic characteristics and previous infections with *Brucella*.

Data collection tools

The tool used was in the form of a questionnaire administered using the Open Data Kit (ODK) filled by Get ODK on an Android mobile phone (Mkandawire, 2019). Refer to the questionnaire in the appendix two, section A.

3.4.2.2 Determination of the level knowledge of *Brucella* milk safety and milk handling practices

Data collection techniques

The technique used was by interviewing milk vendors and consumers using a pre-prepared questionnaire to provide information regarding to their level of knowledge on *Brucella* milk safety and their milk handling practices. Some of the question included if the consumer knew whether Brucella is transmitted via milk and the role of pasteurization, hygiene and fermentation in the control of Brucella in milk.

Data collection tools

The tool used was in the form of a questionnaire administered using the Open Data Kit (ODK) (Mkandawire, 2019). Refer to the questionnaire in the appendix two, section B and C.

3.4.2.3 Establishment of the self-reported *Brucella* infection

Data collection techniques

The milk vendors and consumers were interviewed where they were asked to provide information relating to their demographic characteristics and previous infections with *Brucella*. Some of the questions asked included whether the respondent was aware of brucellosis disease and whether they had been diagnosed with brucellosis in the past one year.

Data collection tools

The tool used was in the form of a questionnaire administered using the Open Data Kit (ODK) (Mkandawire, 2019). Refer to the questionnaire in the appendix two, section D.

3.4.2.3 Consumer questionnaire

The information that was obtained from the milk customers was include quantity, source and use of the milk they purchase. They were also be asked about whether they have had case of *Brucella* infection, whether the disease has caused any serious complications and whether they have a knowledge on the milk safety procedures required to eliminate *Brucella* from the milk. Refer to the questionnaire in the appendix two.

3.4.2.4 Vendor questionnaire

The milk vendors were asked to provide information relating to their business that included the place of origin of the milk they sell, the quantities they sell on a daily basis, if they ferment they fermented milk they sell, information about their customers and also whether they are aware if the milk they are selling has been subjected to pasteurization. They were also asked about whether they have had case of *Brucella* infection, whether the disease has caused any

serious complications and whether they have a knowledge on the milk safety procedures required to eliminate *Brucella* from the milk. Refer to the questionnaire in the appendix two

3.4.3 Analytical techniques

3.4.3.1 Evaluation of milk pH, alkaline phosphatase and prevalence of *Brucella*

Data collection techniques

The techniques used was collection of fresh and fermented milk samples using sterile milk containers for laboratory analysis.

Data collection tools

The milk samples were transported to the laboratory in sterile containers where they were be kept refrigerated awaiting analysis. At the laboratory identification of *Brucella* was done using ELISA and PCR techniques and then analysed for pH, and finally the samples were subjected to an alkaline phosphatase test as described in the sub-sections below.

3.4.3.2 Laboratory analysis for prevalence of *Brucella* species

The milk samples were subjected to ELISA and PCR test for detection of *Brucella*. For ELISA, testing used a detection antibody (primary and secondary), an antigen, coating antigen, buffer, wash and a chromogen using four main steps; coating using antigen or antibody, blocking using bovine serum albumin, detection using a substrate and final read. In between these steps, the wash is used to remove any unbound material, usually by use of a buffer (Michael, 2021).

3.4.3.3 Determination of milk pH

The milk samples were also subjected to titratable acidity test to determine if there is any change in pH and also to determine the pH of the fermented milk. This was done by taking a few ml of the sample and titrating it with a standard alkali and this determines the amount of alkali needed to change the pH of the milk sample from the normal milk pH which is usually about 6.6 to 6.8 to phenolphthalein color change pH added to milk to show the end point (pH 8.3) (Hach, 2019).

3.4.3.4 Alkaline Phosphatase test

The principle that this test is based on is that phenol is freed from disodium phenyl phosphate by the enzyme and thus forming a yellow-colored complex (Rankin *et al.*, 2010).

Procedure

1. 5ml of buffer substrate was pipetted into a clean and dry test tube followed by 1ml of the milk sample to be analyzed and placed in the water-bath.

2. Simultaneously, 1 ml of boiled milk was pipetted from the same sample and 5ml of the buffer substrate into a control tube and placed in the water-bath.

3. It was then be let to stay in the water-bath for two hours after which it was be removed, each inverted and the resulting color read. The tubes were placed such that the control tube was to the left of the stand and the sample test tube placed to the right then the color that has developed was read using the comparator and special disc. The reading that lies in between the two standard color discs was recorded by adding a plus or minus sign to the number of the nearest standard.

3.4.4 Pretesting study tools

A pilot data collection was done in Embakasi South sub-county where twenty respondents were interviewed to test the questionnaire and identify mistakes and errors for corrections. Adjustments were then be made to the tool in readiness for the actual data collection. Embakasi South was chosen as it neighbouring the Embakasi West and it therefore experience the same conditions.

3.4.4 Implementation of the study

3.4.4.2 Recruitment and training of enumerators

3.4.4.2.1 Recruitment

Five enumerators were recruited to assist in data collection exercise. They lived within Embakasi West sub-county for convenience in the exercise by reducing travel time and cost. The duties included attending training, participating in pre-test exercise and interviewing if respondents in the field.

