Human and Animal Brucellosis in Nigeria

Subjects: Microbiology

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Brucellosis caused by Brucella spp. is transmitted by direct or indirect contact with infected animals or their secretions and through the consumption of infected animal meat and unpasteurized milk/milk products. Brucellosis is classified as one of the top neglected zoonosis by the World Health Organization (WHO), and despite this, it does not attract the appropriate attention it requires from both the Federal and State ministries of health in Nigeria. 15.8% (7178/45,363) seroprevalence of brucellosis was recorded in northern Nigeria as against 8.7% (1902/21,740) in the southern part. Brucella abortus, B. melitensis, B. suis, and B. canis were reported in 27 of the 36 states.

Keywords: human and animal brucellosis ; Brucella ; Nigeria ; prevalence and seroprevalence ; systemic review and meta-analysis

1. Introduction

Brucellosis, which is also referred to as the travel-related infectious disease “undulant fever”, “Mediterranean fever”, “gastric remittent fever”, or “Malta fever”, is a zoonotic disease caused by intracellular Gram-negative coccobacilli bacteria of the genus *Brucella* [1][2][3]. The disease is distributed globally, affecting humans, a wide range of wild animals, and economically viable domestic livestock such as cattle, goats, sheep, donkeys, camels, swine, dogs, etc. [4]. Currently, 12 species of the genus *Brucella* are accepted; however, only *B. melitensis*, *B. abortus*, *B. suis*, and in rare cases, *B. canis* are characterized as human pathogens. The global burden of human brucellosis remains very large. The organism causes more than 500,000 infections per year worldwide [3]. The socio-economic impact of brucellosis is enormous and is higher in developing countries than the developed countries, with an estimated 3.5 billion individuals at risk of being infected with one or more *Brucella* spp. and a high morbidity rate in both humans and animals [5][6]. Brucellosis is highly contagious. It is transmitted by direct or indirect contact with infected animals or their secretions and through the consumption of infected animal meat and products such as unpasteurized milk/milk products [1][7]. The risk of acquiring the disease has been attributed to a certain occupation (occupational hazard) but most especially among livestock caregivers. People who work with animals and are constantly in contact with blood, placenta, foetuses, and uterine secretions have an increased risk of contracting the disease. This method of transmission primarily affects farmers, butchers, hunters, veterinarians, and laboratory personnel [4]. However, in endemic areas, human brucellosis has serious public health consequences. The organism can enter the human body through breaks in the skin, mucous membranes, conjunctiva, respiratory and gastrointestinal tracts, resulting in systemic infection with acute and chronic phases [3][8]. The disease may persist as relapse, chronic localized infection, or delayed convalescence. Symptoms of the disease include but are not limited to fever or chill, arthralgia or arthritis, sweating, hepatomegaly, splenomegaly, anorexia, asthenia, fatigue, weakness, pallor, diarrhea, jaundice, lymphadenopathy, rash, and malaise [1][8]. Urbanization and the subsequent expansion of animal industries, coupled with a lack of good hygienic practices, especially in animal husbandry and food handling, partly account for brucellosis remaining a public health problem [1]. It affects people of all races, age groups, and both sexes. Although many countries have made great progress in controlling the disease, *Brucella* infection persists in domestic animals in some regions, and consequently, transmission to the human population is imminent. Brucellosis in livestock is mostly a reproductive disease characterized by infertility, late abortion, retained foetal membranes, and impaired productivity [9]. Brucellosis infects many species, especially cattle, sheep, goats, and pigs. Different *Brucella* types infect different species preferentially. The disease is still widely distributed in Africa, especially in areas with large animal populations [10].

Brucellosis, currently classified as one of the top neglected zoonosis by the World Health Organization (WHO), does not attract the appropriate attention it requires from both Federal and State ministries of health in Nigeria. According to the United Nations Department of Economic and Social Affairs, Population Division 2019 [11], Nigeria is the most populous country in Africa and ranked 7th in the world with over 201 million people. A projection of its population is expected to rise to about 401 million people by 2050, with an estimated livestock population of 20.49 million cattle, 23.07 million sheep, 28.07 million goats, 6.54 million pigs, 18,200–90,000 camels, and 210,000 horses [12][13]. Livestock slaughtered at the

different abattoirs in Nigeria for human consumption are not usually screened for brucellosis. Free-range domestic animals are also commonplace in Nigeria; pet animals, i.e., dogs, cats, and livestock, i.e., goats, sheep, and cattle, move freely amongst the people. The incidence of brucellosis in Nigeria is under-reported. Currently, there is insufficient epidemiological data on Nigeria's prevalence and distribution of human and animal brucellosis. This entry on reported cases of brucellosis in Nigeria was undertaken to determine the true prevalence and distribution of the disease across the country and to make valuable suggestions that will serve as a guide for the implementation of measures for sustainable management of this disease in Nigeria.

