Epidemiology of brucellosis in India: a review

A. K. UPADHYAY, MAANSI, POOJA SINGH and AASTHA NAGPAL

Department of Veterinary Public Health and Epidemiology, College of Veterinary and Animal Sciences, G. B. Pant University of Agriculture and Technology, Pantnagar -263145 (U. S. Nagar, Uttarakhand)

ABSTRACT: Brucellosis is a disease affecting a wide range of animal species including the major food-producing animals as cattle, sheep, goats and pigs. Other species such as bison, buffalo, camels, dogs, horses, reindeer and yaks are also affected and act as a significant local source of infection in some regions. Infections in marine animals (dolphins, porpoises and seals) have further escalated the chances of transmission of the disease in other susceptible hosts. Till date, none of the prevention and control measures have been helpful in the eradication /elimination of this disease. With the initiation of' National Animal Disease Control' programme launched recently which aims at controlling this disease through proper vaccination, one can hope to curtail the problem to some extent.

Key words: Brucellosis, control programme, epidemiology

Brucella comprise ten host specific species: *B. abortus* (cattle), *B. canis* (canids), *B. ceti* (cetaceans), *B. melitensis* (sheep and goats), *B. microti* (*Microtusarvalis*), *B. neotomae* (*Neotomalepida*), *B. ovis* (sheep), *B. pinipedialis* (pinnipeds), *B. suis* (pigs) and *B. inopinata* (isolated from a human patient who had undergone breast implant) (Whatmore, 2009 and Minharro *et al*., 2013). Transmission of *Brucella* among animals mainly occurs through contact following an abortion. Contaminated pasture or animal houses are responsible for the spread of the organisms through ingestion, inhalation, conjunctival inoculation, skin contamination and udder inoculation from infected milking cups account as other modes. In calves, pooled colostrums for feeding newborn calves serve as a source. Artificial insemination procedures transmit the disease but sexual transmission plays a little role in bovines. The sharing of male breeding stock also promotes transfer of infection between farms. Sexual transmission probably plays a greater role in the transmission of *B. melitensis* in sheep and goats along with *B. suis* in swine and *B. canis* in dogs. Other risk factors involve comingling of different flocks and herds, unscreened animal purchase entry into the farm, transhumance of summer grazing, mingling of animals at fairs and closed space animal housing. As the disease is zoonotic in nature, transmission to humans takes place by eating or drinking unpasteurized/raw dairy products and inhalation and can also enter wounds in the skin/mucous membranes through contact with infected animals. Ingestion of raw milk and occupational exposure are the key modes. Person-to-person spread of brucellosis is extremely rare. Infected breast feeding mothers may also transmit the infection to their infants. Sexual transmission has been rarely reported, while uncommon, transmission may also occur via tissue transplantation or blood transfusions.

Brucellosis is of wide economic concern too as it causes huge economic losses. In India, brucellosis in livestock is responsible for an estimated loss of US $3.4 billion per year out of which cattle and buffalo accounted for 95.6% of total losses due to abortions, temporary infertility and sterility in adult animals (Singh *et al*, 2015).

India

The country has largest livestock numbers in the world. The total livestock population consisting of cattle, buffalo, sheep, goat, pig, horses & ponies, mules, donkeys, camels, mithun and yak is approximately 512.05 million according to 19th Livestock Census (2012). One of the primary aims of livestock development programme undertaken by the Government of India is to increase milk and meat production through sustainable disease control programmes.

Epidemiological investigation of brucellosis generally relies upon the sero-prevalence studies. Animals with history of reproductive failure and abortion are generally screened for brucellosis by the Rose Bengal plate test (RBPT), serum tube agglutination test (SAT) and enzyme linked immunosorbent assay (ELISA) kits. Bovine brucellosis is endemic in all the states of India and appears to be on the increase in recent times, perhaps due to increased trade and rapid movement of livestock. Current management practices and herd structure also allow for endemic brucellosis. The preponderance of natural bull service in rural India, especially in buffalo, is perhaps an

important factor in the maintenance and spread of infection. However, a National Animal Disease Control Programme for brucellosis control is being implemented in the country with the aim to eradicate the disease through vaccinations.

