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Assessment of cattle and sheep Brucellosis in Turkey

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ABSTRACT:

The objective of this study is to epidemiologically describe large and small ruminant Brucellosis in Turkey by conducting a register-based study. For this purpose, the data concerning Brucellosis which is a notifiable disease in Turkey, were obtained from anonymous disease reports of the World Organization for Animal Health. Descriptive and analytical statistics used in that study, in the logistic regression analysis, odds ratios were calculated within a 95 % confidence interval. In cattle, 7,889 outbreaks of Brucellosis were registered in all 81 provinces of Turkey between 2005 and 2015 were 15,059 animals contracted the disease. In sheep and goats, 2,277 outbreaks of Brucellosis occurred in the same time period, where 21,241 animals also got sick. There was a decreasing trend in Brucellosis both in humans and in ruminants after the new combating strategy in 2012. The disease in cattle was mostly seen in winter and the highest prevalence was in the East Anatolian Region. Furthermore, Brucellosis in small ruminants was mostly seen in the Central Anatolian region during the winter months. Both species (large and small ruminants) have the lowest rate of outbreaks in the summer months.

Türkiye'deki sığır ve koyun brusellozunun değerlendirilmesi

ÖZET:

Sunulan bu çalışmada Türkiye'de büyük ve küçük ruminantlarda yavru atımına neden olan enfeksiyöz hastalıkların kayıt tabanlı epidemiyolojik bir çalışma ile ortaya konulması amaçlandı. Bu amaçla ihbarı mecburi Brusellozis hastalığında ulusal sistemlere kaydedilen ve Dünya Hayvan Sağlığı veri tabanında herkese açık olarak yayınlanan kayıtlardan yararlanıldı. Bu çalışmada betimsel ve analitik istatistik kullanılmıştır, lojistik regresyon analizinde %95 güven aralığında hesaplanmıştır. 2005-2015 yılları arasında ülkemizde 81 il genelinde 7.889 büyükbaş Brusellozis mihrakı görülmüştür, hastalığa yakalanan hayvan sayısı 15.059 adettir. Aynı tarihler arasında 2.277 küçükbaş Brusellozis mihrakı görülmüş ve 21.241 adet küçükbaş hayvan hastalığa yakalanmıştır. Brusella hastalığı, 2012 yılındaki yeni mücadele stratejisi sonrasında insanda ve gevişgetiren hayvanlarda azalma eğilimindedir. En yüksek prevalans büyükbaş hayvanlarda Doğu Anadolu illerinde, küçükbaş hayvanlarda ise İç Anadolu'da ve kış aylarında en yüksek düzeydedir. Her iki türde de yazın salgınlar en düşük seviyededir.

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1. Introduction

Abortions cause serious reproduction problems in small and large ruminants. The increasing meat demand in Turkey and around the world seen diseases, new disease-causing agents and animal welfare issues making abortion problems a major priority. Moreover, some diseases are zoonotic and threaten human health. The most common infectious agent for ruminant abortion in Turkey is Brucellosis, which has been monitored by the Turkish Veterinary Service since the 1930s.

Infectious agents take a leading role in small ruminant infertility. *B. melitensis*, which causes Brucellosis in these species, is the most dangerous and prevalent bacteria in human Brucellosis, because sheep and goat farming are mostly practised in rural areas of developing countries by indigent farmers the eradication programmes of the disease in these animals are often neglected (2).

The aetiological agent of Brucellosis was identified as the cause of deadly Malta Fever by Dr. David Bruce for the first time in 1886. Danish Veterinary Surgeon L. F. Benhard Bang isolated *B. abortus* from a cattle foetus in 1895 (12). Brucellosis in Turkey was first seen during the importation of high yield cattle in the 1930s, and the first isolation occurred in 1931 (4).

Brucella agents are non-spore-forming, nonmotile, gram-negative, intracellular pathogens that live in the reticuloendothelial system in the reproductive cells of the organism. They usually cause chronic infections that persist for life. Brucella pathogens can live for a long-time outside of the host in optimal conditions. They live for 6 months in a carcase at 0 ºC, 125 days on the land, and 1 year in faeces. They are susceptible to most disinfectants (12). Brucellosis in cattle is mainly caused by *B. abortus* however *B. melitensis*, which is the cause of Brucellosis in sheep and goats, can spread to cattle. *B. abortus* in cattle is widespread and it causes production losses in dairy and beef farms, therefore, there are eradication schemes in most countries for this disease (11).

