Epidemiology of Brucella infection in the human, livestock and wildlife interface in Saudi Arabia: A Literature Review

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Abstract

Brucellosis is a zoonotic disease of public health importance worldwide. Brucellosis is a zoonotic disease, which is endemic in Saudi Arabia. It is an infectious systemic disease that can affect any organ and has no distinguishable symptoms. Investigations are the primary factor in determining the diagnosis of Brucellosis. Brucella species are to blame for this illness. Due to inadequate hygiene and unprotected animal interaction, it is seen as a serious issue in endemic nations. Due to the lack of distinctive symptoms, brucellosis is a difficult disease to diagnose. Due to weak diagnostic procedures, inadequate diagnostic methodologies, and a lack of suitable reagents for diagnosis, the condition is underreported in Saudi Arabia. Although livestock and animals are thought to be possible sources of human infection, it is unclear how these pathogen carriers contribute to the disease's epidemiology in Saudi Arabia's ecosystems. The aim of this research was to provide a comprehensive summary of the incidence and prevalence of brucellosis, associated factors and epidemiology of this disease at the interface between humans, animals and wildlife in the Kingdom of Saudi Arabia. Brucellosis poses a considerable impact on human and has a higher prevalence in developing countries as compared to developed countries. This research demonstrated the presence of anti-Brucella antibodies in humans, livestock and wildlife in the Saudi ecosystem. Transmission between wild animals, livestock and humans is likely to continue due to increased human activities at the wildlife-human interface. This information is an important contribution to the development of public health policy at the interface of human wildlife in the Saudi Arabia ecosystem.

Keywords: *Brucellosis, Brucella, epidemiology, prevalence, incidence, human, livestock, wildlife interface in Saudi Arabia*

1. Introduction

Brucellosis is one of the common zoonoses bacterial diseases worldwide, and it poses a major threat to human and animal health. Brucellosis is brought on by Brucella species. It is classified as a biological agent because of how contagious it is and how it affects human health. The clinical presentation of human brucellosis includes non-specific symptoms such intermittent fever, weight loss, depression, hepatomegaly, splenomegaly, joint pain, and is life-threatening. Additionally, brucellosis causes financial hardship since it prevents people from engaging in their regular daily activities and reduces animal production (Seleem, 2010). One of the top things that have a negative impact on the lives of the poor, according to a Kenyan review of animal diseases, is brucellosis (Sun, Li, Zhang, Zhang, Pei, & Jin, 2020).

Human brucellosis is spread either by direct or indirect contact with diseased animals or by eating tainted food. As there was little infrastructure for disease management, unpasteurized dairy products from diseased cows were seen as a risk of public infection in poor nations. Contaminated carcasses are the main cause of illness for workers in the meat packaging sector. According to veterinarians, inadvertent vaccine exposure and contamination during the support of births in sick livestock are further causes of brucellosis (Elsheikh, 2011).

Additionally, contact with contaminated animal byproducts is having a significant impact on transmission. In addition, clinical laboratories and butcheries have observed airborne bacterial transmission to humans. 13 The main contributing reasons for this condition include ingesting unpasteurized raw milk and coming into contact with sick animals

because Saudi Arabians traditionally drink raw milk largely from sheep and camels. Human brucellosis is one of the ailments that Saudi Arabia receives the most reports of, particularly in Riyadh. In various parts of Saudi Arabia, brucellosis has been the subject of numerous investigations. However, because no systematic review has been done to evaluate the epidemiology of brucellosis in Saudi Arabia, the threat of the disease to humans has increased (Al Anazi, 2019).

The illness has been documented in Saudi Arabia in both humans and animals. The majority of research on human brucellosis has been hospital-focused, with the exception of two recently published investigations that focused on the northern and southern regions of the nation, respectively as part of a nationwide survey to gather baseline information on the incidence of human brucellosis (Alqahtani, 2021). Therefore, the aim of this research is to provide a comprehensive summary of the occurrence and spread of brucellosis, the factors associated with it, and the epidemiology of infection of this disease at the interface in the human, livestock and wildlife interface in Saudi Arabia.

2. Literature review

2.1 Brucellosis Epidemiology

Brucellosis (also called Malta fever or Mediterranean fever) is a zoonotic infectio, is brought on by bacteria belonging to the genus Brucella and results in considerable health and financial losses. In various regions of the world, brucellosis is ignored while being a significant zoonotic disease (Zhang, Zhou, Huang, & Guan, 2019). The appearance of brucellosis in new areas and the expanding human-to-animal transmission rate are important new epidemiological factors (Khurana, et al., 2021).

