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A Review on the Status of Bovine Brucellosis and its Public Health Significance in Ethiopia

Abbas Mohammed and Adem Edao

College of Veterinary Medicine, Haramaya University, Haramaya, Ethiopia

Abstract: A member of the genus Brucella brings on an infectious bacterial zoonotic illness called brucellosis. Clinical signs are similar for all species and commonly include abortion, stillbirth or weak calves, retained placentas and decreased milk yield. Public health significance has the illness, physical incapacity and loss of manpower, resulting in the scarcity of animal proteins due to meat loss. The economic importance of brucellosis depends upon the species of animal affected. It can cause considerable losses in cattle due to abortion and a reduction in milk yield. Vaccinating young female animals is the most rational approach for controlling *B. abortus* infection. The occupational risk of brucellosis is essential because of the high possibility of direct transmission from infected animals to those employed in animal husbandry. This exposed group includes slaughterhouse workers, dairymen, herdsmen and veterinary clinicians. Various methods are used to diagnose brucellosis, including microscopic examination and serological and molecular biology. The diseased animal species from which human transmission occurs has a big impact on brucellosis' value for public health. Public awareness is vital in successfully controlling and preventing brucellosis; isolating infected animals and females at parturition; properly disposing of the aborted fetus, placental tissue and uterine discharge; disinfecting contaminated areas and pasteurization of milk. In Ethiopia, the situation with bovine brucellosis is not effectively managed. Studies indicate that the prevalence of the diseases distributed in any part of Ethiopia is higher in the lowlands than in the highlands. Since brucellosis has no effective treatment, vaccination, hygiene, public health education and awareness creation are the best alternative strategies.

Key words: Brucella *Abortus* · Bovine Brucellosis · Public Health · Ethiopia

INTRODUCTION

In 2020, Ethiopia had the most livestock in Africa, with 65 million cows, 40 million sheep, 51 million goats, 8 million camels and 49 million poultry [1]. Keeping livestock provides a significant amount of animal protein, energy for growing crops, transportation, exporting goods, manure for agriculture and home energy, security during crop failures and a way to build wealth. The sector contributed up to 40% of agricultural Gross Domestic Product (GDP), nearly 20% of total GDP and 20% of national foreign exchange earnings in 2017 [2]. In rural agriculture, the economy's foundation, oxen supply draught force to produce grain crops. The comparatively substantial livestock resources of the country and the contagious illnesses, among other things. One of these contagious illnesses, known as bovine brucellosis, has been observed in some regions of the nation [3].

A bacterial disease affecting animals worldwide, brucellosis is extremely contagious, zoonotic and economically significant [4]. It is caused by gram-negative Cocco-bacilli of the genus Brucella [5]. Cattle, sheep, goats, camels and pigs are the principal hosts of the Brucella bacteria, a human zoonotic. Both B. *melitensis* and B. *abortus* can infect human. Brucella *abortus* natural hosts are cattle (Bostaurus) [6]. Cattle acquire the infection mainly due to ingestion of feed and water contaminated by aborted fetuses, fetal membranes and uterine discharges. Infection in man can therefore occur by ingesting raw milk or milk products or handling infected animals [7]. The bacterium Brucella abortus primarily causes brucellosis in cattle. Currently, ten species are known, including the better-known six classical species comprised of *B. abortus, B. melitensis, B. suis, B. ovis, B. canis* and *B. Neotoma. B. Ceti, B. pinnipedialis, B. microti* and *B. inopinata*, new

Corresponding Author: Abbas Mohammed, College of Veterinary Medicine, Haramaya University, Haramaya, Ethiopia.

species of the genus that harm several animal species, have all been discovered recently [8]. All Brucella species are potentially pathogenic for human, except for *B. Neotoma*, *B. microti* and *B. ovis* [9].

Bovine brucellosis has been controlled in most industrialized countries. Clinical disease is recorded among different animals in many developing countries of Africa, Asia and Central and South America. The impact of brucellosis on human health is a significant issue [10]. It can cause appreciable economic losses in the livestock industry because of abortions, decreased milk production, sterility and veterinary care and treatment costs [11].

In Africa, a high prevalence has been reported in Uganda, Sudan and Senegal; moderate prevalence rates were recorded in Nigeria, Zambia, Ghana and Botswana, while a low prevalence was encountered in Kenya, Djibouti and Eritrea [12].