3.4.4.2.2 Training

The enumerators were properly trained on the questionnaire for a total of 5 days including one day for piloting and one day to discuss the outcome of the pilot exercise. They were also be required to participate in the pilot and final compilation of the questionnaire.

3.4.5 Ethical considerations

Approval to carry out this research was obtained from the Faculty of Agriculture, Department of Food Science, Nutrition and Technology, University of Nairobi and National Commission

for Science, Technology and Innovation (NACOSTI). Milk consumers and sellers were also requested for a verbal consent before being interviewed. All information obtained from the respondents was kept confidential.

3.4.6 Data quality control

Proper training of enumerators was an important factor in ensuring that they have the ability to obtain quality in the field. Back checks will also be employed to verify that the data obtained during the actual exercise is valid and of good quality. The enumerators were also accompanied on schedule and alternately to the field by the supervisor for the actual interview of respondents.

The data obtained from the data collection exercise was checked to ensure that it satisfies the 6 dimensions of data quality, that is, Accuracy, Consistency, Completeness, Timeliness, Uniqueness and Validity. The data must have had an actual representation of the situation at hand, be comprehensive without any missing key elements, available when needed and the data availed is valid and correct. It was also examined to make sure that the data is not duplicated.

3.4.7 Statistical Data analysis

Statistical package for social scientist (SPSS) was used to employed the data obtained from the data collection and be used to produce a report. The researcher established relationships between within categories after which SPSS was used for in-depth analysis of demographic characteristics, milk safety knowledge and handling practices to self-reported Brucella infections. A 95% confidence level was applied such that any P-value below 0.05 was deemed significant (Shrestha, 2019).

CHAPTER 4: RESULTS

4.1 Demographic characteristics of study respondents at Embakasi West

The respondents interviewed were equally distributed in terms of gender with male consumers being 40.2% and female consumers being 59.8%, and 50% each for both male and female respondents for vendors. The occupation of the consumer respondents showed that slightly over a third (36.2 %) were self-employed, 31.4% salaried employees, 14.8% were students while the remaining less than a fifth were distributed among casual labourers (9.2%), house wife (4.8%) and unemployed (3.5%). About half of the vendor respondents (54.2 %) were self-employed, 41.7% salaried employees, and less than a tenth (4.2%) were students. Less than 7.4% of consumer respondents completed primary school education, 34.1% completed secondary school education, 24.9% had a college certificate, 17.9% had a college certificate, and 14.8% had a university degree. The highest education level attained by the vendor respondents was secondary school education, (45.8%) followed by 16.7% for each category with college certificate and university degree. Vendor respondents with college diploma were 12.5%. The difference was significant between the various education levels for vendors based on Gender (p = 0.0254).

Table 1: Distribution of consumers and vendors demographic characteristics in Embakasi West

		Consumers N=229			Vendors N=24		
Demographic Characteristics	Category	Frequency	Percentage	P-value at 95% CL	frequency	percentage	P-value 95% CL
sex	Male	(92)	40.2	0.0656	(12)	50	0.936
	Female	(137)	59.8		(12)	50	
Nature of work	Casual labourer	(21)	9.2	0.685	(0)	0	0.365
	House wife	(11)	4.8		(0)	0	

	Salaried employee	(72)	31.4		(10)	41.7	
	Self employed	(83)	36.2		(13)	54.2	
	Student	(34)	14.8		(1)	4.2	
	Unemployed	(8)	3.5		(0)	0	
Education level	Completed primary	(17)	7.4	0.254	(2)	8.3	0.0354
	Completed secondary	(78)	34.1		(11)	45.8	
	College certificate	(57)	24.9		(4)	16.7	
	College diploma	(41)	17.9		(3)	12.5	
	University degree	(34)	14.8		(4)	16.7	
	Adult education	(1)	0.4		(0)	0	
	No education	(1)	0.4		(0)	0	

Footnote: The figures in parenthesis are frequencies representing the actual value of those interviewed: The P-values compares the different demographic characteristics based on gender.

The monthly income of the consumer respondents ranged from KES 1,000 to KES 50,000 with that majority of the respondents earning between KES 1000 – KES 10,000 (57.6%), while the monthly income of the vendor respondents ranged from KES 1,000 to KES 50,000 with the majority of respondents earning between KES 1000 – KES 20,000 (83.4%). There was a significant difference between the various income levels for consumers. There was significant difference between the monthly income of consumers based on gender (p = 0.045). While for vendors, the difference was not significant between the education levels (P=0855).

Table 2: Income distribution for consumers and vendors by income level at Embakasi West

Consumers	Vendors
N=229	N=24

Monthly Income range in KES	Frequency	Percentage	P-value	frequency	percentage	P-value
1000-10000	(132)	57.6	0.045	(10)	41.7	0.855
11000-20000	(61)	26.6		(10)	41.7	
21000-30000	(16)	7		(2)	8.3	
31000-40000	(7)	3.1		(1)	4.2	
41000-50000	(5)	2.2		(0)	0	
>50000	(8)	3.5		(1)	4.2	

Footnote: The figures in parenthesis are frequencies representing the actual value of those interviewed: The P-values compares the respondent's income level based on gender.

A test of independence was performed using chi square to examine the relationship between consumer demographics (gender, nature of work, monthly income and education level) and the self-reported *Brucella* infections. The relation between these variables was not significant (P-value= 1.719, 3.840, 1.762, 0.555).