National prevalence

In India, brucellosis was first recognized in 1942 and is now endemic throughout the country. Rapid and easy travel and trade further has the potential to increase the endemecity. The disease is reported in cattle, buffalo, sheep, goats, pigs, dogs and humans. The long-term serological studies have indicated that 5% of cattle and 3% of buffaloes are infected with brucellosis (Renukaradhya, 2002).

Earlier reports of serological evidence have suggested the disease to be highly endemic in most parts of India (Chauhan *et al*., 2000). Among the states, Punjab shows the highest disease prevalence probably owing to the constant screening programme running in the state and the high number of bovine population. On the other hand, the seroprevalence rate ranged from 6.6% (123/1860) in central state of Madhya Pradesh (Mehra *et al*., 2000) to 60% in a northeastern state of Assam (Chakraborty *et al*., 2000).

Progress reports of monitoring programs from 2012–2013 by the Indian Council of Agricultural Research also estimates that the current national seroprevalence of brucellosis in cattle is roughly 13.5% and at a stable, endemic equilibrium (Rahman, 2013). The true epidemiological status of the disease in the country remains a concern owing to the absence of proper laboratory facilities, lack of awareness, under-reporting along with improper recording of the history of the disease. Buffalo keepers were totally unaware of the disease and the vaccine available for the disease (Kant *et al.,* 2018). Most of them drink raw milk, sleep in cattle sheds, do not isolate sick cattle or test buffaloes for any disease before purchasing them, apply intrauterine medication with bare hands to buffalo after abortion of foetus, never clean their cattle sheds with a disinfectant and wrongly believe that they can only acquire skin infections from cattle.

Bovine brucellosis

The two *Brucella* species of main concern in India are *B. melitensis* and *B. abortus*. *B. melitensis* is concern with goats and sheep and related animals and most virulent for man. *B. abortus* is the dominant species in cattle and *B. suis* is mainly confined to pigs. In India, different *B. abortus* biotypes (types-1, 2, 4, 6 and 9) have been isolated from cattle. *B. abortus* was also isolated from buffalo and from goat and sheep. *B. melitensis* biotypes 1 and 3 have been isolated from goats and sheep and cattle. *B. suis* may also be present in cattle, buffalo and goats. Though *B. melitensis* is more infectious to man than *B. abortus* and in general is the dominant causative agent of brucellosis, disease caused by infection with *B. abortus* is indistinguishable from that by *B. melitensis* and may be equally severe (Smits and Kadri, 2005)

Brucella biotypes have been observed to have certain dominancy over a region (Sen and Sharma, 1975) such as, *B. abortus* biotype-1 appears to be the predominant biotype (21 out of 39) in most parts of the country, followed by *B. abortus* biotype-3 (8 out of 39) in northern states of Uttar Pradesh and Haryana and the eastern state of Odisha; *B. abortus* biotype 9 in Odisha and *B. abortus* biotypes-4, -6 and -9 and *B. melitensis* biotype-2 in the southern state of Tamil Nadu. Further, *B. melitensis* biotype-1 was encountered in cattle and buffalo from Haryana and in the southern states of Andhra Pradesh and Karnataka (Hemashettar *et al*., 1987). Later, multiplicity of infection with *B. abortus* biotypes-1, 3, 6 and 9 was recorded in Odisha (Mohanty and Panda, 1988). In the northern state of Punjab, the association of *B. suis* in cattle and buffalo abortions has been reported (Mathur, 1985).
Bovine population in India is spread through the country and occurs in majority as compared to other species. Bovine brucellosis is widespread all over the Indian subcontinent. More number of cases of bovine brucellosis makes the plausible transmission to other species as well. Isloor *et al.* (1998) reported overall seroprevalence of 1.9 % in cattle and 1.8 % in buffaloes studied from 19 of 23 states. A seroprevalence study from Uttar Pradesh by Upadhyay *et al.* (2007) recorded 7.25 % prevalence in bovine (12.77 % in cattle and 3.55% in buffaloes). Various reports from Punjab recorded as worst affected bovine population with constant presence of an 11.23% overall prevalence (Dhand *et al.*, 2005) which varied from 0% to 24.3% in different villages. Earlier studies had estimated the disease in the state from as low as 7.54% to as high as 18.07% (Sharma *et al*., 2007). Aulakh *et al*., 2008 estimated a 17.68%prevalence of bovine brucellosis in Punjab and Senthil and Anantha (2013) reported it to range from 3.3% – 11.4% in Chennai. Milk ring test and milk-ELISA conducted on the samples of the same state revealed a prevalence of 4.35% and 5.38% respectively (Kumar, 2017).As high as 29.61% cattle and buffalo were reported to be affected in Uttarakhand (Maansi and Upadhyay, 2015).

