

DISTRIBUTION AND PREVALENCE OF BRUCELLOSIS OUTBREAKS IN EUROPE IN THE PERIOD 2002-2022

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Abstract

Contagious animal diseases that cause huge losses in livestock production and affect national economies are regulated at international level by the World Organisation for Animal Health (WOAH) through the Terrestrial Animal Health Code. The Code lays down the rules for the listed animal diseases that must be reported to the WOAH and among these important diseases is Brucellosis. This is a contagious bacterial disease caused by several representatives from the *Brucella* family which are infectious for specific animal species, including the most common livestock animals like cattle, sheep and goats and swine. Moreover, Brucellosis has a high zoonotic potential and could infect humans as well. In order to trace and analyse the distribution of *Brucella* spp. in Europe over the span of a twenty-years period (2002-2022), we derived data from the ADIS (Animal Disease Information System) managed by the European Commission which showed that five European countries were infected with variations in the prevalence of Brucellosis among the reporting member states. Regarding the identified species, it can be noted that the following were found: the predominant species is *Brucella melitensis*, followed by *Brucella suis*, and lastly, *Brucella abortus*. For the purpose of explaining the measures for disease management and control of Brucellosis we examined the main documents from the relevant secondary legislation of the EU. For the studied period, it can be noted that the most outbreaks of brucellosis were registered on the territory of Italy - 21 outbreaks (*Brucella melitensis*) from March 2014 in sheep to December 2022 in goats, but in the other years it was also found in sheep and goats. For the same period with *Brucella abortus*, there were 18 outbreaks from March 2015 in cattle to June 2022 in cattle, but in 2020, they were found in sheep and goats. *Brucella suis* was not registered.

Key words: animal health, brucellosis, veterinary legislation, disease management, disease surveillance.

INTRODUCTION

Zoonotic diseases nowadays are successfully brought under control in most of the developed countries, but some of them continue to be a constant threat to public health, animal health, and local economies. One of the bacterial diseases with great zoonotic potential is brucellosis, caused by various representatives from the *Brucella* family that affect different animal species. Some of the infections caused by *Brucella* spp. in animals are mandatory to be reported to the World Organisation for Animal Health (WOAH) - brucellosis in cattle caused by *B. abortus*, infection with *B. melitensis* in sheep and goats, and brucellosis in swine caused by *B. suis* (WOAH, 2023). At the same time, the infection was documented in humans long ago (Young, 1983; D'Anastasio et al., 2011) and as Doosti & Dehkordi (2011) argued it was described for the first time two millennia ago and isolated by Bruce in the end of the 19th century. Brucellosis is also known as “undulant fever”, “Mediterranean fever”, or “Malta fever”

(Berhanu & Pal, 2020). Today, brucellosis continues to be a global burden, causing a severe debilitating disease in people (Dean et al., 2012), of which the most vulnerable appear to be veterinarians, farmers, and abattoir workers. As no licensed vaccine against human brucellosis is available, Heidary et al. (2022) emphasised that the control of the zoonosis in humans had to rely on the control, surveillance, and prevention of the disease in animals. The implementation of measures for the management of brucellosis is crucial in regions with insufficient levels of veterinary care, inadequate health and hygiene practices and unsupported food safety requirements - like many developing countries from Africa, central Asia, Middle East and the Mediterranean - where the highest rate of incidences of brucellosis were reported (Qureshi et al., 2023).

Smirnova et al. (2013) reported that currently ten representatives from the *Brucella* family are identified, among which some infect domestic and farm animals like *Brucella abortus* in cattle, *Brucella suis* in swine, *Brucella ovis* in sheep,

Brucella melitensis in goats, *Brucella canis* in dogs, some infect pest animals like *Brucella neotomae* and *Brucella microti* in rodents, while others are contagious for marine animals like *Brucella ceti* in cetaceans and *Brucella pinnipedialis* in seals. Due to the fact that the disease is persistent in livestock, cases of human brucellosis are frequently registered - more than half a million per year in the late 1990s (WHO, 1997), with a significant rise estimated at 2.1 million of annual global incidence in humans (Laine et al., 2023).

