Acta Tropica 164 (2016) 226–232

Contents lists available at ScienceDirect

Acta Tropica

journal homepage: www.elsevier.com/locate/actatropica

Large-scale study of herd-level risk factors for bovine brucellosis in Brazil

Ana Lourdes Arrais de Alencar Mota[a], Fernando Ferreira[b], José Soares Ferreira Neto[b], Ricardo Augusto Dias[b], Marcos Amaku[b], José Henrique Hildebrand Grisi-Filho[b], Evelise Oliveira Telles[b], Vítor Salvador Picão Gonçalves[a,*]

[a] Universidade de Brasília, Laboratório de Epidemiologia Veterinária, Faculdade de Agronomia e Medicina Veterinária, Campus Darcy Ribeiro, ICC Sul – CP 4508, Brasília, DF, 70910-970, Brazil
[b] Universidade de São Paulo, Departamento de Medicina Veterinária Preventiva e Saúde Animal, Faculdade de Medicina Veterinária e Zootecnia, Av. Prof. Dr. Orlando Marques de Paiva, 87, São Paulo, SP, 05508-270, Brazil

ARTICLE INFO

Article history:
Received 20 May 2016
Received in revised form
10 September 2016
Accepted 17 September 2016
Available online 21 September 2016

Keywords:
Brazil
Brucella abortus
Cattle
Risk factors

ABSTRACT

Bovine brucellosis is an important zoonosis caused by *Brucella abortus* that negatively impacts livestock productivity. In 2001, Brazil launched a new national program aimed at eradicating animal brucellosis that included large-scale studies of the prevalence and risk factors to support strategic decision-making. These studies were implemented by the animal health authorities and were underpinned by the scientific coordination of the University of São Paulo and the University of Brasília. The state-level results were published and revealed important differences in herd prevalence among regions. The risk factors varied across states and did not clearly explain the observed spatial disease spread. This study used a consolidated herd-level database of 14 states and 17,100 herds, from the prevalence surveys' data, to gain insights into herd profiles and cattle production practices that might be associated with the risk of brucellosis. At the time of data collection, the study area comprised just over 56 million bovine females aged over 24 months and approximately 1.8 million herds. After an exploratory univariable analysis, all factors with $p \leq 0.20$ were included in a multiple logistic regression model, using the design-based method in order to take herd sampling weights into account. The number of females in the herd markedly increased the risk of infection; compared with smaller herds (less than 30 females), the odds ratio was 3.42 [CI 95% 2.98–3.91] for herds with 31 to 100 females, 5.68 [4.92–6.55] for herds with 101 to 400 females, and 13.14 [10.94–15.78] for herds with more than 400 females. The risk was higher for extensive cattle production farms (OR = 1.23 [1.07–1.42]) and for farms that purchased replacement stock from cattle traders (OR = 1.27 [1.08–1.47]) or directly from other farms (OR = 1.19 [1.07–1.32]). The exclusive use of artificial insemination (OR = 0.57 [0.4–0.81]) and regular veterinary support (OR = 0.68 [0.6–0.77]) appeared to be protective factors. These findings are consistent with the regional prevalence trends observed in the study and provide key guidance for the planning of the national effort to control and eradicate brucellosis. High vaccination coverage of heifers is recommended, especially when targeted to areas where large-scale extensive cattle production predominates. The smaller, more intensive herds, are good candidates for disease accreditation schemes.

1. Introduction

Bovine brucellosis is an infectious disease caused by *Brucella abortus*, which has developed mechanisms to live intracellularly for prolonged periods in its hosts, including cattle. In cattle, the disease is largely associated with reproductive problems, such as abortions, birth of weak calves and low fertility, and often causes serious economic and livestock losses (Jones et al., 2000; Silva et al., 2005).