2. Human and Animal Brucellosis in Nigeria

The economic burden in the livestock industry arising from brucellosis and its morbidity in humans has made this zoonotic disease a global public health challenge [14]. The main objective of this entry was to systematically review the literature reporting brucellosis and perform a meta-analysis to estimate the national prevalence of brucellosis in Nigeria. Of the 99 publications accessed, 14 publications reported *Brucella* infection in humans from 11 states of the 36 states in Nigeria, including the federal capital territory. The remaining 25 states either do not have reports because of the lack of interest in brucellosis, or the reported cases do not meet the inclusion criteria of this entry. Most of the studies on human brucellosis were from high-risk occupational groups, especially abattoir workers. The national prevalence of human brucellosis in Nigeria for all methods revealed in this entry was 17.6%. However, based on the Rose Bengal plate test (RBPT), as reported by about 80% of the publications accessed for human brucellosis, the seroprevalence of the disease in Nigeria was 15.7% (493/3144). This is similar to the 15.8% recorded in Cameroon [15], but lower when compared to the sub-national study in other sub-Saharan African countries, such as the 44% prevalence recorded in Kenya [16], 31.5% prevalence in Ethiopia [17] and 17% in Uganda [18]. Similarly, the prevalence of human brucellosis is also higher in northern African countries such as Egypt, with a prevalence of 23.9% [19]. The prevalence is higher in Nigeria compared to the prevalence of 1.41% reported in Tanzania [20] and the 3.0% national prevalence in Kenya [21]. The high prevalence of human brucellosis from this entry has demonstrated the fact that brucellosis is endemic with a high burden in Nigeria and requires the attention of policymakers and stakeholders in the health sector. The high burden of human brucellosis in Nigeria, as seen in this entry, can be attributed to several factors, which include nomadic pastoralists who run open grazing, abattoir workers, especially those slaughtering animals who are in constant contact with animal blood without personal protective equipment (PPE) (**Figure 1**), and the love of Nigerians for the consumption of animals' intestinal parts, which are the most likely source of zoonotic transmission of the disease in Nigeria. Unfortunately, the animals that are ready for slaughter in Nigeria's abattoirs are sometimes not screened for brucellosis. The spectrum of clinical presentation of human brucellosis, which mimics several other febrile illnesses such as rheumatic fever, typhoid, and malaria, has resulted in several misdiagnoses of this disease since malaria and typhoid fever are also endemic in Nigeria. Additionally, brucellosis is not routinely screened in private and public health care facilities, which obscures the detection and true prevalence of the disease.

Figure 1. Typical abattoir in Nigeria showing butcher slaughtering animals without personal protective equipment.

Although the prevalence of the brucellosis reported in this entry was based on serological investigation, no publication reported human brucellosis based on culture and molecular methods. Nevertheless, the overall prevalence of brucellosis was higher at **15.6%** (7178/**46,022**) in Northern Nigeria than in the Southern part at 8.7% (1902/21,740). The differences in the prevalence rate may be due to the number of research articles reporting brucellosis in Northern Nigeria being higher when compared to the reportage in the Southern part of Nigeria. Moreover, easy access to and frequency of contact of

abattoir workers with animals, e.g., cattle, donkeys, horses, goats, and sheep and animal products, as well as consumption of raw and untreated fermented animal products, especially milk *(nono),* a habit that is very common in northern Nigeria, contribute to the prevalence rates. Furthermore, the uncontrolled movement of nomadic Fulani (herdsmen) from northern Nigeria has contributed significantly to the spread of the disease to other parts of the country, a fact that has long been documented by other authors [22][23].