Infected cattle usually abort only once, or rarely more than once, however, the placenta is colonised by Brucella agents in each pregnancy. Subsequent calves might be born weak or healthy in appearance. They can take the agent during the intrauterine life or by drinking the contaminated mother's milk, so these animals become carriers (12).

B. melitensis, which seen in small ruminants, is the most invasive and pathogenic species amongst the Brucella agents, is the most common in humans. Besides protecting both human and animal health, the biggest benefits of the disease combatting schemes are to increase animal production, to eliminate costs of treatment and hospitalization of people due to the illness, as well as to prevent from labour losses.

Brucellosis is prevalent in Mediterranean States such as Turkey; Greece; Italy; Portugal; Spain; North African countries, sub-Saharan Africa; the Arabian Peninsula; India; China and South America. On the other hand, the disease has been eradicated in Northern European countries such as Sweden, Denmark and the United Kingdom (UK). The first eradication occurred in Norway; Australia; New Zealand and Canada which are now free from Brucellosis. Russia has been combating the disease for a long-time and they use their vaccine called SR82 which was developed in 1970. Some parts of the country have an officially free status from the disease. Brucella eradication began in the United States of America (USA) in 1934, and the country is now mostly Brucella free. While France was previously free, the disease reappeared in that country again in 2010. Brucellosis is widespread among our neighbours: Armenia, Iran, Azerbaijan, Iraq, and Syria (3, 6, 8, 11).

Many combating strategies are used in both national and international levels. The approaches to diagnosing and preventing Brucellosis (for example vaccination of all animals, culling of positive ones, and the vaccination of calves etc.) have been accepted and standardised internationally. What should be taken into consideration while deciding on the strategy is the organisational quality of the veterinary service, prevalence of the disease and their economic resources (2). Consideration should be given to reducing the prevalence first, after eradication takes place. It would create great economic losses, if an epidemic country culled all positive cases and paid compensation. After keeping Brucellosis under control, it will be easier to eradicate it. Then, new outbreaks and reoccurrence of the disease could be prevented by early warning systems. Furthermore, Brucellosis in wild-life always exists as a potential threat (2).

2. Material and Methods

This study contains register-based epidemiological analyses. For Brucellosis, which is a notifiable disease in Turkey, the World Organisation for Animal Health (OIE), and the World Animal Health Information System (WAHIS) data, based on the national database, are used. Animal population data were obtained from the Turkish Statistical Institute, and the large ruminant figures. Small ruminant populations were not used in the project.

According to national regulations, all aborted animals must be tested for Brucellosis. Aborted materials (e.g. foetus, discharge, placenta) are sent to the National Veterinary Institute of each Turkish province by an official veterinarian, who works in the district or province directory of the Ministry. The material is examined to detect Brucellosis. Positive cases are registered on Turkish Veterinary System (Turkvet) by the official veterinarian in the district or province. That data is sent to the OIE by the contact person from the headquarters of the Veterinary Service, every 6 months. These results are published publicly on the organization's website.

The study unit of this research project is the Brucella diagnosed and registered female cattle, sheep and goats. Brucella positive male animals are not monitored and there is no record in the system, therefore it is not included in the study. The target population is the 81 provinces of Turkey, and the sub-population is exclusively large and small female ruminants. There were 14 million cattle, 31 million sheep, and 10 million goats in Turkey in the year 2015. According to the animal statistics of the Turkish Statistical Institute, there were approximately 9 million cows over the age of 12 months.

The study period was between 2005 and 2015. All positive female cattle were used for this project, and cattle and buffalo discrimination was not made in the large ruminant data. Considering the biological age of reproduction, cattle under the age of 12 months were excluded from the population data.

There are descriptive and analytical statistics in that study. Chi-square and Fisher's Exact Test were used to analyse the statistical significance of the contingency tables. Median, mean and standard deviation was shown. In the logistic regression analysis, odds ratios were calculated within a 95 % confidence interval. The p-value threshold between the groups was 0.05.

Statistical calculations and graphics were made by R software and its packages. Outbreak maps were made by QGIS. Since this research used data collected by other organisations and individuals already based on records and animal experiment, biological samples and genetic material were not made. Therefore, Ethics Committee approval is not required.

3. Results

According to the World Organisation for Animal Health (OIE) registers, which were based on Turkish Brusellozis data, there were 7,889 large ruminant outbreaks around Turkey. During this period, 15,059 animals (cases) caught the disease. Three of a total 81 Turkish provinces (Kilis, Yalova, and Zonguldak) had no outbreaks during those dates.