In Ethiopia, Brucellosis remains endemic and a significant public and animal health problem. Brucellosis has been noted as one of the country's essential livestock diseases, as depicted in Ethiopia's first case report of brucellosis in the 1970s [13]. The primary mode of transmission of Brucella bacterium in human is ingesting dairy products with contamination. Here is where pasteurization of milk becomes necessary and Aerosol exposure is a remote possibility, as is direct contact with an infected animal and its waste. Contrarily, the animal contracts the disease through exposure to contaminated food, water, fomites, contact with an infected animal, miscarriage and mating, as well as other means, such as artificial insemination utilizing the semen of males who have the infection. The most common symptom of brucellosis is abortion in ruminant animals, such as sheep, goats and cows; other symptoms include stillbirth, retained placenta and a decrease in milk production [14]. However, the predominant clinical symptoms in bulls are orchitis and epididymitis. Human symptoms include septicemia, respiratory discomfort, headaches and undulant fever [11].

A precise diagnosis of Brucella species infection is vital for controlling the disease in animals and human. Various methods are employed to diagnose brucellosis, including microscopic examination and serological and molecular biology [9]. Various serological tests have been developed and modified to increase sensitivity and specificity. OIE described that no single serological test is appropriate in all epidemiological situations; all have limitations. The Rose Bengal plate test has indicated circulating Brucella antibodies (RBPT, complement fixation test (CFT) and enzyme-linked immunosorbent assay (ELISA), of which CFT has been used as a gold standard and prescribed test for international trade. The significant risk factors for brucellosis include herd size, retained placenta, abortion, number of parity and transhumance at the herd level and age at the animal population level [15].

Among the best preventative measures for brucellosis depends on preventing the exposure of susceptible animals to infection, increasing population resistance through vaccination and applying a test and slaughter policy when the prevalence of the disease is low on a given farm. However, there are currently no vaccines available for humans, highlighting the need to contain this disease in animals and people [16].

In general, the epidemiology of bovine brucellosis and the awareness of the disease differ from place to place. Thus, it is necessary to know the status of bovine brucellosis and its public health in other parts of Ethiopia. Therefore, this review is undertaken to review the status of Bovine Brucellosis in Ethiopia and its public health significance.

Etiology: Numerous animal species, including humans, can contract the gram-negative, facultative intracellular bacterium called Brucellae. Brucella *abortus* is the causative organism for bovine brucellosis. Although Brucell*a abortus* primarily affects cattle, it can occasionally infect sheep, pigs, dogs and horses [3]. Cattle can also become infected by *B. suis* and *B. melitensis* when they share pasture or facilities with infected pigs, goats, or sheep. The cattle infections caused by heterologous Brucella species are usually more transient than that caused by B. *abortus* [3, 4]. Within the genus Brucella, ten species have been identified. *B. ovis, B. canis, B. suis, B. melitensis, B. abortus* and *B. Neotoma* are considered "classical." In contrast, four further species have only recently been identified. The disease can also infect people and non-bovine animals, which significantly contributes to its persistence and spread. The seven identified biovars of Brucella abortus that infect cattle are biovars 1, 2, 3, 4 and 9, with biovar 9 being the most commonly reported. one being the most prevalent in Latin America [8].

Epidemiology

Geographic Distribution: The epidemiology of brucellosis has dramatically changed over the past few years due to improved hygiene, socio-economic conditions and increased international travel. The incidence of human brucellosis was reported for the first time in central Asia and some countries. Particularly in Middle East countries, there is a drastic increase in the incidences of brucellosis in human [10].

Brucella *abortus* is prevalent worldwide except in Canada, Australia, Cyprus, Norway, Finland, the Netherlands, Denmark, Sweden, New Zealand and the United Kingdom. However, Mediterranean Europe, Central and South America, Mexico, Africa, Near East countries, Central Asia, India and Italy have a significant prevalence of brucellosis. Brucellosis is a reportable and notifiable report considering 19 years (1996–2014) by the World Organization for Animal Health (OIE) regarding 156 countries classified countries into three groups based on the situation of brucellosis among animals [17]. The three categories are enzootic for brucellosis: countries that are infected or free of brucellosis for less than three 'years time period non-enzootic for brucellosis: though brucellosis may be present, countries in this category are devoid of disease for three years and free of brucellosis: countries devoid of brucellosis throughout the study period of 19 years. The disease-free status countries are in Europe and Oceania, while high prevalence or enzootic countries are in Central and South America, Africa and Asia [17]. Brucellosis is endemic in Western Asia, India, the Middle East, Southern Europe and South America [18]. A study in Iran reported that *B. abortus* biovar3 is the most prevalent [19]. Brucellosis is mainly caused by *B. abortus* biovar1 in water buffaloes in parts of Africa, South America, Brazil, Italy and Pakistan. In Italy, cattle and water buffalos are affected by *B. abortus,* mainly in southern areas [20]. Reports of *B. melitensis* infection in cattle are pouring, a significant threat in Kuwait, Saudi Arabia, Israel and some southern European countries [8]. The epidemiology of this disease remains dynamic and unpredictable as several new strains could emerge and present strains could adapt to new animal species and changing situations. The condition is rare in children, but in endemic areas, such cases have been reported [21,22].