The complexity of the disease poses the need for an integrated and interdisciplinary approach (Rahama. et al., 2023) and was used to illustrate the concept of “One Medicine”, which further developed into the “One Health” approach with a thorough understanding and principles in zoonotic disease management (Moriyón et al., 2023). With this regard, Faraz et al. (2018) proposed frequent serological surveillance accompanied by screening both categories of humans and animals for acute form of the disease with focus on people from risk groups and animals subjected to international trade, as key epidemiological activities to allow timely diagnosis and control of brucellosis.

The objective of the research is to review and analyze the regulatory provisions related to the implementation of the surveillance of the disease and to study the epizootic situation in Europe in relation to brucellosis.

MATERIALS AND METHODS

As brucellosis falls among the diseases that are regulated at the global level, we analysed the existing legislative framework on animal health control with regard to contagious and zoonotic animal disease. For this purpose, we assessed official documents from international legislation (OIE Terrestrial Animal Health Code), European regulations, and national (Bulgarian) legal acts. The implemented programmes for prevention, control, surveillance, and eradication of brucellosis in domestic animals were evaluated. The number and distribution of the disease outbreaks in livestock for the study period were analysed based on the information derived from the database ADIS (Animal Disease Information System of the EU).

RESULTS AND DISCUSSIONS

A number of countries worldwide were successful in eradicating brucellosis in their livestock, such as Australia, for example (More et al., 2015), and some EU member states like Croatia and Spain, where the disease is almost eradicated, while in Southern Europe (Greece, Italy, Portugal), the infection among livestock and zoonotic cases in humans still alert the public health authorities and the veterinary services (Jamil et al., 2022). The same authors, however, reported a decreasing trend in the number of reported brucellosis in humans in 2020 when compared to 2016, and as the primary etiological agent, *B. melitensis* was confirmed, followed by *B. suis*.

With regard to the complexity needed to address the management of contagious animal diseases and to enhance further the protection of animal health, a new Regulation (EU) 2016/429 was published which entered into force later in 2021. This sole legislative act replaces several other European regulations with the aim to implement a uniform approach to transmissible animal diseases with a focus on trade with live animals and products from them, mandatory reporting on disease outbreaks and implementation of measures for disease control and eradication. The rules laid down by this new “Animal Health law” require profound analysis on long-term epidemiological data and scientific risk assessment (Rankova & Balieva, 2023).

According to the categorization defined in Commission Implementing Regulation (EU) 2018/1882 of 3 December 2018 on the application of certain disease prevention and control rules to categories of listed diseases and establishing a list of species and groups of species posing a considerable risk for the spread of those listed diseases, brucellosis is a disease that belongs to category B.

Subjected to control on international and European level, Brucellosis is defined as “category B+D+E disease”, which according to Art. 1, item 2, 4 and 5 of Commission Implementing Regulation (EU) 2018/1882 means a listed disease which must be controlled in all Member States with the goal of eradicating it throughout the Union, as referred to in Article 9 (1)(b) of Regulation (EU) 2016/429; means a listed disease for which measures are needed to

prevent it from spreading on account of its entry into the Union or movements between Member States, as referred to in Article 9 (1) (d) of Regulation (EU) 2016/429; means a listed disease for which there is a need for surveillance within the Union, as referred to in Article 9 (1) (e) of Regulation (EU) 2016/429.

Commission Decision 2003/467/EC lists the Member States and regions thereof with tuberculosis-free status, brucellosis-free status, and EBL-free status in accordance with Directive 64/432/EEC. Those Member States and regions thereof should be duly listed in the Annexes to this Regulation.

Commission Decision 93/52/EEC sets out the list of Member States and regions thereof with official brucellosis-free (*B. melitensis*) status in accordance with Directive 91/68/EEC. Those Member States and regions thereof should be duly listed in the Annexes to this Regulation.