Table 3: Distribution Consumer demographics by self-reported Brucella infections at Embakasi West.

Socio-demographic Characteristics	**N=229**	**df**	**Consumers reported having Brucella infection= 8**	**p-value**
Gender		1		1.719
Nature of work		5		3.840
Monthly income		7		1.762
Education level		6		0.555

Footnote: P-values are obtained by correlating the effect of Consumer demographics on self-reported *Brucella* infections

4.2 Knowledge Level of milk handling practices and safety to prevent Brucella by study respondents in Embakasi West

4.2.1 Level of knowledge of Brucella milk safety by respondents in Embakasi West

Almost all the consumer and vendor (96.1% and 91.7%) respondents had the knowledge that the mode of transmission of brucellosis is milk. While 94.8% of consumer and 91.7% of vendor had knowledge that pasteurization eliminates *Brucella* in milk. However, 96.1% of consumer and 100% of vendor demonstrated a gap in knowledge on the role of cleanliness and sanitation in controlling *Brucella* in milk. About 82.1% of consumer and vendor had knowledge on the role of milk fermentation in controlling *Brucella* in milk. The difference was significant between the various level of knowledge of milk safety by both consumers (P=0.012, 0.018, 0.032 0.025) and vendors (P=0.035, 0.294, 0.045, 0.013) based on gender.

Table 4: Level of knowledge of Brucella milk safety by consumers and vendors in Embakasi West.

		Consumers N=229			Vendors N=24		
Characteristics	response	Frequency	Percentage	P-value 95% CL	frequency	percentage	P-value 95% CL
Brucella is transmitted via milk	Had knowledge	(220)	96.1	0.012	(22)	91.7	0.035
Elimination of *Brucella* by pasteurization	Had knowledge	(217)	94.8	0.018	(22)	91.7	0.294
Role of Hygiene and sanitation in control of *Brucella*	Had knowledge	(9)	3.9	0..032	(0)	0	0.045
Role of fermentation in Control of *Brucella*	Had knowledge	(188)	82.1	0.025	(18)	82.1	0.013

Footnote: The figures in parenthesis are frequencies representing the actual value of those interviewed: The P-values compares the different levels of *Brucella* milk safety knowledge based on gender.

A test of Independence (chi-square) was performed to assess the association between level of knowledge of *Brucella* milk safety and self-reported infections. There was not a significant relationship between the two variables, at p= (P=0.339, 0.840, 0.432, 1.026)

Table 5: Table Distribution of consumer level of knowledge of Brucella milk safety by self-reported infections.

Knowledge tested	**N=229**	**df**	**Chi square p-value**
***Brucella* is not transmitted via milk**		1	0.339
Hygiene and cleanliness are effective in controlling *Brucella*		2	0.840
Fermentation of milk eliminates *Brucella*		2	0.432
Pasteurization does not eliminate *Brucella*		2	1.026

Footnote: P-values are obtained by correlating the effect of Consumer *Brucella* milk safety knowledge on self-reported *Brucella* infections

4.2.2 Milk handling practices of respondents in Embakasi West

Slightly less than (48.9%) of the consumer respondents and 91.7% of vendor respondents in the study sample were aware that the milk they purchased and sold was pasteurised. While 12.2% of consumer respondents and 4.2% of vendor respondents were aware that the milk they purchased and sold was not pasteurised. Whereas slightly over a third (38.9%) of consumer respondents and 4.2% of vendor respondents interviewed did not know whether milk was pasteurised or not. All most all (94.8%) of consumers boiled their milk prior to consumption, only 5.2% consumed the milk without boiling. A majority of customer respondents (80.9%) purchased their milk and milk products from only one vendor, yet 75% of vendor respondents procured their milk from one supplier. Majority (87.5%) of vendors who purchased milk from more than one supplier did mix the milk they purchased as they sold it. The majority of consumer respondents are not consumers of unpackaged fermented products with only 6.6% purchasing yoghurt and only 19.2% purchasing fermented milk (mala). Similarly, the majority of vendor respondents did not prepare unpackaged fermented products with only 8.3% preparing yoghurt and only 37.5% preparing fermented milk (mala). Of the vendor respondents

who prepared fermented milk products, 79.2% boiled the milk used for making the fermented products. There was significant difference between the various milk handling practices by both consumers (P=value = 0.069, 0.045, 0.036, 0.048, 0.043, 0.012) and vendors (P= 0.026, 0.023, 0.049, 0.037, 0.049, 0.035, 0.029) except for knowledge of pasteurization condition of milk by consumers where no significant difference was observed, when comparison done based on gender.

Table 6: Processes subjected to milk after purchase by consumers and vendors in Embakasi West.