Gram-negative, non-spore-forming, non-motile coccobacilli known as Brucellae are facultative intracellular parasites that typically induce a chronic illness that lasts a lifetime. In addition to B. abortus, B. melitensis, B. canis, and B. suis, B. inopinata also has the potential to infect people. Sweating and soreness in the muscles and joints are brucellosis symptoms. Direct contact with infected animals, consumption of contaminated food products, or inhalation of aerosols is the three main ways in which the disease is spread from animals to humans (McDermott, Grace, & Zinsstag, 2013).

Because brucellosis is endemic in the majority of developing nations and presents as a febrile illness that can occasionally be mistaken for typhoid fever or malaria, it may go undetected in clinical and laboratory settings (Ekiri, et al., 2020). It is particularly common in nations in the Middle East (Musallam, Abo-Shehada, Hegazy, Holt, & Guitian, 2016) and east Africa between 0.0% to 35.8% of people in East African villages was found to have brucellosis. In cattle, goats, and sheep, the prevalence

ranged from 0.2% to 43.8%, 0.0% to 20.0%, and 0.0% to 13.8%, respectively (Djangwani, Ooko Abong, Gicuku Njue, & Kaindi, 2021).

In Saudi Arabia, brucellosis is endemic and is thought to be a significant zoonotic disease. According to reports, it happens across the majority of the Kingdom's areas (Al Anazi, AlFayyad, AlOtaibi, & Abu-Shaheen, 2019), including the south. The prevalence of brucellosis was higher among butchers (8.9%), veterinarians and veterinary assistants (5.4%), and administrative staff (1.1%) in a randomized, multistage selection of 1200 abattoir workers across Saudi Arabia. The Aseer region had a high prevalence (12.8%) of human brucellosis (Alkahtani, Assiry, Chandramoorthy, Al-Hakami, & Hamid, 2020).

The prevalence of human brucellosis was reported to be 53.3% in northwest Asia, 25.9% in southeast Aseer, and 20.6% in the Jazan region among the exposed agro-pastoral populations in southern Saudi Arabia. One of the main factors contributing to the disease's growth in the Kingdom is the importation of a sizable number of sheep to meet the demands of the Hajj season. Therefore, research focusing on the disease's transmission and dissemination is crucial (Al Anazi, AlFayyad, AlOtaibi, & Abu-Shaheen, 2019).

2.2 Sero-prevalence and risk factors of brucellosis among human

The gram-negative bacterium Brucella spp., which causes the highly contagious zoonotic disease known as Mediterranean fever and poses a severe threat to public health, infects both humans and animals. There are currently 11 nominal species in the genus, including B. melitensis and S. suis, which are responsible for the majority of disease in cattle and small ruminants, respectively. The principal natural hosts of these species are

goats and sheep (B. melitensis), sows (B. suis), and cows (B. abortus), all of which are affected by abortion and infertility (Diaz Aparicio, 2013).

When multiple host species are housed together or share grazing areas and water sources, Brucella can spread to other host species and demonstrate host preference (Ducrotoy, 2017). Consuming unpasteurized dairy and infected goods as well as coming into touch with sick persons and animals is the main ways that this disease is spread. It was reported in Royal Oak, Michigan, in the United States, when the germs were isolated in an infected microbiologist's wife, suggesting that the sexual contact might be the cause of infection. The chance of person-to-person transmission is unclear, but likely (Rubach, 2013).

The flu-like symptoms of human brucellosis include a fever, malaise, myalgia, loss of weight, and weakness. The disease is typically difficult to identify and may be mistaken for malaria or other illnesses that cause fevers, which makes clinical diagnosis fascinating. Four brucellosis cases are believed to go undiagnosed for every instance that is diagnosed. Brucella is a significant contributor to fevers of undetermined origin (FUO) and one of the main causes of fevers lasting a long time in endemic areas (Attard, 2018).