There was an increase in cattle Brucellosis outbreaks in autumn and winter. The number of outbreaks rose from 2005 to 2012, and then showed a decreasing trend. The highest outbreaks were seen in 2012, and the lowest was in 2005. The peak month of Brucellosis was in January, the lowest month was July, increasing slightly in August and September.

Cattle outbreaks were concentrated in the Eastern Anatolia region with a total of 3,382 outbreaks in 2005-2015, and the lowest figures were in the Marmara region with 205. Considering the number of female animals over 12 months in all the regions, only the Aegean and the Mediterranean regions had changed in outbreak numbers according to the animal population, however, the ranking of other regions had not changed (Table 1-2).

Table 1: The monthly distribution of Large and Small Ruminant Brucellosis Outbreaks
Tablo 1: *Büyük ve küçük ruminant Brusellozis mihraklarının aylara göre dağılımı*

Months	2005-2011		2012		2013		2014		2015		Total	
	L.Rum	S.Rum	L.Rum	S.Rum	L.Rum	S.Rum	L.Rum	S.Rum	L.Rum	S.Rum	L.Rum	S.Rum
January	465	233	132	45	392	232	204	28	68	13	1,261	551
February	471	234	220	54	247	185	128	22	120	29	1,186	524
March	392	107	219	17	173	48	73	5	140	34	997	211
April	295	66	148	9	91	3	29	1	132	24	695	103
May	230	66	132	10	60	0	16	2	110	18	548	96
June	184	54	67	4	13	0	13	0	83	11	360	69
July	165	38	33	2	17	2	7	0	45	1	267	43
August	169	39	46	5	11	0	9	1	37	1	272	46
September	175	61	54	3	21	3	12	1	30	3	292	71
October	166	68	114	2	41	4	3	1	32	9	356	84
November	287	130	211	16	96	13	49	7	65	21	708	187
December	292	175	319	55	157	22	58	10	121	30	947	292
Total	3291	1271	1,695	222	1,319	512	601	78	983	194	7,889	2,277

Table 2: The Large and small ruminant Brucellosis outbreaks by regions
Tablo 2: *Büyük ve küçük ruminant Brusellozis mihraklarının bölgelere göre dağılımı*

Regions	2005-2011		2012		2013		2014		2015		Total	
	L.Rum	S.Rum	L.Rum	S.Rum	L.Rum	S.Rum	L.Rum	S.Rum	L.Rum	S.Rum	L.Rum	S.Rum
Aegean	201	175	57	19	38	32	8	9	10	5	314	240
Black Sea	744	161	579	74	440	151	149	16	190	66	2,102	468
East. Anatolia	1093	163	715	24	611	27	336	13	627	28	3,382	255
Inner Anatolia	784	293	175	42	127	118	75	15	65	45	1,226	513
Marmara	152	291	16	35	16	26	5	15	16	37	205	404
Mediterranean	120	131	81	20	27	132	6	9	12	11	246	303
S. East Anat.	197	57	72	8	60	26	22	1	63	2	414	94
Total	3,291	1,271	1,695	222	1,319	512	601	78	983	194	7,889	2,277

The difference in the distribution of outbreaks according to the seasons was statistically significant ($p < 0.05$). The logistic regression analysis showed that winter had the highest value followed by autumn and summer, and spring was chosen as a reference category (Table 3).

Table 3: Seasonal distribution of Brucellosis in Turkey
Tablo 3: *Türkiye'de Brusellozisin mevsimsel dağılımı*

Category	Estimate	Std. Error	OR (95% CI)	P value
Spring(Intercept)	0	0	ref	P<0.001
Winter	1.0077	0.4019	2.73 (1.24-6.02)	
Autumn	-0.9407	0.4482	0.39 (0.16-0.93)	
Summer	-1.5607	0.4736	0.20 (0.082-0.053)	

As reported by the registers, 412 of the 15,059 bovine cases with Brucellosis had died, and 2,201 were destroyed because they were not suitable for consumption. The remaining 12,446 cattle were slaughtered to consume with heat treatment. The lethality rate, or the case fatality rate, (the mortality rate of infected animals) was 3.9 % between the dates mentioned (Table 4).