Process milk is subjected on purchase		Consumers N=229			Vendors N=24		
Practice	Outcome	Frequency	Percentage	P-value 95% CL	frequency	percentage	P-value 95% CL
Pasteurization condition of milk purchased (sold)	pasteurized	(112)	48.9	0.069	(22)	91.7	0.026
	Not pasteurized	(28)	12.2		(1)	4.2	
	Did not know	(89)	38.9		(1)	4.2	
Heating of milk by consumers prior to consumption	Milk Boiled	(217)	94.8	0.045	-	-	-
	Milk not boiled	(12)	5.2		-	-	
Number of shops (suppliers)	one	(185)	80.8	0.036	(18)	75	0.023
	More than one	(44)	19.2		(6)	25	

Mixing of milk from different shops (suppliers)	Mixed	-	-		(3)	12.5	0.049
	Did not mixed	-	-		(21)	87.5	
Consumption (sale) of ready to drink unpackaged fresh milk	Consumed(sold)	(72)	31.4	0.048	(22)	91.7	0.037
	Did not Consume (sell)	(157)	68.6		(2)	8.3	
Consumption (sale) of unpackaged fermented milk(mala)	Consumed (sold)	(44)	19.2	0.043	(9)	37.5	0.049
	Did not Consume (sell)	(185)	80.8		(15)	62.5	
Consumption (sale) of unpackaged Yoghurt	Consumed (sold)	(15)	6.6	0.012	(2)	8.3	0.035
	Did not Consume (sell)	(214)	93.4		(22)	91.7	
Boiling of milk prior to fermentation	Boiled	-	-		(19)	79.2	0.029
	Did not boil	-	-		(5)	20.8	

Footnote: The figures in parenthesis are frequencies representing the actual value of those interviewed: The P-values compares the respondent's milk handling practices based on gender.

A Chi square test was done and the results shows no significant relationship between milk handling practices and the self-reported *Brucella* infection (P= 1.518, 0.880, 0.179, 0.160, 0.241, 0.581).

Table 7: The relationship between consumer milk handling practices and consumer self-reported infections.

Knowledge of milk handling tested	**N=229**	**df**	**Consumers reported having Brucella infection= 8**	**p-value**
Is the milk you buy heated to boiling?		2		1.518
Do you heat the milk to boil you buy before consumption?		1		0.880
Do you mix milk from different shops?		1		0.179
Do you buy ready to drink fresh milk from milk vendors?		1		0.160
Do you buy ready to unpackaged fermented milk (mala) from milk vendors?		1		0.241
Do you buy ready to unpackaged yoghurt from milk vendors?		1		0.581

Footnote: P-values are obtained by correlating the effect of Consumer milk handling practices on self-reported *Brucella* infections

4.3 Self-reported *Brucella* infection by respondents in Embakasi West

Majority of the consumer respondents (70.7%) were aware of the brucellosis disease, however only 29.2% of vendor respondents were aware of brucellosis disease. Only 3.5% of consumer respondents and 8.3% of vendor respondents had been diagnosed with the brucellosis disease. Of the consumer respondents diagnosed with brucellosis disease, 2.6% were in Embakasi West, Nairobi. About 2.6% of the consumer respondents and 12.5% of vendor respondents suspected fresh milk from the shops they purchased to be the source of the disease. The total cost of medication to cure the disease, spent by consumer respondents in the study sample was between KES1, 000 and KES10, 000 with a majority (95.6%) spending a maximum of KES1, 000. There was significant difference amongst the self-reported *Brucella* infections responses by both

consumers (P-value = 0.047, 0.012, 0.033, 0.038, 0.027, 0.015) and vendors (P-value =0.026, 0.021, 0.044, 0.011) when comparison done based on gender.

Table 8: Self-Reported Brucella infection by consumers and vendors in Embakasi West.

		Consumers N=229			Vendors N=24		
Infection description	Response	Frequency	Percentage	P-value 95% CL	frequency	percentage	P-value 95% CL
Knowledge of brucellosis disease	Had knowledge	(162)	70.7	0.047	(7)	29.2	0.026
	Did not have knowledge	(67)	29.3		(17)	70.8	
Diagnosed with Brucellosis	Have been diagnosed	(8)	3.5	0.012	(2)	8.3	0.021
	Have not been diagnosed	(221)	96.5		(22)	91.7	
Family member Diagnosed with Brucellosis	Have been diagnosed	(4)	1.7	0.033	(1)	4.2	0.044
	Have not been diagnosed	(225)	98.3		(23)	95.8	
Location of diagnosis	Within Nairobi	(6)	2.6	0.038	-	-	
	Outside Nairobi	(223)	97.8		-	-	
Source of infection	Milk from the shop	(6)	2.6	0.027	(3)	12.5	0.011

	they frequent					
	Other sources	(223)	97.8		(21)	87.5
Total cost spent on treatment in KES	0-1000	(219)	95.6	0.015	-	-
	1001-5000	(9)	4		-	-
	5001-10000	(1)	0.4		-	-

Footnote: The figures in parenthesis are frequencies representing the actual value of those interviewed: The P-values compares the respondent's self-reported *Brucella* infections based on gender.

4.4 Laboratory test for milk obtained from milk bars and ATMs at Embakasi West

All the fresh and fermented (mala and yoghurt) samples that were subjected to analysis using the OIE TERRESTRIAL MANUAL OF 2018 returned Negative results for *Brucella spp.* The samples were also subjected to titratable acidity test to determine the pH for fresh and fermented (mala and yoghurt) milk.

Table 9: Laboratory analysis of milk samples collected from Embakasi West.