Since the beginning of the twentieth century, many countries have adopted stringent measures for the control and eradication of brucellosis in animal populations to mitigate production losses and risks to human health (Poester et al., 2009). Most recorded cases of infection and clinical disease caused by bovine brucellosis worldwide are observed in the Middle East, the Mediterranean, sub-Saharan Africa, Latin America and some zones of China and

* Corresponding author.
E-mail addresses: vitorspg@unb.br, vitorspg@uol.com.br (V.S. Picão Gonçalves).

http://dx.doi.org/10.1016/j.actatropica.2016.09.016
0001-706X/

India (WAHID, 2012). The countries or zones considered to be free of the disease are concentrated in areas of greater socio-economic development, such as North America and Europe, and in east Asian countries and Oceania, such as Japan, Australia and New Zealand (OIE, 2014). Previous studies on the factors associated with *Brucella* spp. infection dynamics highlighted the importance of a high population density (Salman and Meyer, 1984; Matope et al., 2010), large herd size (Kellar et al., 1976; Salman and Meyer, 1984; Kadohira et al., 1997; McDermott and Arimi, 2002; Muma et al., 2006; Tun, 2007; Lee et al., 2009; Al-Majali et al., 2009; Matope et al., 2010), extensive production (Kadohira et al., 1997; Silva et al., 2000; McDermott and Arimi, 2002; Renukaradhya et al., 2002; Blasco, 2004; Martins et al., 2009) and intense animal purchase or transportation (Kadohira et al., 1997; Renukaradhya et al., 2002; Muma et al., 2006; Berhe et al., 2007; Stringer et al., 2008; Jergefa et al., 2009; Kaoud et al., 2010). When large herds are affected by bovine brucellosis, a greater proportion of the animals are infected, and the disease tends to persist longer in the herd, making eradication difficult. Adequate production and sanitary management practices, such as the use of calving paddocks and use of veterinary assistance, are cited as protective factors that cause a marked reduction in the level of infection in herds (Van Waveren, 1960; O'Connor, 1972; Vanderwagen et al., 1978; Luna-Martínez and Mejía-Terán, 2002; Rosales et al., 2002; Aricapa et al., 2008; Al-Majali et al., 2009; Jergefa et al., 2009).

In Brazil, the first attempts to control bovine brucellosis date back to the 1940s and 1950s with the establishment of serological examinations for cows that aborted, the segregation of positive animals, voluntary vaccinations of animals and guidelines for animal transportation (Poester et al., 2002; Lage et al., 2005). In 1976, Ministerial Decree no. 23 regulated the diagnostic testing protocol based on rapid or slow seroagglutination and required the slaughter of animals that tested positive and voluntary vaccination with B19 of heifers between three and eight months of age (Brazil, 1976). However, these measures alone without the implementation of a structured national animal health program resulted in little change in the Brazilian situation at that time (Paulin and Ferreira Neto, 2002).

A national study conducted in 1975 revealed a prevalence of affected animals of 4.1% in the northern region, 2.5% in the northeast, 6.8% in the central west, 7.5% in the southeast and 4.0% in the south (Brazil, 1977). In the following years, studies carried out in some states revealed changes in the epidemiological situation of bovine brucellosis that were primarily associated with the effectiveness of the vaccination programs. In the state of Rio Grande do Sul, a 2.0% reduction in disease prevalence in animals was reported in 1975, and a 0.3% reduction was reported in 1986. In Minas Gerais, the prevalence decreased from 7.6% in 1975 to 6.7% in 1980. In Paraná, the estimated prevalence in 1975 was 9.6% and decreased to 4.6% in 1989 (Poester et al., 2002; Brazil, 2006).

In 2001, the National Program for the Control and Eradication of Brucellosis and Tuberculosis (*Programa Nacional de Controle e Erradicação da Brucelose e Tuberculose* – PNCEBT) from the Ministry of Agriculture, Livestock and Food Supply (*Ministério da Agricultura, Pecuária e Abastecimento* – MAPA) established a new regulatory framework and a renewed political will to control and eradicate these diseases. This program proposed harmonized measures of prevention and control for the whole country (Lage et al., 2005).