Organized sector (41.30% on serological basis and 27.02% through milk tests) bears a greater burden as compared to non-organized or small herds (4.34% on serological basis and 3.06% through milk tests). Mehra *et al*. (2000) reported 6.5% (111/1629) prevalence in cattle from organized farms, compared to 5.1% (12/231) from

unorganized sector. Similar observation was made by Isloor *et al*. (1998) in a detailed study of 47 organized farms in Karnataka, wherein 207 of 4995 (4.1%) serum samples from cattle showed titers for brucellosis. This high prevalence of animal brucellosis is responsible for human infections due to close contact with animals.

Brucellosis in sheep and goats

Polding (1942) first reported the isolation of *B. melitensis* in goats. Thereafter, *B. abortus* was isolated from cases of abortion in Haryana (Mathur, 1967). *B. melitensis* biotype-1 was isolated in the states of Karnataka, Andhra Pradesh, Maharashtra and Gujarat, and *B. melitensis* biotypes-1 and 3 in Haryana (Sen and Sharma, 1975; Hemashettar *et al*., 1987). After investigations of 50 isolates from goats and 38 from sheep, Mathur (1985) opined that *B. melitenses* and *B. abortus* infections were common in sheep and goats. The sheep isolates included 32 isolates of *B. melitensis* and 6 of *B. abortus* as compared to 39 isolates of *B. melitensis* and 11 *B. abortus* from goats. He concluded that *B. abortus* infections of these animals were much higher in India as compared to other countries. *B. abortus* biotype 4 has been observed as a predominant biotype in small ruminants of Tamil Nadu (Darshana *et al*., 2016).

B. melitensis is the major cause of abortion in sheep and goats in many countries including India where infection is wide spread (Ghosh and Verma, 1985). Serological surveys of small ruminant brucellosis have indicated varying levels of infection in different states. A number of 4.9% of sheep and 7.6% of goats in Karnataka (Desai *et al*., 1995); 11% of sheep and 18% goats in northern state of Delhi; 50% sheep and 16% goats in Punjab and 33% sheep and 30% goats in the western state of Rajasthan (Kumar *et al*., 1997b); 55% of goats in Andhra Pradesh (Mrunalini *et al*., 2000) and 24% of goats and 4.7% of sheep in Uttar Pradesh (Singh *et al*., 2000) have been recorded. It was observed that flocks with history of abortions had high incidence of brucellosis (Mrunalini *et al*., 2000).In a national survey of sheep and goat brucellosis, Isloor *et al.* (1998) examined serum samples originating from 10 states, which included 6305 from sheep, and 3849 from goats with cumulative incidence in sheep as 7.9% compared to 2.2% in goats. The serological evidence of *B. ovis* infection in 6 out of 102 rams has been reported in the northern state of Himachal Pradesh (Katoch *et al*., 1996). Mangalgi *et al*. (2015) recorded a prevalence of 8.23% in sheep and 4.43% in goats. None of the sheep while 5.81% goats were found to be affected in Uttarakhand region(Maansi and Upadhaya,2015).The organized sector samples showed higher seroprevalence in goat (7.79 %, 35/449) than sheep (4.06 %, 35/861) by RBPT. Similarly, in iELISA, goat samples showed a higher seroprevalence (9.35%, 42/449) compared to sheep (7.50%, 65/861) (Kanani *et al.,* 2018).