Test performed		*Brucella spp., pH*			
Method applied		OIE Terrestrial manual-2018			
Testing facility		Analabs limited, Nairobi			
Milk products Type	**Category**	**Samples tested**	***Brucella spp.* presence**	**KEBS Specifications**	**Mean pH**
1. Fresh milk	Supermarkets ATMs	5	Negative	Shall be absent	6.7
	Milk bars without ATMs	8	Negative	Shall be absent	6.8
	Milk bars with ATMs	7	Negative	Shall be absent	6.7
2. Fermented milk (mala)	Milk bars without ATMs	6	Negative	Shall be absent	4.6

	Milk bars with ATMs	6	Negative	Shall be absent	4.6
3. unpackaged yoghurt	Milk bars without ATMs	3	Negative	Shall be absent	4.4
	Milk bars with ATMs	2	Negative	Shall be absent	4.4
Total		37			

CHAPTER 5: DISCUSSION

5.1 Demographic characteristics by respondents in Embakasi West

According to this study, there are more females than males interviewed as customers. In another research on Human Brucellosis reported that the majority of those interviewed were female (n = 238, 61.7%) (Kiambi, et.al, 2020). There is equal number of male and female vendors operating milk bars and ATMs within Embakasi West. The gender equity points to an equal representation of vendors in the milk sales business. Women are responsible for purchases of milk from the milk bars and ATMS which is also supported by research done by Walke *et al* in 2014. There was no association between gender and self-reported Brucella infections. This study was contradicted by another study by Minas, M, 2007 who observed that Males, because of the work they do, were affected frequently by brucellosis more than females (Minas, 2007). A similar study in a pastoral community by Babo et.al, 2022, showed that gender influences information access on brucellosis and knowledge transfer on brucellosis appeared to be influenced by gender, more so from veterinarians towards male gender in the community. In the current study show that despite the slight difference in gender by number, both genders are equally exposed to the same level of risk of Brucella infections.

The majority of respondents are employed (self-employed and salaried employees) with a few numbers being students, unemployed, house wife and casual labourers. Nonetheless, there are no significant association between employment and self-reported Brucella infections. Minas, M. 2007, found that the population residing in urban centres are not at potential risk for acquiring brucellosis because all dairy products commercialized in Greece are produced from milk that have been subjected to pasteurization process (Minas, 2007).

Majority of interviewed consumers are in the lowest income range and thus showing that they prefer unpackaged milk as opposed to high income earners. The study of Walke *et al*. in 2014 found similar results, with the majority of respondents interviewed earning no more than KES30, 000 per month (Walke *et al*., 2014).

Almost all the consumers completed a basic education level of minimum secondary school. This is a good indicator that they possess the ability to understand the parameters relating to safe handling and consumption of milk they purchase in relation Brucella transmission. Kiambi, G. S et.al (2020), Noticed that most participants (dealing with milk sales) reported

either having attained a maximum of primary school education (n = 155, 40.2%) or no education (n = 130, 33.7%) (Kiambi, et.al, 2020).

There is equal number of male and female vendors operating milk bars and ATMs within Embakasi West. The gender equity points to an equal representation of vendors in the milk sales business. Another research carried out in six counties with ATMs density found that the majority (59%) of those interviewed were male, while female respondents were 41% (Ayuya *et al.,* 2020)

More than half of the vendors interviewed are self-employed which may imply that they are the owners of the milk bars and ATMS. This may be a positive indicator with relation to enforcement of measures that help control transmission of Brucella in the milk offered for sale. A different study established that milk ATMs business employs 3350 operators nationally and that the operators had an employment experience of two years (Ayuya *et al.,* 2020).

Vendor respondents interviewed completed a minimum basic education of secondary school and above. This is a good indicator when it comes to comprehension of proper handling and consumption of milk and in particular with relation to control of transmission of Brucella. In different research, it was established that 54% of the employees attained secondary school education, while 6% had primary school education while 40% had tertiary school education as the highest level (Ayuya *et al.,* 2020). The 2014 Kenya Demographic and Health Survey, reports that 43 % of women and 49% of men had a minimum secondary school education (KDHS, 2014).

5.2 Milk safety knowledge and handling practices to contain Brucella of respondents in Embakasi West

5.2.1 Level of knowledge of Brucella milk safety knowledge by respondents in Embakasi West

Consumers are knowledgeable when it comes to the milk safety and quality. This is supported by a study by Kirino *et al*. in 2016 that found that the respondents who had the knowledge that milk can be a source of diseases, correctly gave examples such as brucellosis were mentioned by 46.9%, stomach ache and/or diarrhoea mentioned by 6.3% and typhoid mentioned by 2.9% (Kirino *et al*., 2016). However, there is a gap on hygiene and cleanliness as a way of controlling transmission of Brucella with a similar case for fermentation of milk. In a study by Onyango D.L. *et al* on Brucellosis risk factors and milk hygiene handling practices in pastoral communities in Isiolo County, they found out that milk handling and hygiene practices are not

at the best possible level of standard because of poor knowledge of hygiene and challenges of unavailability of water for cleaning. (Onyango et.al. 2021). Another study by Nadhem M. et.al, (2020) on Consumer milk safety perception in Kenya concluded that generally, consumers have the knowledge on the importance of milk safety but lack an awareness of the specific milk-related safety and quality issues (Nadhem *et al*., 2020).