The burden of brucellosis in animals, as observed in this entry, was highest in pigs, at 28.3%, compared to in other animals such as sheep, at 23.3% and camels, at 20.9%. The lowest prevalence was among chickens, with an 8.4% prevalence recorded. The higher prevalence of the disease in pigs could be attributed to multiple *Brucella* spp. detected from the samples investigated in the SS as reported by Bello-Onaghise et al. [24] based on the culture method. From 30 blood samples, 81 *Brucella* isolates were documented (24 *B. abortus*, 27 *B. melitensis*, and 30 *B. suis*), as well as 68 isolates (19 *B. abortus*, 24 *B. melitensis*, and 25 *B. suis)* from 25 vaginal swabs, giving an overall prevalence of 100% (55/55) as reported in that study. Although the report of co-infection among different *Brucella* species is very rare in literature, only Bello-Onaghise et al. [24] have been able to document this in Nigeria to the best of researchers' knowledge. In this entry, the occurrence of brucellosis in animals varied from region to region and animal to animal. Interestingly, despite the higher occurrence of the disease in Northern Nigeria, the SS geopolitical zone of Nigeria reported the highest prevalence of brucellosis at 48.6% (206/424) in animals from four publications. The lowest occurrence was observed in the SE, with a prevalence of 3.9%, while the SW was 7%. Other studies included the NC at **16.6%,** the NE at 18%, and the NW at 14.2%. This entry also showed evidence of geographical variations in the prevalence of brucellosis not only in the sources of samples but also in the types of samples evaluated. Investigation of brucellosis from different samples across the country revealed the prevalence of the disease estimated to range from 5% in the aborted foetus to 50% in hygroma fluid. Bloodstream infection with brucellosis was estimated at 13.5%, and its prevalence in milk was estimated at 10.2%. The prevalence of brucellosis from vaginal swabs obtained from different animals was 12.4%, while a prevalence of 29.4% was observed in the lymph node of cattle from NW Nigeria. Thus far, only 7 out of the 104 publications reported culture detection methods [24][25][26][27][28][29][30], while a single publication reported molecular methods [31]. The Rose Bengal rapid test is the most popular diagnostic method reported by 11/14 publications on the detection of human brucellosis, while 95/107 publications reported RBPT as the detection method in animal samples. Several publications also reported other diagnostic methods across the country. Although in this entry, it was observed that several publications reported funding from donors, grants, and/or direct receipt of diagnostic kits from some laboratories for their studies, unfortunately, researchers were unable to determine if the donors or the providers of those kits have any influence on the outcomes of their studies.

Four different *Brucella* species were recorded, including *B. abortus*, *B. melitensis*, *B. suis*, and *B. canis.* However, *B. abortus* biovar 1 has been documented as the most frequently encountered brucellosis in cattle globally [32][33] , while biovar 3 has been reported to be a common biovar in Côte d'Ivoire [34] and Nigeria [27]. *B. melitensis* was mostly reported in humans, and *B. abortus* with biovars 1 and 3 was frequently detected in animals from Nigeria [27][28]. *B. melitensis* was mostly encountered in sheep, goats, and pigs, with few reports in cattle. This agreed with a study conducted in China by Liu et al. [35] in which *B. melitensis* infection was common in sheep and goats. Meanwhile, *B. suis* was observed only in sheep, goats, and pigs. This entry also revealed the detection of *B. canis* only in dogs in Nigeria. In Nigeria, a similar distribution pattern of the biodiversity of brucellosis in the different regions occurred. From the Northern to the Southern region, *B. abortus* is the most encountered species in animals, followed by *B. melitensis.* Only the NC and the SS reported *B. suis*, while 99% of the *B canis* detected in dogs were observed in the SE, with only 1% from SW Nigeria. Brucellosis in Nigeria, as seen in this entry, is spread across the country and has been responsible for reproductive disease in animals associated with abortion, stillbirth, death of young animals, placenta previa, the birth of immature calves, delayed calving, male infertility, and heavy reductions in milk output.