Risk Factors: Risk factors associated with bovine brucellosis have been described in (Figure 1) to include: host, agent, management and survival of Brucella in the environment [23]. A significant association between Brucella infection and risk markers, such as abortion, retention of placenta and repeat breeding, is reported by some researchers. A significant association between brucellosis and abortion and retention of the placenta, but not between brucellosis and repeat breeding and no significant association between Brucella seropositivity and abortion and retention of the placenta [24]. The prevalence of those infection risk factors is best understood for bovine brucellosis and, to a lesser extent, for ovine and caprine brucellosis [25].

Host Risk Factors: Brucella abortus is the most common Brucella organism infecting cattle. On the other hand, *B. suis* and *B. melitensis* can potentially infect cattle [26,27]. *B. melitensis* and *B. suis* can infect humans through cow's milk. *B. melitensis* is the primary cause of brucellosis in goats. On the other hand, goats may be infected with *B. abortus* [7]. *B. abortus* and *B. melitensis* might infect camels. Camel milk is possibly a significant source of human infections in Middle East countries. The predominant cause of brucellosis in dogs is *B. canis*; however, brucellosis in dogs can also be caused by *B. abortus, B. suis* and *B. melitensis* on occasion. *B. abortus* has also been recorded from Yak and the seroprevalence of Brucella has been examined in Yak [28]. Cattle are susceptible to infection with Brucella abortus depending on their age, sex and reproductive status. Pregnant, sexually mature cattle are more likely to contract the organism than are sexually immature cattle of any sex [28]. Young, sexually immature cattle generally do not become infected following exposure or recover quickly. Sexually mature females are more susceptible to *B. abortus* infection than bulls. This susceptibility increases during pregnancy and animals get more susceptible with the advance of pregnancy [23].

Agent Risk Factors: Brucella *abortus* is a facultative intracellular parasite capable of multiplication and survival within host phagocytes [16]. The organisms are phagocytosed by polymorph nuclear leukocytes, in which some survive and multiply. These are then transported to lymphoid tissues and the fetal placenta [29].

Management Risk Factors: Almost always, the movement of diseased animals is what causes the disease to spread from one herd to another and from one location to another. The unregulated activity of battle from infected herds or areas to bovine brucellosis-free herds or areas is the major cause of breakdowns in bovine brucellosis eradication programs. Other management factors influencing inter-herd transmission are proximity to infected herds, waterways and scavengers. Various cattle husbandry practices have also been shown to be associated with the spread of *B. abortus* infection within herds [16]. Vaccination level, population density, methods of housing and use of maternity pens influence

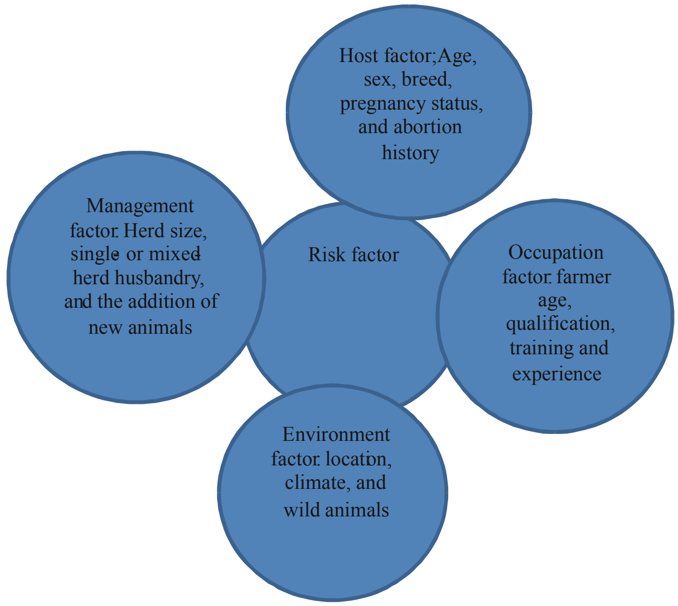

Fig. 1: Risk factor for brucella infection

the probability of exposure to disease. Many factors affect the epidemiology of bovine brucellosis; the most important are herd size and mobility, contiguity to infected herds, the concentration of cattle and nature of production (dairy herds) are more susceptible than beef cattle [30]