Vendors are aware of the mode of transmission of Brucella spp. This contributes towards the safety of milk they sell. In different research, it was established that vendors received at least one training program on milk safety, but however, dairy trainings they received had no impact on the vendor milk handling practices and quality measures (Alonso *et al*., 2018). However, there might be a lack of understanding of the role of hygiene and sanitation plays in the control of Brucella spp., in milk. A similar case is reported by a researcher who found out that Milk traders put inadequate effort in keeping proper hygiene for the milk they offer for sell at the markets: because the milk is often sold without boiling, the milk storage containers are not properly cleaned in order to prevent milk spoilage and contamination (Onyango *et.al,* 2021).

5.2.2 Milk handling practices by respondents at Embakasi West

Consumers have knowledge of the pasteurization status of the milk they purchased, however there are some consumers who not know if the milk they purchase had been pasteurized. Which highlights a gap in sensitization of consumers by vendors on the status of the milk they purchased. In comparison, vendors sold milk that they know are pasteurized. In different research, 99% of vendors reported to only sell pasteurized milk (Ayuya *et al.,* 2020).

Majority of consumers subject their milk to adequate heat treatment prior to consumption and this is one way of ensuring safety of their milk prior to consumption. Another study by Blackmore, E. et.al (2022) found that consumers prefer raw milk from informal markets, which is then heat treated at home before consumption. Walke, *et.al* in 2014, established that 99% of respondents who bought raw milk boiled their milk prior to consumption with 95% of them believing that boiling rendered their milk safe for consumption (Walke *et al*., 2014). Boiling is one way of ensuring safety of the milked consumed and this is supported by a study done by

The majority of consumer respondents purchase their milk from only one vendor. A study which did not state whether households purchase milk from a particular source, however, observed 40% of consumers buy milk from a corner kiosk or shop, 16% form the milk dispenser

in a milk bar, 12% directly at the producer's gate, while 11% from a milk bar in a dairy shop (Schneider, 2018).

Majority of Consumers do not consume fermented products. Consequently, majority of vendors do not prepare fermented products, however of those that did prepare, they boiled their milk prior to fermentation to ensure of the safety. Another study established that about two-third of the vendors sold value added milk products in addition to liquid milk whereby 64% sold mala (or fermented milk) and 21% sold yoghurt (Alonso *et al.*,2018).

5.3 Self-reported Brucella infections among respondents in Embakasi West

Brucellosis is a disease that is known by the majority of the respondents, however the infection rate of the disease among respondents was low. In another study, it was observed that 79% of respondents had heard of brucellosis with 18% mentioning germs/bacteria as the cause of the disease (Obonyo *et. al*, 2013) whereas in a different study, it was observed that the majority (85%) of those interviewed had not heard about Brucellosis (Lindahl *et al*., 2015).

Only a small percentage of reported infections were in Nairobi and this could indicate effectiveness of measures put I place to curb spread of the disease (Delia *et al.*, 2018). In different research, the prevalence of brucellosis in humans in Kajiado County was found to be 14.1% and in Kiambu County was 2.2% (Ogola *et al*., 2014)

There are treatment costs related to the disease which this will an impact on the economic impact when diagnosed with the disease given the economic status of those interviewed. Another research established that the cost of brucellosis treatment in Africa ranged from 9 Euros in Tanzania to 200 Euros in Morocco, and as high as 650 Euros en Algeria (Akakpo *et al*., 2009).

5.4 Laboratory analysis for samples obtained from milk bars and ATMs at Embakasi West

Milk marketed in milk bars and ATMs within Embakasi West have no *Brucella species* on the samples tested. The same result was arrived at by a study done to investigate the role played by unpasteurized hawked milk in the conveyance of Brucellosis within Eldoret municipality which found no reaction between the MRT and all the milk samples (Namanda *et al*., 2009). Brucella is one of the microorganisms that is transmitted via milk and thus may occasionally be positively identified in milk and dairy products.

In the current study, however, there was no confirmed positive case in the sampled area and this may be due to several factors such as; Knowledge of brucellosis, its transmission and transmission was low among the respondents. This could have had a massive impact on the spread of the bacteria in milk marketed in the area. Furthermore, the rules detailed in the Code of hygienic practice for milk and milk products (KS1552:2016) bans the direct marketing of raw milk to consumers in municipalities enforced by the Kenya Dairy Board and local Authorities. This effectively implies that the majority if not all of the unpackaged milk marketed within Embakasi West have been subjected to requisite pasteurization process that is effective enough to eliminate Brucella in milk (Delia *et al.,* 2018).

CHAPTER 6: CONCLUSION AND RECCOMENDATION

6.1 CONCLUSION

Consumers and vendors interviewed have a good knowledge of the safety of milk in relation to presence, transmission and elimination of *Brucella spp.* in milk through appropriate milk handling practices and hygienic conditions. However, data collected and analyzed showed that the number of self-reported cases of brucellosis is in a small percentage of the respondents interviewed. Thus, the prevalence of brucellosis in the sampled area is low. Microbial analysis of fresh and fermented milk samples in milk bars in Embakasi West sub-county shows that they are of good quality and that there is absence of *Brucella spp., in* the sampled milk.

6.2 RECCOMENDATION

1. Sensitization of the members of the public on brucellosis, and its impact on the general wellbeing of the consumers.
2. Training of the vendors on proper handling, storage and sale of unpackaged milk in milk shops and milk bars within Embakasi West sub-county.
3. The government to continue enforcing the ban on sale of raw milk in Embakasi West sub-county and by extension in Kenya.