Most phenotypic detection methods of *Brucella* consist of bacteriological isolation and biochemical identification, which solely relies on a combination of some investigating parameters to characterize suspicious colonies [36]. Unfortunately, this typing method often fails to correctly differentiate some strains, which was seen in the case of the strains reported in Plateau State by Bertu et al. [27]. Thus, there is a need for other combined identification methods, such as the use of molecular tools to characterize *Brucella* species with good discriminatory capacity and the potential to evaluate relationships between species, such as the multiple-locus variable of tandem repeat analysis (MLVA) [37][38]. Future studies on brucellosis should also focus more on the proper use and interpretation of diagnostic testing for animals as recommended by the WHO, FAO, and OIE [1][39][40]. There was stability in the trend of human brucellosis from 2001 to 2012. The trend began to fluctuate from 2013 to 2020, with a decline in 2021. The observed decline in human *Brucella* infection may be connected to the improved abattoir environment in some states in Nigeria when compared to previous years. The peak of human *Brucella* infection in Nigeria was observed in 2016 from SE Nigeria [41] (**Table 1** and **Figure 2**). There was a fluctuation in the trend of the disease in animals from 2003 to 2021, with a

remarkable increase in the trend of the disease from 2008 to 2019 and a sharp decline by 2020. The peak of the disease in animals was observed in 2012, though there was no report on the outbreak of the disease in Nigeria in 2012. Furthermore, the number of articles reporting *Brucella* infection in 2012 was also lower than in some of the years under review, while the number of animals screened for brucellosis in 2012 was also lower than the number of samples screened for some years under review. Hence, the increase cannot be attributed to sampling size. Despite the problem of antibiotic resistance being on the rise in brucellae [8], unfortunately, there was no single report on antimicrobial susceptibility testing on the *Brucella* species isolated from both humans and animals, thus making it difficult to determine the pattern of resistance of *Brucella* spp. in Nigeria. The use of quality molecular tools in detecting *Brucella* infection in Nigeria is also lacking and has contributed to many reported un-typed *Brucella* species. There is a need to focus more on culture and molecular methods to determine the epidemiological link between *Brucella* species and its biodiversity from humans and animals, to know the prevailing biovars, and for prompt interventions. The findings from this entry would serve as baseline information on the national prevalence of *Brucella* infection in Nigeria. The generated data would help estimate the true burden of *Brucella* infections in Nigeria. As it is today, national data on human and animal *Brucella* infection are lacking in both State and Federal Ministries.

Limitations: Researchers' inability to determine the prevalence of the disease based on certain variables such as age, sex, cattle herds, breeds of animals, and mortality rate both in humans and animals are part of the limitations of this entry. The use of serological methods, as seen in this entry, is of national importance because of their usefulness in detecting antibodies against *Brucella* species. However, the results are only reliable when the diagnostic methods and procedures are properly conducted and the outcomes are well interpreted. Interestingly, serological methods have several shortcomings, including the antisera's ability to cross-react with other bacterial pathogens such as *Escherichia coli* 0157, *Salmonella* Urbana group N, *Francisella tularensis*, and *Yersinia enterocolitica* 0:9 [130].

Conclusions: This entry revealed a national prevalence of 19.2% of human *Brucella* infection and 13.1% prevalence of *Brucella* infection in common domestic animals, respectively, from 2001 to 2021. This entry also indicated that only 27 states, including the FCT, reported brucellosis in Nigeria across the six geopolitical zones. Researchers' study also revealed the highest occurrence of brucellosis is in Northern Nigeria. Four *Brucella* species, *B. abortus*, *B. melitensis*, *B. suis*, and *B. canis*, have been reported in Nigeria. Culture and molecular methods of detection of brucellosis and reports of antimicrobial susceptibility testing remain a conjecture. This entry will help researchers redirect their research focus and serve as a guide for policymakers on measures for managing brucellosis in Nigeria and other sub-Saharan countries.The need for improved sanitary conditions of the abattoirs, the use of personal protective equipment by animal handlers, vaccination of animals against bovine brucellosis, and ranching of animals to curb the spread of the disease should be paramount to all the stakeholders.

Table 1. Seroprevalence of reported human brucellosis in Nigeria (2001–2021).