Around 10 new cases per 100,000 people are reported each year, which amounts to more than half a million new cases. Additionally, because brucellosis typically results in abortion, infertility, and a decrease in milk and meat output, it has a considerable negative economic impact on the animal business globally (Rossetti, 2017). In spite of the fact that brucellosis has been eradicated in many developed nations, it is still

prevalent in a number of regions, including the Mediterranean region (Musallam & Abo-Shehada, 2016), Africa (Vhoko, 2018), and some developed nations with a low income, few resources, and little access to livestock (such as sheep, goats, cattle, water buffalo, camels, and pigs). Its prevalence varies around the world because a high incidence rate— higher than in other nations in the world—was recorded in the majority of African nations. In addition, the Aseer region of the Kingdom of Saudi Arabia (KSA) recorded a high incidence rate between 2004 and 2012 (McDermott, Grace, & Zinsstag, 2013).

In many nations, the slide agglutination test, which looks for antibodies to brucella in serum, is regularly used to screen for human and animal brucellosis. The Slide Agglutination Test is a quick, reasonably priced, and successful method for brucellosis diagnosis. However, as several things affect its reaction and reading, it could provide falsely negative results. The main preventative measure for brucellosis infection is the avoidance of raw meat and unpasteurized dairy products, such as milk and cheese, as well as the promotion of personal protection measures like wearing thick gloves, eye protection, and clothing for those who come into direct contact with animals. For some animals, vaccination is controlled, particularly when it comes to Brucella abortus and Brucella melitensis strains. Nothing has been confirmed for humans, and study is still ongoing (Khan & Zahoor, 2018). For patients who are at high risk, such as pregnant women and children, the treatment entails taking a combination of the antibiotics doxycycline and rifampin for 42 days in addition to evaluating the clinical signs (Solera, 2010).

At least 35 years have passed since the first incidence of human brucellosis in Saudi Arabia was reported. Back discomfort, subacute hepatitis, arthritis, abortion, and endocarditis are among the clinical features of human brucellosis from the Riyadh region. Brucellosis is a contagious illness that is widely prevalent in the Kingdom of Saudi Arabia. In 2011 there was a significant incidence of brucellosis, according to the Ministry of Health (MOH) (18/100,000 people). Numerous endemic region investigations have revealed a significant proportion of pediatric patients afflicted with this illness (Aloufi & Memish, 2016).

According to a different study, brucellosis is a significant public health concern in the KSA (Alshaalan & Alalola, 2014). Despite brucellosis incidence declining between 2004 and 2012, it remained higher than in other developing and developed nations (Aloufi & Memish, 2016). The biggest risk of contracting brucellosis was among male individuals between the ages of 15 and 44 due to the prevalence of the disease. The biggest numbers of cases were reportedly found in Al-Qassim and Aseer in the south, followed by Hail and the northern borders of Saudi Arabia. Another study on the epidemiology of brucellosis among abattoir employees from slaughterhouse locations in various Saudi Arabian cities was conducted. It was discovered that 1.8% of workers had brucellosis. Negative titers were obtained from office workers, drivers, and maintenance workers while positive titers were collected from veterinarians, butchers, and workers (Alkahtani & Assiry, 2020).

Since the early 1980s, brucellosis has been an endemic illness in the KSA. There are several possible explanations for this, but the most obvious ones include the rapid modernisation of the past forty years and the widespread importation of animals from regions where brucellosis is endemic, such as various African nations. The KSA has a long history of housing camels, which includes the consumption of raw milk, consuming camel meat, and direct contact with diseased animals or their byproducts, which are the main ways to contract the disease (Garcell, 2016).

Additionally, drinking raw, unpasteurized camel milk is a custom in some parts of Saudi Arabia. Furthermore, KSA is the hub of Islam and the location of the Prophet's Mosque and the Two Holy Mosques, which are revered by all Muslims. These mosques host a huge number of pilgrims who come to conduct Omrah and the Hajj ceremonies. The most recent research in the agro-pastoral sectors in southern Saudi Arabia looked at the prevalence of brucellosis across several regions in the Kingdom of Saudi Arabia. The study found that having sheep and living in specific places increase the chance of contracting brucellosis (Al-Hakami & Alqahtani, 2019).

2.3 Seroprevalence of brucellosis among exposed agro-pastoral communities in Saudi Arabia

Animals with the brucellosis disease experience significant productivity losses as a result of the disease's effects on the reproductive system, including decreased milk production, abortion, weak offspring, weight loss, culling and condemnation of infected animals due to infertility, lameness, and difficulties with trade and export. In people, the symptoms are vague and can be mistaken for those of other illnesses that cause

fever, including malaria, typhoid fever, rheumatic fever, and arthroses (Makita & Fèvre, 2011). Additionally, the affected individuals' illnesses result in decreased job capacity, and the government incurs costs for research, an eradication program, and a loss of investment. Infected domestic animals, wild animals, and their products can infect people (Assenga, 2015).