Environment Risk Factors: In countries with temperate or cold climates, there is a marked seasonal variation in the incidence of bovine brucellosis, with most cases occurring in the spring and summer. When conditions are right, Brucella has a comparatively high propensity to survive outside mammalian hosts compared to most other dangerous bacteria that do not produce spores. Numerous studies have assessed the persistence of Brucella under various environmental conditions. Thus, when pH, temperature and light conditions are favorable, that means pH>4; high humidity, low temperatures and the absence of direct sunshine may allow Brucella to maintain its infectiousness in water for several 'months' fetuses and fetal membrane, feces and liquid manure, wool, hay, on building, equipment and clothes. Brucella can endure drying, especially when additional organic material is present and it may survive in dust and soil. Survival is prolonged at low temperatures [31]. The disease's epidemiology may be affected by the organism's ability to survive in its environment. A contaminated environment or equipment used for milking or artificial insemination is an additional source of infection. Permanent calving camps and lush pastures, mainly if they are wet and muddy, may play a crucial part in the disease's propagation. Brucella is sensitive to direct sunlight, disinfectant and pasteurization [32].

Occupations at Higher Risk: People who work with animals or come into contact with infected blood are at higher risk of brucellosis. Examples include veterinarians, dairy farmers, ranchers, slaughterhouse workers, hunters, microbiologists and farmers and those handling artificial insemination, abattoir and slaughterhouse personnel working in endemic areas at risk [32,33]. Brucellae are considered potential bioweapons [33].

Pathogenesis: In cattle, infection with B. *abortus* is usually due to the ingestion of infected material. The bacteria penetrate the mucosal epithelium of the gastrointestinal tract and are transported to regional lymph nodes, either free or within phagocytic cells. If these bacteria are not localized or are not killed, they can spread to other organs, joints and bursa. This phase of bacteremia is subclinical and may take several weeks to some months [34].

The bacteria then localize in the pregnant uterus and udder of cows' and bulls' testicles and accessory sex glands. In pregnant cows, the chorioallantoic membrane becomes inflamed and ulcerated and bacteria can spread via the blood to the fetus and placenta. The preference of the bacteria for these sites is thought to be due to the presence of the sugar alcohol erythritol, a fetal product concentrated in the chorion, cotyledons and fetal fluids. In mature, non-pregnant cows, the bacterium localizes in the udder. Infection of the udder is often clinically inapparent, with no gross lesions. Brucella localizes and replicates primarily in macrophages in mammary secretions or phagocytes; they form an essential source of organisms for frequent reinfection (and potentially for infection of calves and human via the milk). Hence, if the cow later becomes pregnant, the uterus can become infected during a subsequent bacteremic phase [32].

Clinical Finding: *Animals' incubation times range from 14 to 120 days* [14]. The reproductive system is where brucellosis in livestock first manifests itself clinically. Abortion occurs after the fifth month of pregnancy in extremely vulnerable, non-vaccinated pregnant cows, a cardinal feature of the disease [6]. Retention of the placenta and metritis are common sequels of abortion. Females often have one abortion, maybe because they have developed immunity. In general, metritis brought on by abortion with placenta retention and prolonged calving intervals may result in permanent infertility [14]. B *abortus* produces weak calves, stillbirths and abortions in cattle. Retention of the placenta and impaired lactation are both possible outcomes. *Bulls occasionally have testicular abscesses, orchitis, epididymitis and seminal vesiculitis.* Infertility sometimes occurs in both sexes due to *metritis or orchitis/epididymitis*. Hygromas, particularly on the leg joints, are common in some tropical countries [6]. Chronic infections can lead to arthritis. Except in fetuses and newborns, simple infections rarely cause systemic symptoms and deaths are uncommon. Infections in non-pregnant females are typically adult females who are pregnant and have the B abortus virus and are asymptomatic but develop placentitis, which generally causes abortion between the fifth and ninth months of pregnancy [35]. The placenta, fetal fluids and vaginal exudates heavily shed microorganisms, even without abortion. Infections of the local lymph nodes and mammary glands are possible and bacteria can excrete in milk [35].