Commission Implementing Regulation (EU) 2021/620 of 15 April 2021 laying down rules for the application of Regulation (EU) 2016/429 of the European Parliament and of the Council as regards the approval of the disease-free and non-vaccination status of certain Member States or zones or compartments thereof as regards certain listed diseases and the approval of eradication programmes for those listed diseases cancel Decision (2003/467/EC) and Decision 93/52/EEC.

The Commission Implementing Regulation (EU) 2021/620 contains a list of free zones and zones with eradication programs. In order to achieve status, a number of conditions are defined in Art. 66-72 of Commission Delegated Regulation (EU) 2020/689 of December 17, 2019, supplementing Regulation (EU) 2016/429 of the European Parliament and of the Council as regards rules for surveillance, eradication programmes, and disease-free status for certain listed and emerging diseases. Disease-free status based on eradication programmes is acquired according to Art. 71 of Commission Delegated Regulation (EU) 2020/689.

For mandatory eradication programmes for category B diseases, a final report with additional annual information is submitted every 6 years. This applies to tuberculosis, rabies, and brucellosis until the disease is eradicated in the territory of the Member States. Final reports on the implementation of eradication programmes

are submitted in order to apply for disease-free status.

In accordance with Art. 31, paragraph 1 of Regulation (EU) 2016/429, Member States which are not free or for which there is no information that they are free from one or more of the listed diseases referred to in Article 9, paragraph 1, letter b) of the same regulation, in their entire territory or in zones or compartments thereof, introduce a programme to eradicate the relevant disease or to prove that they are free from the specified disease from the list. The programme is implemented in relation to animal populations affected by the disease in question and covers relevant parts of the territories of the Member States or relevant zones or compartments thereof ("compulsory eradication programme") and applies until the conditions for obtaining disease-free status for the relevant territory of the Member State or zone. Member States submit a draft of the mandatory eradication programme to the EC for approval. It is approved by an act of implementation of the Commission, and more specifically, the Commission Implementing Regulation (EU) 2021/620. Commission Delegated Regulation (EU) 2020/689 determines the specific requirements regarding individual diseases for obtaining disease-free status, on the basis of which relevant programmes for the eradication of diseases are developed.

Eradication programmes - for diseases in category B are mandatory, with the goal of eradicating the disease and obtaining the free status of zones or compartments. The duration, deadlines for presentation, approval, and reporting of the programmes are determined, which is implemented every year through reports with the results of the conducted supervision, etc. data that show the progress of programme implementation.

Delegated Regulation (EU) 2020/689 establishes criteria for the granting of disease-free status for Member States or zones or compartments thereof, and the requirements for the approval of eradication programmes for Member States or zones or compartments thereof.

Recognition of disease-free status is determined in Annex V, Part II, Chapter 1, Section 1 to Commission Delegated Regulation (EU) 2020/689 of 17 December 2019 supplementing

Regulation (EU) 2016/429 of the European Parliament and of the Council as regards rules for surveillance, eradication programmes, and disease-free status for certain listed and emerging diseases. It is achieved at the territory level - for the territory of the entire country or a zone of it (Rankova & Balieva, 2023).

In December 2021, the Republic of Bulgaria received a notice from the European Commission, General Directorate "Health and Food Safety", about the need for revision of „Programme for supervision and control of the brucellosis disease (*Brucella melitensis*) in sheep and goats in the Republic of Bulgaria in 2022-2024" to fulfil the requirements of Annex IV, Part I, Chapter 1, Section 1 “Granting of the status” and Section 2 “Maintenance of the status” of Delegated Regulation (EU) 2020/689 with regard to the conditions for granting and maintaining the status of a livestock facility free from infection with *Brucella abortus*, *B. melitensis*, and *B. suis* without vaccination. The change affected the sampling scheme by increasing the scope of the susceptible small ruminants (sheep and goats) and the number of samples for serological testing. Until that moment, the programme provided for a one-time serological examination of all sheep and goats over 6 months old, reared in a herd with less than 50 animals and a one-time serological examination of 25% of sheep and goats over 6 months old, reared in a herd with more than 50 animals.