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CHAPTER 8: APPENDICES

8.1 Appendix one: Study tools

8.1.2 Data tools instruments

Table 10: Data collection tools, instruments and recording space

Data	Instruments/ Equipment	Manufacturer-name	Tool	Data recording space
Specific Obj 1: To establish the demographic characteristics milk vendors and milk consumers				
Demographic characteristics	Mobile phones	Samsung	Open data kit questionnaire	online
Specific Obj 2: To determine the level of knowledge of *Brucella* milk safety and milk handling practices among milk vendors and milk consumers				
Brucella milk safety knowledge	Mobile phones	Samsung	Open data kit Questionnaire	online
Knowledge on milk handling practices	Mobile phones	Samsung	Open data kit Questionnaire	online
Specific Obj 3: To establish the self-reported *Brucella* infection of milk vendors and milk consumers				
self-reported *Brucella* infection	Mobile phones	Samsung	Open data kit questionnaire	online
Specific Obj 4: To evaluate the pH, alkaline phosphatase and prevalence of *Brucella* species in fresh and fermented milk sold in milk dispensers and milk bars.				
status *Brucella species* pH test Alkaline phosphatase test	Elisa kit		checklist	Form Form Form

8.2 Appendix two: Questionnaires

8.2.1 Milk customer questionnaire

A. DEMOGRAPHIC INFORMATION

Date of Interview		Name of Interviewer	
Location of Interview			
Respondent's First Name			
Mobile number			
Gender	1 – Male 2 – Female 3 – Other (specify)		
Age			
Marital status	1. single 2. Married 3. Separated 4. Divorced 5. widow 6. widower 7. Others (specify)		
Highest Education Level (Tick Correct)	1. Degree 2. Diploma		

	3. College certificate 4. Completed Secondary 5. Completed primary 6. Adult Education 7. No education 8. Pre-primary 9. Others (specify)
Occupation (Tick Correct)	1. Salaried employee 2. Self-employed 3. Farmer 4. Casual labourer 5. Student 6. Housewife 7. Unemployed 8. Others (specify) 9. N/A
Monthly income	
Name of milk vendor shop	
Daily fresh milk quantities purchased	
Daily yoghurt quantities purchased	
Daily mala quantities purchased	
Reason for choice of dispensed milk	

B. *BRUCELLA* MILK SAFETY KNOWLEDGE

	TICK APPROPRIATELY	**Feedback**	**RemarKES**
1.	Brucellosis is not transmitted via milk.	**True**	
		False	
2.	Mixing of milk from different locations increase the risk of cross contamination.	**True**	
		False	
3.	Heating to boil does not eliminate *Brucella* in milk.	**True**	
		False	
4.	Hygiene and cleanliness are effective in controlling *Brucella* in milk.	**True**	
		False	
5.	Fermentation of milk eliminates *Brucella*.	**True**	
		False	
6.	It is not necessary to boil milk before fermentation.	**True**	
		False	
7.	Milk should always be stored under refrigeration temperatures	**True** **False**	
8.	Fermented milk prepared from raw milk cannot transmit brucellosis.	**True**	
		False	

C. MILK HANDLING PRACTICES

	MILK HANDING PRACTICES		**Comments**	**Interviewer's remark**
1.	Is the milk you buy heated to boiling?	1. Yes 2. No 3. Don't know		
2.	How do you heat to boil the milk you buy for consumption?	1. Boil first 2. Consume without boiling		
3.	Do you mix milk from different shops?	Yes/No		
4.	Do you buy ready to drink fresh milk from milk vendors/ ATMs?	Yes/No		
5.	Do you buy unpackaged yoghurt from milk vendors/ ATMs?	Yes/No		
6.	Do you buy unpackaged fermented milk from milk vendors/ ATMs (mala)?	Yes/No		
7	Do you prepare fermented milk products from the milk you purchase from milk vendors/ ATMs?	Yes/No		

8.	If yes, do you boil first or just ferment?	1. Boil first 2. Ferment without boiling		

D. SELF REPORTED *BRUCELLA* INFECTIONS

	***BRUCELLA* INFECTIONS**	
1.	Are you aware of Brucellosis disease?	Yes/No
2.	Have you been diagnosed with brucellosis in the last one year?	Yes/No
3.	Has there been any other member of your family been diagnosed with Brucellosis in the last one year?	Yes/no
4.	Number of family members diagnosed	(number)
5.	If yes, where was it diagnosed?	1. Nairobi 2. Upcountry 3. Others(specify)
6.	If Nairobi, what was the suspected source?	1. Fresh milk from milk vendors/ ATMs 2. Yoghurt from milk vendors / ATMs 3. Mala from milk Vendors / ATMs 4. Other (specify)
7.	If yes to question 2, What was the total treatment related costs incurred?	