Farmers, veterinarians, and those employed in the meat sector are at danger due to the disease. Animals can contract infections from aborted parts, vaginal secretions, milk, and semen from sick animals. Spillover from both domestic and wild species causes transmission in wildlife. In Saudi Arabia, communities that practice pastoral and agro-pastoral farming frequently come into contact with wildlife, animals, and people. This connection encourages the unrestricted spread of disease to humans, cattle, and wildlife (Al-Hakami & Alqahtani, 2019).

One of the most pervasive zoonoses in the world, brucellosis is endemic to the majority of African nations. The epidemiology of the disease in Sub-Saharan Africa (SSA) is poorly understood, and the data that are currently available are insufficient. The first brucellosis outbreak in Tanzania was documented in Arusha in 1927. With individual animal level seroprevalence ranging from 1 to 30%, previous assessments in Tanzania have shown that the disease affects cattle in a variety of production systems, locations, and zones. Brucella hasn't been isolated in more than 50 years, yet during that time B. abortus and B. melitensis were, respectively, isolated from cattle and small ruminants (Lymo, 2013).

With a seroprevalence ranging from 0.7 to 20.5%, the disease has been observed in people in a number of locations, including Manyara, the Lake Victoria zone, the Western zone, Arusha, Tanga Municipality, Northern Tanzania, and the Morogoro region (James, 2012). According to a serosurvey conducted in the Serengeti ecosystem, 24 and 17% of the populations of buffaloes and wildebeests, respectively, are exposed to Brucella spp (Assenga, 2015).

Brucellosis, also known as undulant fever, Malta fever, or Mediterranean fever, is a serious zoonotic illness that, particularly in endemic locations, results in significant human morbidity as well as large economic losses. Small, facultative intracellular gram-negative coccobacilli called Brucella spp. are the source of this highly contagious illness (Jorgensen, 2015). In agropastoral areas where raw milk and meat are carelessly ingested, the disease continues to be a neglected zoonotic disease (Musallam I. , Abo-Shehada, Hegazy, Holt, & Guitian, 2016).

Its clinical manifestations range from an asymptomatic infection to a chronic illness characterized by recurrent symptoms (Aghaali, Mohebi, & Heydari, 2015), which can cause substantial morbidity in people and continues to be the primary health issue. People who work in the agro-pastoral sectors, i.e., those who are involved in farming, abattoirs, and the processing of animal products, are most commonly reported to have brucellosis. Typically, direct or indirect contact with infected animals or their products causes human brucellosis (Al-Hakami & Alqahtani, 2019).

The best way to prevent brucellosis is to avoid such contact or, even better, to better eliminate the illness from animals, both of which may be beyond the financial and human resources of many developing nations. It

seems more practical to make efforts to lessen the effects of the illness and lower the risk of infection through personal hygiene, the adoption of safe working practices, environmental protection, and food hygiene. Due to the scarcity or unreliability of vaccines, prophylaxis has a minimal role in the prevention of human disease (Aghaali, Mohebi, & Heydari, 2015).

In Uganda's Kiboga district, a high seroprevalence of human brucellosis (17%) was observed. In Ouagadougou, Burkina Faso, the estimated herd-level prevalence of brucellosis was 3.6%, 5.6%, and as high as 11.4% in Maranhao State, Brazil (Al-Hakami & Alqahtani, 2019). The primary risk factor for human infection is still animal sickness. The prevalence of human brucellosis in Saudi Arabia has been suggested. Reports from the Aseer region have shown minimal and patchy symptoms of the disease in its epidemiological context. Al-Qassim, Aseer, and Hail reported greater rates of up to 25% in one report. The largest risk of contracting brucellosis was among young, male Saudi citizens who lived in highly endemic areas (Aloufi & Memish, 2016).

Zoonotic illnesses like brucellosis are challenging to manage primarily because to their animal reservoirs. If the sample procedure is not used properly, the estimate of their prevalence would also be unreliable and insignificant. The size of the sample, the duration, and the scope of the investigations may be the cause of the significant regional variation in the results. To build effective control methods, it is necessary to conduct extensive multicenter investigations to identify prevalence and risk factors. The locations of the disease's endemic spread must be identified, and effective health and educational controls must be implemented there (Al-Hakami & Alqahtani, 2019).