The PNCEBT was developed with the objective of lowering the prevalence and incidence of bovine brucellosis based on compulsory vaccination of calves between three and eight months of age with the B19 vaccine, control of animal transportation and certification of brucellosis-free or monitored properties. The program seeks to increase the supply of low-risk food products to benefit public health and the productivity and competitiveness of livestock products in domestic and foreign markets, thereby offering consumers a safer and higher value product (Brazil, 2006; Lage et al., 2005).

Because knowledge of the epidemiological situation of the disease is extremely important at the onset of a disease control program and the last nationwide study on brucellosis was conducted in the 1970s (Brazil, 1977), in 2001, MAPA's Department of Animal Health demanded new studies on the prevalence and risk factors of bovine brucellosis in all Brazilian states. The studies are being conducted since then, as a first step of the onset of PNCEBT in each state. Field work is carried out by trained veterinary officers of the state animal health services, with the technical support of the University of São Paulo (*Universidade de São Paulo* – USP) and the University of Brasilia (*Universidade de Brasília* – UnB) (Poester et al., 2009). Studies of the following 16 Federative Units (FUs) have been published to date: Bahia (BA), Federal District (DF), Espírito Santo (ES), Goiás (GO), Maranhão (MA), Mato Grosso (MT), Mato Grosso do Sul (MS), Minas Gerais (MG), Paraná (PR), Rio de Janeiro (RJ), Rio Grande do Sul (RS), Rondônia (RO), Santa Catarina (SC), São Paulo (SP), Sergipe (SE) and Tocantins (TO).

These cross-sectional random surveys were carried out between October 2001 and December 2004 using a standardized sampling method, questionnaire and database, except for MS, where a state survey had been previously carried out in 1998 (Poester et al., 2009), and for MA, where data collection ended in March 2009 (Borba et al., 2013). Each state was split into regions based on distinct cattle production characteristics, such as average herd size, predominant production purpose (dairy, beef, dual-purpose) and feeding systems (extensive grazing, confined, mixed). A simple random sample of herds was conducted in each region. Within each selected herd, there was a random sample of cows aged 24 months or older. The prevalence for each state was estimated assuming a stratified sampling procedure, where each region was a stratum whose sampling weights were taken into account in the calculation. State-level results are detailed in Table 1 and the geographical location of each state is displayed in Fig. 1.

The prevalence studies revealed a very heterogeneous situation between states (Fig. 1) and between regions within the same state (Fig. 2). The areas traditionally known for having extensive farming systems for beef production, which coincide with the areas containing the largest herds, form a broad swath of high disease prevalence that encompasses the central western states of the country as well as the northern states of RO and TO (Figs. 1 and 2). Conversely, the southern states, where small-scale farming predominates, have lower herd prevalence. Prevalence was also variable within some states, such as RS, where the most southwestern region, along the border to Uruguay, and with high concentration of extensive beef farming, showed a prevalence of approximately 7.7% (Fig. 2), whereas the prevalence in the northern regions of the state, characterized by small dairy herds, was below 1% (Marvulo et al., 2009).

The analysis of risk factors yielded heterogeneous results across states. Although the observed spatial distribution of herd-prevalence of bovine brucellosis suggests an association between certain production typologies and health management practices (e.g., the highest prevalence occurs in regions dominated by larger extensive herds), no variable/factor has been clearly and systematically identified in the states studied.

Based on the hypothesis that an assessment of risk factors using data obtained from the state-based prevalence surveys would be limited in statistical power by the number of herds sampled and epidemiologically restricted to intrastate analysis, the main objective of this study was to evaluate the association of bovine brucellosis with possible risk factors in all previously sampled regions of Brazil using a consolidated database with information from 13 contiguous states and the Federal District. In the region studied, there were 1,852,872 herds with female cattle with ages greater than or equal to 24 months at the time of data collection, accounting