Table 4: The number of dead, destroyed and slaughtered animals due to Brucellosis
Tablo 4: *Brusellozisten dolayı ölen, imha edilen ve kesilen hayvan sayıları*

Years	Died	Destroyed	Slaughtered	Cases	Case-Fatality Rate (%)
2005-2011	285	201	8490	8974	4.95
2012	57	1,517	760	2,336	2.44
2013	42	316	1,979	2,337	1.8
2014	18	108	733	859	2.1
2015	10	59	484	553	1.81
Total	412	2,201	12,446	15,059	(mean 3.9)

Considering the animal population of the provinces, there was no significant change in the ranking between regions. Also, there was a positive correlation between the number of animals and the number of Brucellosis outbreaks (Figure 1).

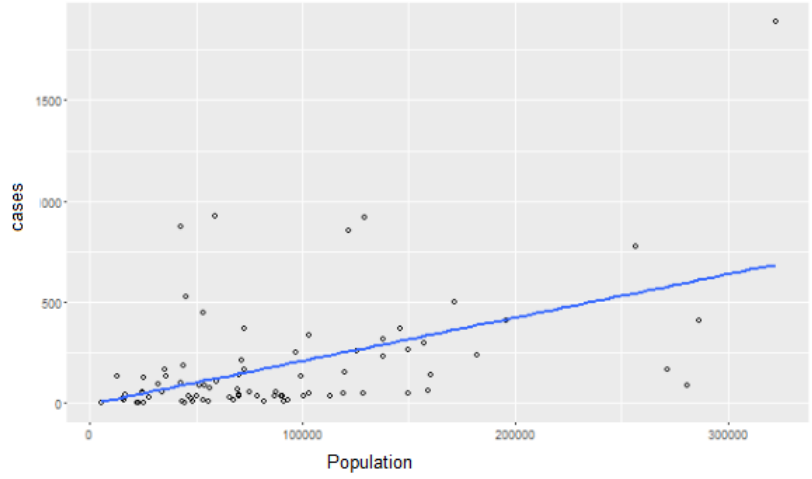

Figure 1: Correlation between population and cases

Şekil 1: *Popülasyon ve olgular arasında korelasyon*

According to The World Organisation for Animal Health (OIE) registers, which were based on Turkish Brucellosis data, there were 2,277 small ruminant outbreaks around Turkey (Table 1), and total 21,241 animals caught the disease. In Bartın and Batman provinces, B. melitensis had not seen between 2005 and 2015.

Outbreaks in autumn and winter peaked with 512 in 2013 and went back to 78 in 2014, which was the lowest number. January was the most intensive month for sheep and goat Brucellosis, and July was the lowest.

Small ruminant Brucellosis were concentrated in the Marmara region with a total of 404 outbreaks in 2005-2015, and the least in the South East Anatolia region with 94 outbreaks. The cases (number of sick animals) were seen mostly in the Central Anatolia and the least number was in the Eastern Anatolia region and the least numbers were in the Eastern Anatolia region over the period (Table 1, Figure 2-3).