Brucellosis is still a significant public health issue, particularly in rural areas. Even among marginalized communities like animal laborers, it is still largely unknown in many locations what clinical or subclinical impacts it may have. Without a thorough understanding and application of appropriate sampling methodologies, prevalence cannot be correctly estimated. It has been proposed that variations in the findings may be related to the timing and scope of the inquiry. Studies conducted across the Middle East came to the conclusion that the quantity of samples and laboratory tests used in brucellosis surveillances varied. The frequency of brucellosis was reported to be 7.3% in humans and 15.0% in infected animals in Najran (Elsheikh, 2011), a location next to the present two regions. Shepherds and butchers had significantly lower incomes than other professions, which increased their risk of contracting the disease. Non-Saudi nationals are more likely to contract the virus than Saudi nationals, with the former group being more vulnerable. Some of the significant hazards associated with brucellosis include contact with an aborted animal or a retained placenta (Musallam & Abo-Shehada, 2016).

The World Health Organization (WHO) has named human brucellosis as one of the seven neglected zoonotic diseases. It typically comes from an animal reservoir in humans. The high-risk occupational categories most commonly impacted by brucellosis include veterinarians, laboratory workers, abattoir and slaughterhouse staff, livestock caretakers, and farmers. These people become infected through direct contact with diseased animals or corpses, inhalation of infectious aerosols, or consumption of their products (raw milk, cheese, and unpasteurized milk. Acute non-specific symptoms of brucellosis include back pain,

headaches, anorexia, weight loss, weakness, and arthralgia. These symptoms are also present in other illnesses, such as malaria and typhoid, which results in incorrect diagnosis and treatment (Alkahtani A. , Assiry, Chandramoorthy, Al-Hakami, & Hamid, 2020).

2.4 Brucella infection in the human, livestock and wildlife interface in Saudi Arabia

The bacterial genus Brucella causes the infectious disease brucellosis, which affects both humans and a variety of animal species. It is characterized by lesions in the lymphatic system and joints as well as lesions in the genitalia and fetal membranes. In endemic nations, brucellosis poses a substantial hazard to public health and causes significant economic losses in the production of cattle (Asakura, 2019). Human brucellosis has been linked to severe debilitating illness that necessitates protracted treatment with a combination of antibiotics, acute febrile illness, a permanent crippling sequel, high medical costs, and income loss due to lost working hours. Pregnant women have also reported spontaneous miscarriage and in utero foetal death during the first trimester (Andriopoulos, 2018).

Climate change and its consequences for the relevant populations' husbandry techniques, eating habits, and social behaviors are linked to the hazards of zoonotic disease transmission from animals to humans (El-Moselhy & Zayet, 2018). Due to lack of attention, inadequate diagnostic facilities, lack of public knowledge, insufficient public-sector animal health services, and impoverished or low-income areas, brucellosis is prevalent and neglected throughout Sub-Saharan Africa. However, domestic ruminants, particularly cattle, have greater understanding of the

prevalence of risk factors for infections, and this species bias is reflected in management measures (Madut & Muwonge, 2018).

However, due to the presence of factors that favor the disease's widespread distribution and transmission in the majority of the region, surveillance of bovine brucellosis is typically subpar and mass control is challenging to implement (Tumwine, 2015). These factors include unrestricted animal movement, pastoralists' migrations in search of pasture and water, purchases of diseased cattle for replacement or upgradation from livestock markets, the anarchic development of urban livestock breeding and the nature of the animal production system, insufficient sanitary measures, demographic factors, legal concerns, the climate, deforestation, and wildlife interaction (Sagamiko, 2020).

The illness still affects domestic animals in many locations, frequently infecting human populations, and brucellosis cases are still reported in several nations despite significant success in managing the disease. In areas where cattle are the primary source of human sustenance, including food and income, zoonotic brucellosis is more prevalent. Despite being a significant human illness throughout the Mediterranean region of Europe, Africa, the Middle East, South and Central Asia, and Central and South America, brucellosis is usually ignored, underreported, and neglected (Mufinda Franco, 2017).

Human brucellosis is an endemic disease in Sub-Saharan Africa, and estimates of seroprevalence have been published for a number of nations, including 3.8% in Chad, 3.3% in Central African Republic, 7.7% in Tanzania, 24.1% and 31.82% in Nigeria, 17% in Uganda (Tumwine, 2015), and 1- 5.6% among traditional pastoralists (Fulani) and 0-1.6%

among non-pastoralists in Togo In Cameroon, there is both a National Program for the prevention and control of new and re-emerging zoonoses and an operational and functional "One Health" National Strategy. In order to manage the health security of the animal and human population, the sectors of animal health, human health, and environmental health collaborated to develop the "One Health" National Strategy (Aloufi & Memish, 2016).