8.2.2 Milk vendor questionnaire

A. DEMOGRAPHIC INFORMATION

Date of Interview		Name of Interviewer	

Location of Interview	
Respondent's Name	
Name of the shop	
Gender	1 – Male 2 – Female 3 – Other (specify)
Age	
Mobile number	
Marital status	8. single 9. Married 10. Separated 11. Divorced 12. widow 13. widower 14. Others (specify)
Highest Education Level (Tick Correct)	10. Degree 11. Diploma 12. College certificate 13. Completed Secondary 14. Completed primary 15. Adult Education

	16. No education 17. Pre-primary 18. Others (specify)
Occupation (Tick Correct)	10. Salaried employee 11. Self-employed 12. Farmer 13. Casual labourer 14. Student 15. Housewife 16. Unemployed 17. Others (specify) 18. N/A
Monthly income	
Milk shop type	1. Supermarket ATM 2. Milk shop with ATM 3. Milk shop without ATM
Daily fresh milk quantities sold	
Daily yoghurt quantities sold	
Daily mala quantities sold	
Place of origin of milk	

B. *BRUCELLA* MILK SAFETY KNOWLEDGE

	TICK APPROPRIATELY	**Feedback**	**RemarKES**
1.	Brucellosis is not transmitted via milk.	**True**	
		False	
2.	Mixing of milk from different locations increase the risk of cross contamination.	**True**	
		False	
3.	Pasteurization does not eliminate *Brucella* in milk.	**True**	
		False	
4.	Hygiene and cleanliness are effective in controlling *Brucella* in milk.	**True**	
		False	
5.	Fermentation of milk eliminates *Brucella*.	**True**	
		False	
6.	It is not necessary to pasteurize milk before fermentation.	**True**	
		False	
7.	Fermented milk prepared from raw milk cannot cause brucellosis.	**True**	
		False	

C. MILK HANDLING PRACTICES

	MILK HANDING PRACTICES		**Comments**	**Interviewer's remark**
1.	Is the milk you sell pasteurized?	4. Yes 5. No 6. Don't know		
2.	Do you procure milk from different suppliers?	Yes/No		
3.	Do you mix milk from different sources?	Yes/No		
4.	Do you sell ready to drink milk?	Yes/No		
6.	If yes, do you further boil the ready to drink milk?	Yes/No		
7.	Do you prepare yoghurt?	Yes/No		
8.	Do you prepare fermented milk (mala)?	Yes/No		
9.	If yes in any of 5 & 6, do you boil first or just ferment?	3. Boil first 4. Ferment without boiling		

D. SELF REPORTED *BRUCELLA* INFECTIONS

	***BRUCELLA* INFECTIONS**	
1.	Are you aware of brucellosis disease?	Yes/No
2.	Have you been diagnosed with brucellosis in the last five years?	Yes/No
3.	If yes, what was the suspected source?	1. Fresh milk from milk shop 2. Yoghurt from milk shop 3. Mala from milk shop 4. Other (specify)
4.	Was there any case of abortions related to the infection?	Yes/No
5.	What was the total treatment related costs incurred?	
6.	Number of family members diagnosed	

8.3 Appendix three: Participants consent forms

8.3.1 Informed consent information sheet

Title of project: CONSUMER AND VENDOR MILK SAFETY KNOWLEDGE AND PRACTICES ON *BRUCELLA* AND *BRUCELLA* PREVALENCE IN MILK SOLD IN MILK DISPENSERS AND MILK BARS IN EMBAKASI WEST SUB-COUNTY, NAIROBI KENYA

You are being requested to take part in a research study to provide information that will aid in the realization of the objectives of this research.

The study aims to contribute towards the reduction of cases of brucellosis infections arising from ingestion of fresh and fermented milk sold in milk dispensers and milk bars.

The purpose of the study is to come up with information on the milk vendor and consumer *Brucella* milk safety knowledge and the prevalence of *Brucella* species in Embakasi West sub-county, Nairobi Kenya that can be used by the stakeholders in the milk value chain towards the reduction of transmission through milk consumed on a daily basis.

In this study, you will be expected to provide truthful information concerning your household to the enumerator allocated to you. Once you consent to participate in the study, you will be asked questions and the responses you give will be captured in this questionnaire. With your cooperation, the interview will last for approximately ____minutes after which the enumerators will leave your homestead.

The data collected shall only be seen by members affiliated with the study, and will not be linked to any identifying information such as name, address or other personal details that you will supply. The data collected shall be averaged over many participants and therefore your individual data shall not be identifiable.

This study presents no known risk(s) to you or your family. You may decide to discontinue participating in the study at any time, however we encourage you to remain in the study and respond to all questions. You have the right to demand that any data you have provided until that point be withdrawn/destroyed.

If you have any questions with regards to this information sheet, you should ask the enumerator before the study begins.

8.3.2 Consent Form

Researcher (name): _____contact: _____

Title of project: CONSUMER AND VENDOR MILK SAFETY KNOWLEDGE AND PRACTICES ON *BRUCELLA* AND *BRUCELLA* PREVALENCE IN MILK SOLD IN MILK DISPENSERS AND MILK BARS IN EMBAKASI WEST SUB-COUNTY, NAIROBI KENYA

Kindly tick where appropriate:

1. I confirm that I have read (or been read to) and understood the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had the questions answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected. ☐

3. I understand that relevant sections of information and data collected during the study may be looked at by other members of this research team. ☐

4. I give permission for these individuals to have access to these records. ☐

5. I agree to take part in the study without any demands and of my own free will. ☐

Name of respondent: _____

Date: _____

Signature: _____ OR

Thumb Print