In Human: *B. melitensis* has the most significant risk for human infection, followed by *B. suis* and *B. abortus*. However, several other species are virulent for human [35]. The primary source of transmission of *B. abortus* to human is through the consumption of unpasteurized or raw milk or milk products, including butter, whey, cheese, yogurt, ice cream, etc. Infection through raw vegetables, water with fecal contamination and consumption of undercooked animal meat are also reported. Sour milk, yogurt and hard cheese produce propionic and lactic fermentation. Therefore, the survival of the organism is comparatively less. Contamination in dairy products, thereby preventing transmission, is related to the poverty level [19].

Brucellosis in man is also considered an occupational disease of dairy farmers, milking workers, animal handlers, dairy industry workers, slaughterhouse staff, butchers, hunters, shepherds, laboratory personnel, veterinary assistants, scientists and veterinarians. Infection through skin wounds may occur in persons working in the meat industry, veterinarians and livestock handlers. Inhalation is a significant cause of infection in slaughterhouse personnel. Laboratory-acquired infection is reported as a potential health emergency for laboratory personnel. Brucellosis is considered a common laboratory-transmitted Infection [21].

Brucellosis can spread from wild animals to domestic animals and humans. Moreover, little knowledge of the disease and its transmission among livestock handlers negatively reflects their attitude and practice toward disease control strategies. The pathogen has been classed as a category (B) bio-weapon candidate. B. *suis* was the first biological weapon utilized by the American army in biological warfare [36].

Undulant fever, loss of appetite, weight loss, night sweats, discomfort, weariness, chills, sleeplessness, joint pain, constipation, migraines, myalgia, sexual impotence, anxiety, depression and weight loss are the most prevalent symptoms of human brucellosis [37]. Sudden abortions during the first or second trimesters are observed in pregnant women [38]. The transmission of brucellosis from person to person is infrequent. However, sexual and intrauterine information to the infant is also possible. Moreover, infants may get an infection from breastfeeding mothers infected with brucellosis [39].

Transmission: Brucella can spread horizontally or vertically [35]. Brucella organisms are detected in larger concentrations in pregnant animals' uteruses. The placental membranes and uterine secretions of aborted fetuses are the principal sources of infection [40]. In addition, in-utero rare instances of transmission, transmission from person to person and transmission linked to tissue transplantation have been noted. Aerial germs continue to provide a serious risk of illness by inhalation or contact with the conjunctiva [17]. Infected bulls may potentially disseminate illness from one herd to another through spontaneous or artificial insemination [41].

Diagnosis: The choice of samples for brucellosis diagnosis is mainly based on the clinical indicators seen in animals. The essential samples include vaginal secretions (swabs), aborted fetuses (stomach contents, spleen and lung), fetal membranes and milk, sperm and arthritic or hygroma fluid [42]. Growth usually develops after 3-4 days; However, cultures should not be dismissed as negative until 7-10 days have passed [43].

Microscopic Staining: The disease can be confirmed by demonstrating the bacteria in smears. The smears are made from vaginal discharges, placenta, colostrum, fetal using the modified Ziehl-Neelsen (MZN) stain, examine stomach contents, the lochia of an aborting cow and the abomasum of an aborted fetus [44]. Samples of all kinds can be gathered for microscopic analysis and cultivation. Additionally, B. abortus is frequently isolated from the secretions of udders that are not lactating. This organism can also be grown from the placenta, stomach, spleen and lungs of aborted fetuses [44, 45].

Enzyme-Linked Immune Sorbent Assay (ELISA): Still now, there is only one report [46] suggesting antigen detection by enzyme-linked immunosorbent assay (ELISA) as an acceptable alternative to blood culture for the diagnosis of brucellosis since sensitivity and specificity are 100% and 99.2% respectively. Antigen detection methods are potentially useful but have not been validated. Molecular technique: species of Brucella can be identified by molecular techniques [45]. Molecular detection of Brucella species can be done directly on clinical samples without previous isolation of the organism [46].

Polymerase Chain Reaction (PCR): Brucella DNA in pure cultures can be found using polymerase chain reaction (PCR) assays and Clinical specimens include pus, cerebrospinal fluid, whole blood, urine, different tissues and synovial or pleural fluid. Direct detection of Brucella DNA in brucellosis patients is difficult due to the low number of bacteria in clinical samples and the inhibitory effects of matrix components. Basic sample preparation techniques should concentrate on the bacterial DNA template and reduce inhibitory effects [6].