With the assistance of the RESPOND project-USAID, the National Program for the Prevention and Fight against Emerging and Re-Emerging Zoonoses was developed and, in 2014, a National Program for the Prevention and Control of Emerging and Re-Emerging Zoonoses was implemented in Cameroon. Five priority zoonotic diseases were selected from a list of relevant zoonoses for Cameroon, including rabies, anthrax, highly pathogenic avian influenza, Ebola and Marburg virus disease, and bovine tuberculosis. These diseases were selected using input from the human health, livestock, and environment, wildlife, research, and higher education sectors (CamOHNS, 2016).

However, Cameroon has been found to have a poor implementation of crucial zoonoses, including animal brucellosis control methods (e.g., restricting movement of diseased cattle, reporting disease to the veterinary services, testing of animals). There is a lack of information on the epidemiological situation of human brucellosis in the country, especially the seroprevalence of brucellosis among vulnerable communities and populations at risk, including abattoir workers and pregnant women in the Adamawa region, which is the main livestock-

producing region of Cameroon. Brucellosis is a significant notifiable disease around the world (Awah-Ndukum & Kudi, 2014).

To increase brucellosis detection rates, little to no coordinated veterinary and medical effort is made. Achieving sufficient preventative measures and planning for successful control programs of brucellosis in animals and people is impossible due to the lack of active involvement of populations at risk and sound health systems. Widespread endemic in Cameroon, prevalence rates of bovine brucellosis have been observed to range from 3 to 31% in individual cattle to 16.2 to 35.0% in herds (Bayemi & Mah, 2015).

While brucellosis affects sheep and results in late abortions, stillbirths, reduced fertility, and decreased milk production that result in significant economic losses, it affects humans and has a wide range of clinical symptoms like undulant fever, malaise, insomnia, arthralgia, sexual impotence, nervousness, and depression. Human brucellosis is also recognized for producing encephalitis, meningitis, endocarditis, arthritis, orchitis, and prostatitis due to numerous organ involvements. Brucellosis can also cause spontaneous abortions in expectant mothers (Alqahtani, 2021).

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The most widespread zoonotic disease in the world is brucellosis, however many of the endemic nations have successfully reduced the illness's occurrence over time. With an average incidence per 100,000 people from 2003 to 2018 of 15.34, several other emerging nations, such as KSA, continue to have a higher incidence than the global average

(Statistical Year Book, Ministry of Health, Kingdom of Saudi Arabia, 2008, Statistical Year book. Ministry of Health, Kingdom of Saudi Arabia, 2018, Ministry of Health).

B. melitensis is regarded as the most widespread and virulent strain in the globe, including KSA. Exposure to animals and animal products might cause infection. B abortus, on the other hand, is more common but less dangerous for both humans and animals. In humans, B. Suis is a dangerous infection, but B. Canis only causes minor illness. Different species of Brucella, or biovars, have physiological and biochemical characteristics B. abortus, B. melitensis, and B. Suis are three species that have seven, three, and five different biovars, respectively (Jindan, 2020).

According to past investigations in KSA, the clinical signs and symptoms of brucellosis in people can vary from asymptomatic to severe disease and consequences. According to various studies and case reports conducted in KSA, brucellosis is characterized by fever, joint pain, headache, muscular discomfort, anorexia lethargy, and nausea or vomiting. The most prevalent ongoing symptom of brucellosis is fever (Al Anazi, AlFayyad, AlOtaibi, & Abu-Shaheen, 2019).

The severity of brucellosis in KSA is so extreme that it can be used as a gauge of the disease's widespread prevalence. Eliminating brucellosis from animals is the first step in managing it in humans. This has been accomplished successfully in many industrialized nations by preserving their brucellosis-free herds, which go through certain serological tests and other safety precautions before being imported or exported from/to other nations. The enormous demand for animal slaughter for Hajj and for human use throughout the year makes KSA's control methods difficult.

Poor animal quarantine practices and a lack of legislation to regulate the marketing and movement of animals are additional obstacles (Alqahtani, 2021).