Decision No. 156 of March 18, 2022, of the Council of Ministers approved a National Programme for the prevention, supervision, control, and eradication of animal diseases, including zoonoses, for the period 2022-2024, as a part of which is “Programme for supervision and control of the brucellosis disease (*Brucella melitensis*) in sheep and goats in the Republic of Bulgaria in 2022-2024”. The mentioned programme contains a new scheme for the surveillance of the disease, namely: all non-castrated sheep and goats over 6 months of age, raised on the territory of the country, should be examined once serologically. The rules applicable to individual diseases are listed in separate delegated acts, with a difference depending on whether it is a free zone or the disease is endemic to that zone/country:

1. CATEGORY B - rules for compulsory eradication programmes status „disease-free“ in accordance PART II of Regulation (EU) 2016/429 and Commission Delegated Regulation (EU) 2020/689 and rules for prevention and control in accordance PART III of Regulation (EU) 2016/429 and Commission Delegated Regulation (EU) 2020/687;
2. CATEGORY D - rules for movements between Member States in accordance PART IV of Regulation (EU) 2016/429 and Commission Delegated Regulation (EU) 2020/688; or entry into the Union in accordance PART V of Regulation (EU) 2016/429 and Commission Delegated Regulation (EU) 2020/692;
3. CATEGORY E - rules for surveillance, diagnostics, and case definitions in accordance PART II of Regulation (EU) 2016/429 and Commission Delegated Regulation (EU) 2020/689.

To summarise the relevant European and Bulgarian legislative provisions on measures for control and eradication of Brucellosis, an overview of the legal framework is shown in Table 1 below.

Table 1. Corresponding legal acts on disease management regarding Brucellosis provided by the European and Bulgarian legislation

№	European legislation	National legislation
1.	Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health (Animal Health Law) (OJ L 84, 31.3.2016)	Law on veterinary activities (Prom. SG 87/1 Nov 2005, amend. SG 71/11 Aug 2020) (BG)
2.	Commission Implementing Regulation (EU) 2018/1882 of December 3, 2018, on the application of certain disease prevention and control rules to categories of listed diseases and establishing a list of species and groups of species posing a considerable risk for the spread of those listed diseases (OJ L 308, 4.12.2018)	Decision No. 156 of March 18, 2022 of the Council of Ministers approving a National Programme for the prevention, supervision, control and eradication of animal diseases, including zoonoses for the period 2022-2024 (BG)

3.	Commission Delegated Regulation (EU) 2020/687 of December 17, 2019, supplementing Regulation (EU) 2016/429 of the European Parliament and the Council, as regards rules for the prevention and control of certain listed diseases (OJ L 174, 3.06.2020)		surveillance programmes and of eradication programmes and for application for recognition of disease-free status, and to the computerised information system (OJ L 412, 8.12.2020)	December 1982 on the notification of animal diseases within the Community (OJ L 378, 31.12.1982) (BG)
4.	Commission Delegated Regulation (EU) 2020/688 of December 17, 2019, supplementing Regulation (EU) 2016/429 of the European Parliament and of the Council, as regards animal health requirements for movements within the Union of terrestrial animals and hatching eggs (OJ L 174, 3.6.2020)		8. Commission Implementing Regulation (EU) 2021/620 of April 15, 2021, laying down rules for the application of Regulation (EU) 2016/429 of the European Parliament and of the Council as regards the approval of the disease-free and non-vaccination status of certain Member States or zones or compartments thereof as regards certain listed diseases and the approval of eradication programmes for those listed diseases (OJ L 131, 16.4.2021)	
5.	Commission Delegated Regulation (EU) 2020/689 of December 17, 2019, supplementing Regulation (EU) 2016/429 of the European Parliament and of the Council as regards rules for surveillance, eradication programmes, and disease-free status for certain listed and emerging diseases (OJ L 174, 3.6.2020)			
6.	Commission Delegated Regulation (EU) 2020/692 of January 30, 2020, supplementing Regulation (EU) 2016/429 of the European Parliament and of the Council as regards rules for entry into the Union, and the movement and handling after entry of consignments of certain animals, germinal products and products of animal origin (OJ L 174, 3.6.2020)			
7.	Commission Implementing Regulation (EU) 2020/2002 of December 7, 2020, laying down rules for the application of Regulation (EU) 2016/429 of the European Parliament and of the Council with regard to Union notification and Union reporting of listed diseases, to formats and procedures for submission and reporting of Union	Ordinance No. 23 of 14.12.2005 on the procedure and method for announcing and registering infectious animal diseases (Prom. SG 6/20 Jan 2006), which introduces the requirements of Council Directive 82/894/EEC of 21		