Region	State	No of Samples Tested	No of Positive Sample	Seroprevalence %	Detection Methods							*Brucella* Type			Reference
					RBPT	SAT	cELISA	iELISA	IgM	IgG	IgG/IgM ELISA	*Brucella* spp.	*Brucella abortus*	*Brucella melitensis*	
NC	Kwara	189	42	22.2%	42	0	0	0	0	0	0	42	0	0	[42]
	Abuja	224	40	17.9%	40	0	0	0	22	18	0	40	0	0	[43]
	Nasarawa	160	16	10%	16	0	0	0	0	0	0	16	0	0	[44]
Total		573	98	17.1%	98	0	0	0	22	18	0	98	0	0	
NE	Bauchi	285	95	33.3%	95	0	0	0	6	18	0	95	0	0	[45]
	Not indicated	500	26	5.2%	26	0	0	0	0	0	0	26	0	0	[46]
	Borno	106	4	3.8%	4	0	0	0	0	0	0	4	0	0	[47]
	Bauchi	100	11	11%	11	0	0	0	0	0	0	0	11	0	[48]
Total		990	136	13.7%	136	0	0	0	6	18	0	125	11	0	
NW	Kaduna	1	1	100%	0	1	0	0	0	0	0	0	1	0	[49]
	Kaduna	100	19	19%	0	0	0	19	0	0	0	19	0	0	[50]
	Sokoto	137	1	0.7%	1	0	0	0	0	0	0	0	1	0	[51]
Total		238	21	8.8%	1	1	0	19	0	0	0	19	2	0	

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Region	State	No of Samples Tested	No of Positive Sample	Seroprevalence %	Diagnostic Methods							*Brucella* Spp.			Reference
					RBPT	SAT	cELISA	iELISA	IgM	IgG	IgG/IgM ELISA	*Brucella* spp.	*Brucella abortus*	*Brucella melitensis*	
SE	Enugu	682	195	28.6%	195	0	0	0	0	0	0	195	0	0	[51]
	Total	682	195	28.6%	195	0	0	0	0	0	0	195	0	0	
SS	Akwa Ibom	228	70	30.7%	29	0	0	0	0	41	0	0	0	70	[52]
	Total	228	70	30.7%	29	0	0	0	0	41	0	0	0	70	
SW	Lagos	422	27	6.4%	27	0	0	3	0	0	0	27	0	0	[53]
	Oyo	11	7	63.6%	7	0	0	0	0	0	0	7	0	0	[54]
	Total	433	34	7.9%	34	0	0	3	0	0	0	34	0	0	
Grand Total		3144	554	17.6%	493	1	0	22	28	77	0	471	13	70	

NC: North-Central, NE: North-East, NW: North-West, SE: South-East, SS: South-South, SW: South-West, RBPT: Rose Bengal plate test, SAT: serum agglutination test, cELISA: competitive enzyme-linked immunosorbent assay, iELISA: indirect enzyme-linked immunosorbent assay, IgM: immunoglobulin M, IgG: immunoglobulin.

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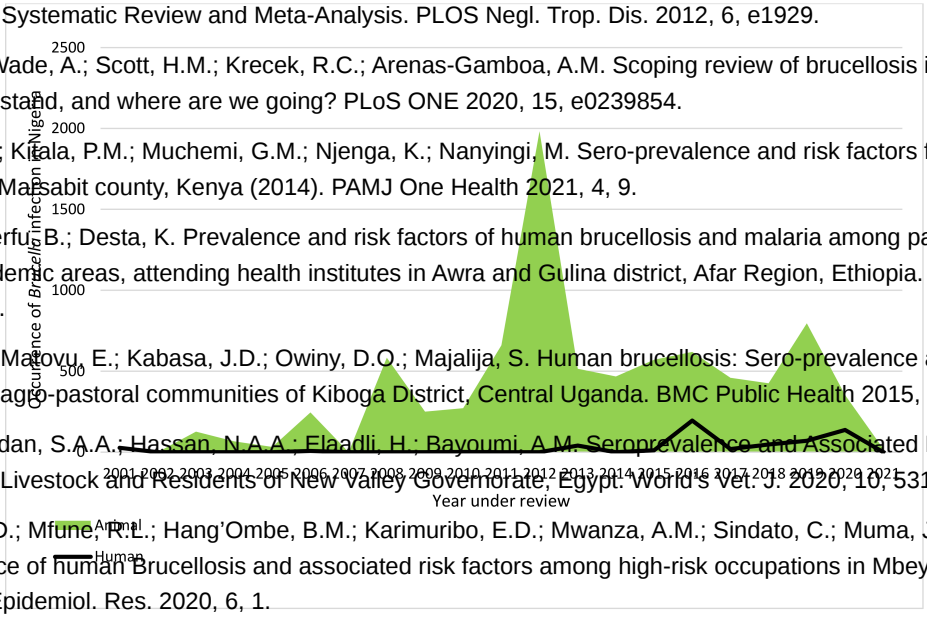

Figure 2. Trend of human and animal brucellosis in Nigeria from 2001 to 2021.

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