Regarding food management and safety, many developed nations, including KSA, have additional concerns. One recent meta-analysis about Brucella spp. prevalence in raw milk or milk products from many Middle Eastern nations, including KSA, estimated the overall prevalence to be 29% (Abedi, 2020). Although much has been done in KSA to date, especially in areas with high infection rates, to eradicate the disease, systematic national brucellosis control efforts are still missing. Laws that firmly prioritize pasteurization of milk and milk products should be passed. Additionally, effective surveillance and institutional prophylactic measures are required to control the spread of Brucella throughout KSA, which necessitates knowledge of the molecular epidemiology of the circulating strains/alleles by various techniques like multilocus sequence typing (MLST), pulsed field gel electrophoresis (PFGE), etc (Alkharsah, 2018).

As there are currently no licensed vaccinations for human anti-Brucella, creating a safe and effective vaccine should be the top priority. Despite the fact that several candidate vaccines, like as the S19 vaccine strain, have been proposed and evaluated (Lalsiamthara & Lee, 2017), the deployment of these live, attenuated vaccines has been constrained since they still exhibit some virulence. Since there is always a risk of brucellosis re-emerging, research into safe, efficient, cross-protective and human-exclusive vaccines must be accelerated (Tukana & Gummow, 2017).

3. Discussion

The current analysis gives a thorough overview of the incidence, prevalence, risk factors, and effects of brucellosis on the Saudi population. Lack of clarity in articulating the procedures employed, particularly in how they define the cases and the sample technique, was one of the key problems that impacted the quality of the identified studies in this study. We were unable to determine for certain research whether the study had been planned to control bias (Al Anazi, AlFayyad, AlOtaibi, & Abu-Shaheen, 2019).

Between nations and within each nation, brucellosis incidence and prevalence vary. These variations may be the result of study bias. They cannot, however, be excluded or eliminated. Among 4900 participants in a research in southern Saudi Arabia, 2.3% had active illness, while 19.2% had serological evidence of exposure to Brucella antigen. But a Riyadh research on 1733 individuals estimated that 8.8% of them had brucellosis (153 patients had positive brucellosis). The two defining characteristics of the investigation may be time and geographical area (Alkahtani A. , Assiry, Chandramoorthy, Al-Hakami, & Hamid, 2020).

Seroprevalence rates range from 8% in Jordan to 12% in developing nations from the Middle East 5% to 12% in Kuwait and Lebanon. Prevalence was higher in low- and middle-income nations than in industrialized nations. However, brucellosis affects particular subgroups of these populations, such as Turkish immigrants in Germany. Human brucellosis is not frequent in the US. Less than one case per 100,000 people is the prevalence, and for the past ten years, about 100 cases have

been documented annually (Centers for Disease Control and Prevention (CDC) Brucellosis, 2016). Between 2004 and 2010, the prevalence of human brucellosis in China grew from 0.92 cases per 100,000 people to 2.62 cases per 100,000 people. According to national figures from the Saudi Arabian Ministry of Health, brucellosis prevalence peaked in 1990 with 72 cases per 100,000 people annually and has been stable since 1996 with 32 and 38 cases per 100,000 people annually (Li, Yu, & He, 2012).

Previous investigations found that fever; hepatomegaly, splenomegaly, swollen spine, arthritis, and lymphadenopathy were the most typical presenting signs of brucellosis in Saudi individuals. Additionally typical were mild anemia, leukopenia, and relative lymphocytosis. The most frequent infectious agents were B. melitensis, B. abortus, and B. suis, and The most typical symptoms of brucellosis in children, according to our review, are fever, arthralgia, malaise, weight loss, arthritis, hepatosplenomegaly, and lymphadenopathy. The majority of patients also have B. melitensis species isolated from them. The literature has shown that practically all organs may be damaged, and a variety of problems may develop (Al Anazi, AlFayyad, AlOtaibi, & Abu-Shaheen, 2019). According to Hartigan, brucellosis causes more intrauterine fetal deaths, abortions, and preterm births than other bacterial illnesses. Compared to pregnant women without brucellosis, pregnant women with brucellosis have a higher risk of abortion and intrauterine fetal mortality (Aloufi & Memish, 2016).