Despite the strict legislative framework and all the preventive measures introduced at the international level, a lot of countries in the Mediterranean region and the Middle East remain endemic for brucellosis (Musallam et al., 2016). Control and eradication of this disease are dependent on its rapid detection and monitoring, but Alamiana et al. (2017) pointed out that the usual bacteriological methods were time-consuming and required special equipment and conditions for the detection of *Brucella* strains. At the same time the authors argued that there was a high similarity, among species within the *Brucella* genus, thus hindering their identification. Bahmani & Bahmani (2022) proposed a “test-and-slaughter” technique, introduced as a routine measure in Middle Eastern countries in order to eliminate the pathogen, combined with extensive livestock vaccination programmes.

In Italy, where brucellosis in small ruminants is still present, attention was paid to the importance of maintaining a proper protocol, including notifying the authorities about clinical symptoms such as abortions on farms, followed by epidemiological examinations for the confirmation of the infections and consequent implementation of the precautionary measures (Brunetti et al., 2023). This approach is also introduced through Regulation (EU) 2016/429

that determines measures against contagious animal diseases, a fundamental prerequisite for which is the maintenance of efficient information systems with reliable epidemiological data as ADIS.

Our analysis showed that for the study period (2002-2022), the prevalence and number of brucellosis outbreaks registered in the ADIS database varied among the EU member states. Regarding the identified species, it can be noted that the following were found: the predominant species was *Brucella melitensis*, followed by *Brucella suis*, and lastly, *Brucella abortus*. Similar findings were reported by De Massis et al. (2015) for Italy after the predominantly isolation of *B. melitensis* from farm animals from 156 outbreaks in 2011.

In September 2018, the first outbreak of the disease in sheep with *Brucella melitensis* was registered once in the Kingdom of Spain, while in Italy it appeared in January 2014 also in sheep, where 6 outbreaks were detected for the year. In 2015, the disease continued to be present, with the number of outbreaks increasing by another 10 per unit, but the trend was interrupted in 2016, as outbreaks were reported only for 2 units. In 2017, there were no confirmed cases of the disease, and since then only sporadic outbreaks have been registered (ADIS, 2023).

In the Kingdom of Spain, the peak of confirmed outbreaks was in 2021, when their number reached 9 out of a total of 14 for the study period.

For the study period (2002-2022), cases of brucellosis caused by *Brucella melitensis* were reported by 5 EU member states (Figure 1) - Austria (3 outbreaks during 2018 and March 2019 in cattle only), Cyprus (3 outbreaks during 2022 in cattle and sheep/goats (mixed herd), France (1 outbreak during November 2021 in cattle), Italy (21 outbreaks), and Spain (14 outbreaks during September 2018 in sheep to July 2021 in sheep, which is found mostly in sheep but is found in goats and cattle). The affected species of animals differ from country to country and can be divided into two main groups:

- ✓ cattle - Austria, Cyprus, and France;
- ✓ sheep and goats - Italy and Spain.

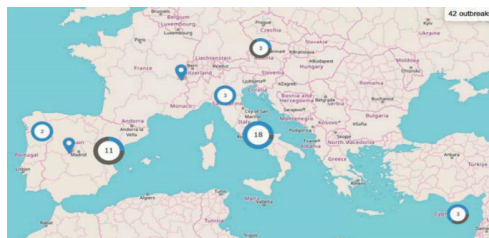


Figure 1. Reported outbreaks caused by *Brucella melitensis* in European member states in 2002-2022 (source ADIS)

For the study period (2002-2022), brucellosis (*Brucella suis*) outbreaks were declared in 4 countries in Europe (Figure 2) – France (2 outbreaks during February 2014 in cattle), Belgium (1 outbreak during December 2016), Spain (1 outbreak during October 2022 in sheep), and Portugal (1 outbreak during December 2022 in cattle). The affected animal species in all three countries were cattle, but in Spain in October 2022, the disease was detected in sheep.