Brucellosis in pigs

Pig farming is restricted to certain parts of the country and lack of emphasis accounts for only a few reports on porcine brucellosis. Mathur (1985) isolated *B. suis* biotype-2 from Yorkshire pigs in Tamil Nadu. Two organized piggeries having animals with clinical history of abortion in sows and orchitis in boars revealed the presence of *B. suis* biotype-1 in the farms of Southern India (Shome *et al*., 2018).

Records show the seroprevalence levels of 3.2% in Madhya Pradesh (Soni and Pathak, 1969), 11.3% in Tamil Nadu (Kumar and Rao, 1980) and 6.3% in Karnataka (Krishnappa *et al*., 1981) states. However, Thoppil (2000) observed 9.5% seroprevalence in 756 pigs slaughtered in Karnataka. Shome *et al.* (2018) established an association in clinical symptoms as abortion in sows and orchitis in boars with brucellosis seropositivity.

Brucellosis in dogs

Pillai *et al*. (1991) *first reported about presence of B. canis* infection in Tamil Nadu using *B. canis* antigen in mercaptoethanol test (MET) on 640 dogs with 2.18% (14) presence. These initial findings were reconfirmed in a similar serological survey of 460 dogs, which showed 2% infection (Srinivasan *et al*., 1992). There was no evidence of breed or sex predisposition in canines. However, Maansi and Upadhyay (2015) on 26 dog samples recorded a prevalence of 7.69% in male dogs through RBPT and ELISA and none of the female dogs was positive by serological test. A study by Sharma (2014) on canines exhibiting symptoms of abortion, orchitis, anorexia, persistent temperature, itching etc. revealed a prevalence of 32.6%.

Human brucellosis

Humans in India live in close proximity with the animals thereby stand at a greater risk to zoonotic infections. As brucellosis in animals is prevalent throughout the country, cases of human brucellosis are witnessed regularly with *B. melitensis* and *B. abortus*, of which the *B. melitensis* exhibits higher virulence and with much severe and extended illness with harsh consequences. Mathur (1985) isolated 53 strains of *Brucella* confirmed as B. *melitensis* biotype-1. He also concluded that brucellosis occurred more frequently in villages than in cities. It was also inferred that most human infections occurred with *B. melitensis* in the geographic regions where *B. abortus* was primarily responsible for bovine brucellosis, indicating the role of sheep and goats as the source of infection. In addition isolation of other *B. melitensis* biotypes-2 and 3

along with biotype-1 was reported from Delhi and Haryana (Sen and Sharma, 1975). Moreover, Hemashettar *et al*. (1987) recorded the presence of *B. melitensis* biotype-1 infection in a patient who did not show any agglutinating antibodies.

Human brucellosis is reported from most parts of the country and is closely related to animal husbandry activities (Hemashettar and Patil, 1991). Several reports indicate it to be a common disease in India. Numerous researches report the serological evidence of human brucellosis ranging between 0.9 and 18.1% in the country (Kumar *et al.,* 1997).

Several risk groups have been screened and have been found to be significantly associated with a risk of picking the infection. In India, abattoir workers, laboratory personnels, dairy farmers and veterinary clinicians have been studied extensively for the presence of the disease. A much higher prevalence has been initiated in abattoir workers (Barbudhe *et al.*, 2016).Studies on veterinarians, para-veterinarians and farm attenders revealed 25% infected in New Delhi (Kumar *et al*., 1997b); 21% in Goa (Barbuddhe and Yadava, 1997); 6.8% in Assam (Hussain *et al.*, 2000); 9.7% Maharashtra (Mohanty *et al*., 2000) and 6.8% in Orissa (Kumar *et al*.,1997b).The study by Thakur and Thapliyal (2002), revealed a prevalence rate of 4.97% in samples obtained from persons exposed to animals. An overall prevalence recorded was 7.04% in personnel engaged in veterinary health care in Karnataka, India (Shome *et al*., 2017). The study also indicated high brucellosis prevalence of 16% in para-veterinarians and animal handlers compared to 5-6% in veterinarians and artificial insemination workers. The association of Para-veterinarians, animal handlers and veterinarians (p-value < 0.05) was reported to be significant in comparison to artificial insemination workers and veterinary students. Another study in Punjab during 2012-13 revealed maximum in vet para-clinical staff (25.28 %) followed by dairy workers (16.10%) and veterinarians (11.01 %). Proch *et al.,*2018 observed that in India, the risk is higher in para-veterinary staff than veterinarians and in those who have been practicing for a longer period of time The seroprevalence rates have been recorded to be as high as 17-34% in high-risk groups like abattoir workers, veterinarians and animal attendants (Appannanavar *et al*., 2012). High prevalence among butchers and attoabir workers was reported in Delhi. Around 5.31% of animal handlers were positive for Brucella agglutinins (Pandit and Pandit, 2013).