In the high-risk areas, extensive educational programs for medical staff, veterinary professionals, and cattle owners should be launched in order to reduce the prevalence of brucellosis on a national scale. These programs

should cover the main risk factors associated with brucellosis as well as its economic and zoonotic significance. Monitoring the status of these control and preventative initiatives should be done on a regular basis. Our research for English-language papers is constrained by this review. However, the majority of research projects carried out in the Arab world by universities and research centers are written in English. There's a chance we missed some publications because we solely searched PubMed. Few of the main cross-sectional research in Saudi Arabia examined the prognosis, impact, and effects of brucellosis on the community and healthcare systems. The results of the included studies were also not changed for test performance because, in accordance with the laboratory protocol, they might exhibit diversity and this information wasn't provided (Al-Hakami & Alqahtani, 2019).

Therefore, different regions have different incidence and prevalence of the brucellosis disease. Humans are greatly affected by brucellosis, which is more common in developed nations. The findings also indicated that brucellosis was a risk factor for poor reproductive outcomes. The biggest risk factors for brucellosis, according to studies done in Saudi Arabia, are consuming raw milk and milk products as well as contact with sick animals. The known risk factors for brucellosis are adjustable, and by concentrating on public awareness campaigns, these problems can be eliminated. Future research should emphasize the need for high-quality studies and healthcare services to investigate the prognosis and impact of these diseases on Saudi society (Al Anazi, AlFayyad, AlOtaibi, & Abu-Shaheen, 2019)

4. Conclusion

Brucellosis is a bacterial infection transmitted from animals to humans. In most cases, people become infected by eating raw or unpasteurized dairy products. Sometimes, the bacteria that cause brucellosis can be transmitted through the air or through direct contact with infected animals. Signs and symptoms of brucellosis may include fever, joint pain, and fatigue. This infection can usually be treated with antibiotics. However, treatment takes a period ranging from several weeks to several months, and infection may recur. Brucellosis affects hundreds of thousands of people and animals worldwide. Avoiding raw milk products and taking precautions when working with animals or working in a laboratory may help prevent brucellosis.

Brucellosis is transmitted to humans through the consumption of milk and its derivatives contaminated with bacteria, and brucellosis is transmitted through direct contact with an infected animal by touching the skin or meat of an infected animal, or by inhaling or smelling the body odor of the infected animal or spray contaminated with bacteria, or by drinking unpasteurized milk, or Eating dairy products contaminated with bacteria from the infected animal. Therefore, people whose nature of work requires contact with animals (such as farmers, veterinarians, and butchers) are considered the most vulnerable to brucellosis. Brucellosis is a common disease that occurs in winter and spring. The incubation period ranges from one to three weeks. It is very unlikely that brucellosis can be transmitted from person to person except in very rare cases such as unprotected sexual intercourse or through mother-to-child transmission (through breastfeeding or childbirth).

There is a significant frequency of brucellosis, a neglected crippling zoonosis and occupational danger, in many impoverished nations. Contact with diseased animals and animal products can result in transmission to people. The contagious zoonotic disease known as human brucellosis is brought on by Brucella species. It is one of the most prevalent public health issues that developing nations, including Saudi Arabia, continue to mainly ignore. People who reside in rural areas who frequently interact with cattle are more likely to contract brucellosis.

To spread knowledge of brucellosis, associated risk factors, and control strategies, public awareness initiatives and health education should be promoted, particularly among livestock professionals and in agropastoral communities. Encouragement for animal professionals to continuously employ PPE and good personal hygiene habits at work, regular brucellosis screening, and adherence to safe animal-product handling procedures are just a few of the topics that should be covered during the training.

In Saudi Arabia, it is crucial to conduct serological surveillance of human brucellosis and the risk factors linked to it, especially among livestock experts and in agropastoral communities. It is imperative that the integrated "One Health" approach be strengthened and that sectoral policies, including interdisciplinary strategies between experts in animal and human health, concerned target stakeholders, and affected communities, be involved. These groups must be made aware of the importance of having detailed information on both animal and human brucellosis for the country's effective management. The conclusion supported the idea that brucellosis is widespread in the Saudi Arabian

rural and urban areas under investigation. To boost the rate of detection, identify patients who require treatment for acute disease, and impose control measures, the study suggests routine isolation of Brucella spp. and direct PCR detection in clinical samples. As suggested before, brucellosis vaccination of susceptible animals would significantly increase prevention.

It is important to improve community alertness, especially in rural areas, to raise awareness of brucellosis and associated risk factors. Drinking raw milk must be primarily depressing. Seasonality should be taken into account more when applying organized measures like immunization, isolation, and elimination of ill animals as well as meticulous hygiene in the manufacturing process. To learn more about the reasons behind the seasonality, more research is needed.

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