Serology: Screening and confirmatory serological tests can be roughly categorized into these two classes. Some screening tests are used in field clinics or regional laboratories, such as the Rose Bengal Buffered Plate Agglutination Test (BPAT). The Rose Bengal Plate Test (RBPT) has an extremely high sensitivity to ensure that diseased animals are not overlooked. For dairy cattle, the milk ring test is an excellent screening procedure. Milk and serum screening is also done using indirect ELISA assays. Confirmatory tests, including the Fluorescence Polarization Assay (FPA), competitive ELISA and Complement Fixation Tests (CFT), are highly helpful in separating antibody responses brought on by vaccination from those brought on by field infections [47].

Complement Fixation Test (CFT): The complement fixation test s the most popular test for the serological verification of animal brucellosis. Detects specific antibodies of the IgM and IgG1 type that fix complement. The CFT is very specific, but it is time-consuming and needs highly trained workers as well as appropriate laboratory equipment, making it less suited for application in underdeveloped countries. Although its specificity is critical for brucellosis control and eradication, it may produce false negatives when IgG2 antibodies prevent complement fixation. Because IgM antibodies are largely eliminated during inactivation, the CFT measures more IgG1 antibodies than IgM antibodies. Because antibodies of the IgG1 type frequently emerge after antibodies of the IgM type, CFT is the ideal method for brucellosis control and surveillance [45].

Standard Tube Agglutination Test (SAT): Due to its ease of use and low cost, SAT is the most widely used diagnostic tool for brucellosis diagnosis worldwide. SAT accounts for aggregated quantity of IgM and IgG, while the quantity of specific IgG is measured by 2-mercaptoethanol (2ME) treatment of the serum sample. IgG antibodies are essential for detecting active brucellosis and excellent indicators of active brucellosis. A quick drop in IgG antibody titer is an indication of effective therapy. The persistence of SAT antibodies in some successfully treated patients indicates over-diagnosis of human brucellosis, resulting in unfair treatment [48].

Fluorescence Polarization Assay (FPA): Is a diagnostic method for detecting antibodies. It provides a sensitive screening test and a particular confirmatory test and the sensitivity specificity can be adjusted by changing the cut-off value between positive and negative reactions [23]. The FPA can distinguish vaccinal antibodies in most vaccinated animals and eliminate some cross-reactions [49].

Table 1: Bovine Brucellosis is prevalent in various areas of Ethiopia.

Locations	Test used	Prevalence (%) **	Sources
South Omo zone	RBT/CFT	5.26	[14]
Afar	RBT/CFT	5.7	[51]
Bench Maji	RBT/CFT	1.94	[58]
Jimma	RBT/CFT	4.3	[57]
Central highland of Ethiopia	RBT/CFT	1.2	[38]
Borena	RBT/CFT	2.4	[54]
Hawassa	RBT/CFT	2.7	[31]
Kombolcha	RBT/CFT	2.08	[13]
Ambo and Debrebirhan	RBT/CFT	0.20	[50]
Eastern showa	RBT/CFT	2.0	[55]
East Wollega Zone	RBT/CFT	1.9	[53]
Jigjiga	RBT/CFT	1.38	[56]

** CFT confirms all serological prevalence results

Status of Bovine Brucellosis in Ethiopia: Prevalence: Brucellosis has been noted as one of the most important livestock diseases in the country as it has been depicted [48]. Ethiopia's first case report of brucellosis was in the 1970s [13]. However, in the last decades, several serological surveys have shown that bovine brucellosis is an endemic and widespread disease in Ethiopia [14].

Ethiopian researchers studying bovine brucellosis have indicated that seroprevalence of the disease is varied from place to place ranging from 0.20% in Ambo and Debrebirhan[50] to 5.7% in Afar [51], which might be due to the differences in animal production and management systems as well as reasonably difference in agro-ecological conditions of the study places and see (Table 1). Reports indicated that the prevalence of bovine brucellosis was much higher in an area where farmers practice the communal use of grazing land than in clan-based herd segregation areas. Numerous studies have revealed that Brucella infection in cattle often occurs in Ethiopia, especially in rural areas [14]. As an extensive system entail raising numerous cattle across a vast region in shared pastures, contamination of the pastures with discharges from the reproductive tract may result in brucellosis [52].

There are reports of the overall prevalence of human and animal brucellosis in various regions of Ethiopia at different times by various authorities. These are noted in Table 1, found on the following pages accordingly. Seroprevalence of bovine Brucellosis was reported in areas like 1.9% in East Wollega Zone [53]; 2.4% in Borena [54]; 5.26% in the South Omo zone [14], 2.7% in Hawassa [31], 2.0% in Eastern showa [55], 1.2% in Central High Land of Ethiopia (AdeaBerga, Holeta Town and Wolmera) [37], 0.40% in Sendafa [5], 5.7% in Afar [51], 0.20 in Ambo and Debrebirhan [50], 1.38% in Jijjiga [56], 4.3% in Jimma [57], 2.08% in Kombolcha [13] and 1.94% in Bench Maji [58]. The result (5.7 %) reported by [51] in Afar is a high prevalence compared with the other results.