Human brucellosis is characterized by various symptoms especially pyrexia of unknown origin (PUO). A prevalence of 0.8% to 6.8% from different areas has been observed in persons complaining of PUO (Sen *et al*., 2002). Shome *et al.* (2017) recorded intermittent fever to be the most predominant symptom (71.62%) followed by spondyloarthropathy (52.70%), epididymo-orchitis (12.16%) and problem of infertility (8.10%). A 10 year study conducted in Chandigarh on persons with PUO reported 9.94% prevalence on serological basis. However, Barbuddhe *et al*. (2000) reported maximum number of positives in patients with spondylitis followed by acute polyarthritis. Fever and upper back pain were also assessed as significant predictors for both acute and chronic forms of brucellosis, respectively (Patra *et al*., 2018). Noteworthy association [$P < 0.0001$] was also established between fever, joint pain, low backache, and fatigue and significant tube test titers, whereas no association was found between weight loss, headache, and sleep disturbance (Mangalgi *et al*., 2015). About 4.2% women with abortion were reported by Randhava *et al.* (1974) to possess *Brucella* agglutinins.

Extensive studies related to age group have been performed in Karnataka. In a study on children in Bijapur, Mantur *et al.* (2004) observed a prevalence of 1.6% with a Standard tube agglutination titre of $\geq$ 1:160 while a prevalence of 1.8% was observed in adults in the same region (Mantur *et al.,* 2006). Since then, several reports of human brucellosis from the same region have been reported (Tikare *et al.,* 2008). Children and young adults were most commonly affected in Karnataka rural area as compared to the persons beyond 60 years ((Mangalgi *et al*., 2015). High brucellosis seroprevalence between 6.75-8.90% was observed by Shome *et al.* (2017) in persons between 21-40 years of age. Regarding sex association, higher percentage of infection in female children (14.3%) was observed compared to male children (10.9%) (Dutta *et al*.,2017).This was in accordance with Patil *et al.*(2016) who observed that the median age of the patients with brucellosis was 31 years in his study and males outnumbered females unlike Dutta *et al.* (2017).

The disease is prevalent in almost all the states/cities of the country with wide variation. Among all, Punjab reports the highest (26.6%) cases of human brucellosis. A prevalence of 0.8% in Kashmir, 0.9% in Delhi, 6.8% in Varanasi, 8.5% in Gujarat and Belgaum, 11.51% in Andhra Pradesh, 19.83% in Maharashtra. Patil *et al*. (2016) reported disease from Gadag (21.1%), Haveri (17.4%) and Koppal (18.5%) districts of Karnataka. Thus systematic review suggests that the states like Punjab, Odisha, Andhra Pradesh, Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, Uttarakhand and Goa have endemicity of the disease.

CONCLUSION

Brucellosis is an endemic disease in India. It is widely prevalent in all the domesticated species of animals and in humans as well. Despite having the knowledge about the disease and its easy mode of transmission, the disease has

faced negligence as far as its control is concerned. India needs to have an effective plan to control the disease either by vaccination or by easy implementable policy for the removal of the infected animals of a herd. The challenge persists as the country has various religious beliefs. With a much higher prevalence observed in humans, the effective strategies for controlling the disease require immediate and stern action.

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