Due to the fact that wildlife was also a part of the epidemiology of brucellosis and wild boars continued to serve as reservoirs for the pathogen, Lo Re III et al. (2024) argued that the incidence and geographic range of swine brucellosis will continue to expand.

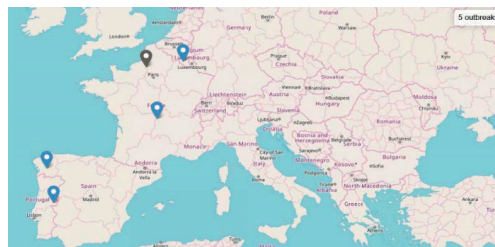


Figure 2. Reported outbreaks caused by *Brucella suis* in European member states in 2002-2022 (source ADIS)

For the study period (2002-2022), brucellosis (*Brucella abortus*) outbreaks were declared in 3 countries in Europe (Figure 3) - Italy (17 outbreaks), Spain (1 outbreak during August 2020), and Belgium (1 outbreak during December 2013). The affected animal species in all three countries were cattle, but in Italy in March 2020, the disease was detected in small ruminants.

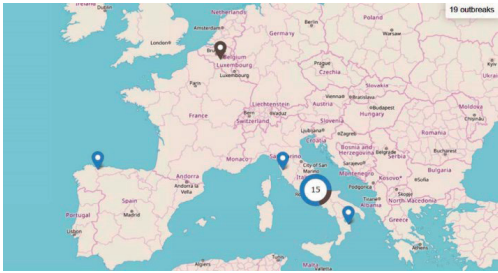


Figure 3. Reported outbreaks caused by *Brucella abortus* in European member states in 2002-2022 (source ADIS)

For the studied period, it can be noted that the most outbreaks of brucellosis were registered on the territory of Italy - 21 outbreaks (*Brucella melitensis*) during March 2014 in sheep to December 2022 in goats, but in the other years it was also found in sheep and goats. For the same period with *Brucella abortus*, 18 outbreaks were reported during March 2015 in cattle to June 2022 in cattle, but during 2020 it was found in sheep and goats. *Brucella suis*, was not registered.

The Kingdom of Spain was another of the notifying countries in which outbreaks of the disease with different representatives of the *Brucella* family (1 outbreak with *Brucella suis*) and (1 outbreak with *Brucella abortus*) were registered.

As the occurrence and reoccurrence of brucellosis are to some extent dependent on the characteristics of the communities such as level of education, economic development and cultural practices, there are a number of studies that confirm the crucial need for close cooperation between all stakeholders, starting from farmers to veterinarians, governmental bodies, policymakers, and international organisations (Khoshnood et al., 2022; Mohan et al., 2017). Moreover, for the success of the eradication programmes it is important to educate society (Pal et al., 2020), in particular animal owners, about brucellosis and its economic losses after an outbreak (Montaseri et al., 2024), as well as the zoonotic potential among high-risk groups (shepherds, butchers, and farmers) (Patel et al., 2023).

Further enhancement of the programmes related to the control of brucellosis could be achieved through the implementation of machine learning techniques to create algorithms for the prediction of the epidemiology of the disease.

Thus, effective early warning systems and risk management could be executed by the public sector to minimise the impact of brucellosis on public health (Tito et al., 2023).

CONCLUSIONS

Regardless of the in-depth study of the causes and factors for the spread of brucellosis, it is still found everywhere in the world, including in the developed countries of the European Union. Its zoonotic nature gives it even greater importance, alongside economic importance, in the context of agricultural losses in the presence of an outbreak. That is why humane and veterinary doctors should not rule it out when making their diagnoses, since the control and prevention measures defined in European and national regulations are not sufficient to combat it, and a complex approach with vaccination programmes has to be conducted.

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