Public Health Importance of Bovine Brucellosis: Brucellosis (especially *B. melitensis*) remains one of the most common zoonotic diseases worldwide, with more than 50,000 human cases reported annually [42]. The significance of brucellosis as zoonotic has increased recently, due to the expansion of international commerce in animals and animal products, with increased urbanization, intensive farms and animal products and nomadic animal husbandry [59].

Despite the advances in surveillance and control, the prevalence of brucellosis is increasing in many developing countries due to various sanitary, socio-economic and political factors [60].

Compared to animal brucellosis, the study of human Brucellosis in Ethiopia is sparse, with even less information on risk factors for human infection [42]. A study conducted on human brucellosis in some parts of rural areas of Ethiopia indicates prevalence was 48.3% in Afar and 34.9% in Somali Regional State. 68.4% of all households in Afar and 57.5% of households in the Somali Regional State had at least one animal reactor [61]

The main risk to the general public is drinking unpasteurized milk from infected cows [50]. People handling infectious material (including vaccines) must be advised of appropriate occupational health and safety requirements [16].

Transmission of Brucellosis to human occurs mainly through the consumption of unpasteurized dairy products [47], especially raw milk, soft cheese, butter and ice cream, through direct contact with infected animal parts (such as the placenta by inoculation through ruptures of skin and mucous membranes) and the inhalation of infected aerosolized particles. Brucellosis is an occupational hazard for shepherds, butchers, veterinarians, dairy industry professionals and personnel in microbiologic laboratories [23]. However, consuming hard cheese, yogurt and sour milk is less hazardous since both propionic and lactic fermentation occurs. Although the bacterial load in animal muscle tissues is modest, human illness has been linked to eating undercooked traditional delicacies such as the liver and spleen [62].

The most common symptoms of brucellosis include undulant fever in which the temperature can vary from 37°C in the morning to 40°C in the afternoon; night sweats with a peculiar odor, chills and weakness; insomnia, anorexia, headache, arthralgia, constipation, sexual impotence, nervousness and depression [37]. Human Brucellosis is well recognized for its complications and involvement of internal organs. Its symptoms can vary depending on the site of infection. Spontaneous abortions, mainly in the first and second trimesters of pregnancy, are seen in pregnant women infected with Brucella [47]. Brucellosis symptoms and signs are sometimes confused with other illnesses, such as enteric fever, malaria, rheumatic fever, TB, cholecystitis, thrombophlebitis, fungal infection, autoimmune disease and tumor [45]. Because of these relatively non-specific signs, brucellosis is constantly misdiagnosed as malaria, which is very prevalent in sub-Saharan Africa. Person-to-person transmission is not a significant problem except through blood or organ transfer which should be subject to proper control [14].

Public health significance includes physical incapacity, illness and loss of manpower and the Occupational risk of brucellosis is significant because of the high possibility of direct transmission from infected animals to the people employed in animal husbandry [37].

For the prevention of brucellosis in human, no vaccine is available. Therefore, preventive measures will be essential to minimize the risk of infection in the human population. Such measures should include improved food hygiene, including the pasteurization of milk and protection from infection of high-risk groups such as milkers and other dairy industry workers [63].

Economic Importance: Economic importance on average, an outbreak of bovine brucellosis results in a loss of milk production of the herd by as much as 20%, which can reach 40-50% in early abortion. There is also a loss of calves and interference with breeding operations, in addition to the loss of milk production [24]. This is especially important in beef herds, where calves are the primary source of revenue. In a herd infected by the illness, the average period between calving may be extended by several months as a common side effect of infertility [61

With the exception of Tariku (1994) [64], who reported a brucellosis-related yearly loss among 193 cattle estimated to be 88,941.96 Ethiopian Birr ($5231 equivalent), primarily due to reduced milk production and abortions, there is little information available in Ethiopia on losses specifically caused by brucellosis in the various types of production systems (Chaffa State Farm, Wollo, from 1987 to 1993) [6]. International veterinary regulations prohibit the movement and commerce of animals when brucellosis is found in a herd, flock, area, or nation, which results in substantial economic losses. In general, economic costs caused by brucellosis include abortion losses, Reduced milk supply, Culling and condemning of animals due to breeding failure Endangering a country's animal export commerce, Human Brucellosis results in lost work hours and medical expenses [63].

Prevention and Control

Vaccines: Vaccination is generally advised for seroprevalence rates of 2–10%. Vaccines like *B. abortus* strain 19 (S19), a live vaccine, are typically given to female calves aged between three and six months as a single subcutaneous dose of 5-8×10 ^{10} viable organisms [25]. Depending on the farming conditions, a test and segregation method alone for high seroprevalence rates may or may not be sufficient. This might be good for farms when combined with basic hygienic measures, but supplementing with vaccination may be necessary to control the illness in settings involving a large number of animal production. Farm bio-safety measures should be used to reduce the risk of infection through personal cleanliness, adopting safe working practices, environmental protection and food hygiene, hence lowering the likelihood of the spread of illness. Brucella organisms have a long shelf life in the environment when the right conditions are present. Compared to most other families of non-sporing pathogenic bacteria, their capacity to tolerate inactivation under natural settings is quite strong [65].

In Animals: It is practical to prevent and control brucellosis by an understanding of local and regional variations in animal husbandry practices, social- customs, infrastructures and epidemiological patterns of the disease. Common approaches to control brucellosis include quarantine of imported stocks, hygienic disposal of aborted fetuses and fetal membranes and discharges with subsequent disinfection of contaminated areas. Animals in advanced pregnancy should be isolated until parturition [66]. Furthermore, replacement stock should be bought from a brucellosis-free herd and the decision to immunize hazardous animals should be made. It is also possible to eradicate by testing and slaughtering positive reactors [67].

Controlling and eliminating the infection in animal reservoirs is the most logical technique for avoiding human brucellosis. Furthermore, farmers must be educated on handling and disposing of an aborted fetus, fetal membrane and discharges, as well as not to consume unpasteurized milk and slaughterhouse employees on infection transmission, particularly by skin abrasion [48]. Rifampicin is recommended at 600-900 mg combined with doxycycline at 200 mg daily. An appropriate alternative is to combine doxycycline therapy (6 weeks duration) with parenterally given gentamycin (5 mg/kg) for seven days [68]

Treatments: Treatment with antibiotics of domestic animals is not usually successful. Despite the high treatment failure and relapse rates in humans, treatment is based on the drug combination of doxycycline and streptomycin, which is currently the best therapeutic option with fewer side effects and relapses, particularly in cases of acute and localized brucellosis [67]. Neither streptomycin nor doxycycline alone can prevent the multiplication of intracellular Brucella. Typically, antibiotics serve as the cornerstone of treatment; however, prolonged care may be necessary. Surgery could be essential for localized diseases like endocarditis [6]. Although treating cattle is not a frequent practice in developing nations, diseased animals are isolated, culled, or slain to stop the infection from spreading to neighboring herds at a significant veterinary expense [45].

CONCLUSION AND RECOMMENDATIONS

Brucellosis is a bacterial disease of worldwide distribution that causes the most important public health problem in developing countries. It is a significant public health problem and an economically significant disease in Ethiopia. People living in pastoral rearing systems areas where humans closely live with animals are more likely to have brucellosis. Humans are infected if there is contact with animals at abortion, parturition, or post-parturition from splashing infected droplets into the eye or drinking unpasteurized milk or milk product. Work-related exposure is observed in people interacting with diseased animals or their tissue. This disease is the most important cause of reproductive inefficiency and abortion in animals. *B. brucellosis* can be eradicated by isolating diseased animals, giving the vaccine to young female animals and test-slaughter methods. Microscopic examination and serological and molecular techniques are the common diagnostic method for diagnosing bovine brucellosis. The disease has a high economic impact by reducing the reproductivity and productivity of the animal and has zoonotic importance. Studies indicate that the disease's prevalence is distributed in any part of Ethiopia and is high in the lowlands compared to the highlands. The status of bovine brucellosis is not well studied in Ethiopia and much is remained to address the problem.

Based on the previous conclusion, the following suggestions are made;

- More research is needed on bovine brucellosis to know its status and economic and public effect.
- Public education on the disease's transmission and source of infection needs to be taken.
- The government, public health officers and veterinarians must work together to reduce its economic and zoonotic impact.
- Pasteurization of milk should be widely practiced to prevent human infection,
- Isolation of aborted animals and proper disposal of aborted fetuses and fetal membranes.
- Eradication programs should be enforced to protect human health.

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