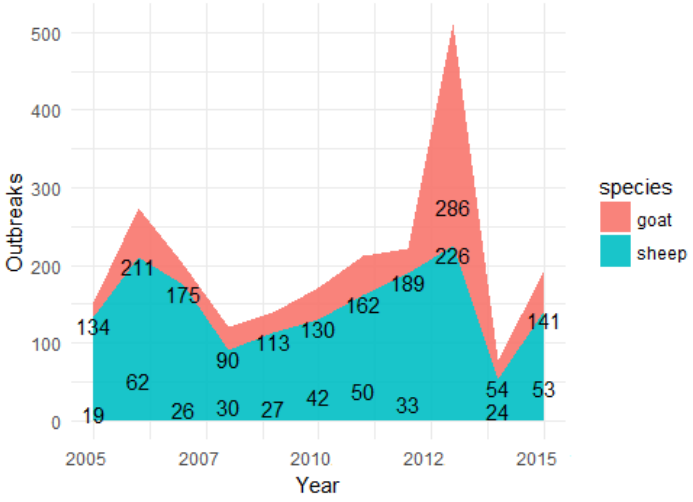

Figure 2: Sheep and goat Brucellosis in Turkey, 2005-2015

Şekil 2: *Türkiye'de koyun ve keçi Brusellozisi, 2005-2015*

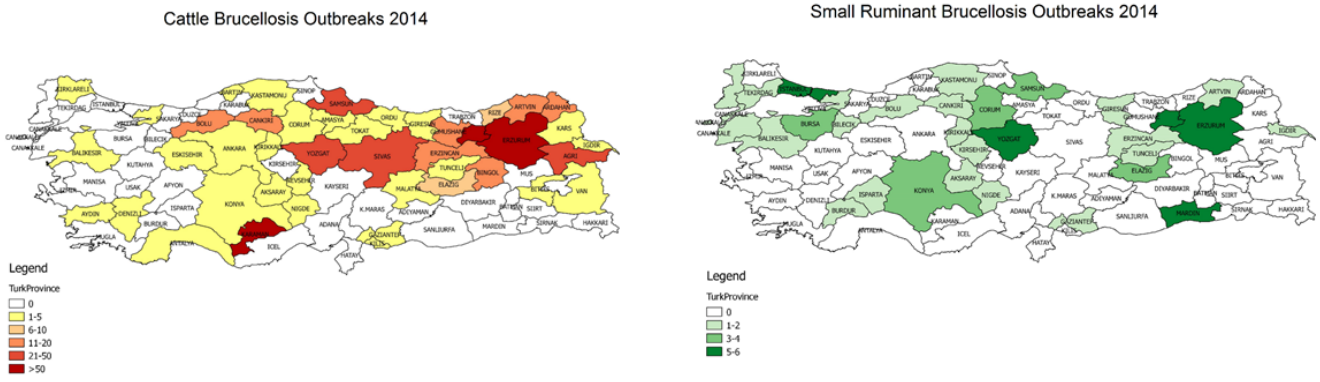

Figure 3: Brucellosis maps of large and small ruminants in Turkey

Şekil 3: *Türkiye'de büyük ve küçük ruminantlarda Brusellosiz haritaları*

It can be seen that there was a decline in human Brucellosis from 2005 to 2015 (Table-5). Two deaths, due to Brucellosis was recorded over a two-year period in 2005 and 2008.

Table 5: Human Brucellosis Cases (OIE, Wahis)

Tablo 5: *İnsan Bruselloz Vakaları (DHÖ, Wahis)*

Year	Human cases	Died
2005	14644	1
2006	10790	0
2007	11803	0
2008	9818	1
2009	9324	0
2010	7658	0
2011	7177	0
2012	6759	0
2013	7225	0
2014	4475	0
2015	4173	0

4. Discussion and Conclusion

This study was conducted to determine the distribution of Brucellosis in Turkey based on national data in recent years. It covered the 11-year period, from 2005 to 2015.

According to the distribution of the Brucellosis outbreaks during the year, the highest numbers were observed in December, January and February months. Considering the periods in which cows give birth in our country; the abortion cases are considered to be in the 5-7th month of pregnancy.

Another important finding is the decrease in human Brucellosis cases and deaths. This may be related to disease control in ruminants, or to the widespread use of pasteurized milk and dairy products instead of raw milk. In Italy, for example, the Northern regions are officially free from Brucellosis and human cases are sporadic. However, in the Southern regions, Brucellosis is high in animals and seroprevalence in humans is about 3%. Also, it is common to sell raw milk and milk products directly in local markets in the Southern regions of Italy (9). In a study conducted in the El Behira region in Egypt, it was reported that human cases and animal Brucellosis progressed in parallel (5).

The case/fatality rate (the lethality) due to Brucellosis was 3.9 % between the dates 2005 and 2015. It is reported that the mortality rate in animals aborted from Brucellosis is around 1% (1). The 16% recorded in 2005 may have been a registration error, and when this data is removed, the mortality rate drops to 2.6%.

Due to the geographical distribution of the disease, large and small ruminant outbreaks accumulated in the Eastern and Central Anatolia regions respectively. The least number of outbreaks were observed in the Marmara region for large ruminants and the South East Anatolia for small ruminants.

A two-fold increase in outbreaks was observed after 2012 when the vaccination strategy was changed and vaccination of all small ruminants was implemented (Figure 2). This increase was thought to be due to vaccine-induced false positivity or false infection.

It is debatable that eradication of a disease is beneficial and even possible to eradicate. A systematic approach is required before, during and after the eradication program. Moreover, eradication approaches varied from each other (7). Thanks to epidemiological studies, the existence and prevalence of the disease in our country will be able to be understood better, and the competent authorities will be able to take measures to protect and control the disease in accordance with that knowledge.

The studies showed that the outbreaks are concentrated during the winter period, when animals are usually kept in barns to keep warm; hence, the spread of the disease between animals inside barns can be prevented by strict biosecurity measures during that time. The seasonality of the disease must be considered as a combat strategy. It was observed that the positive correlation between animal population and the disease. Personal and equipment requirement of eradication schemes should be planned due to these findings. Especially in the rural areas where people keep livestock animals intensively, the sufficient number of personnel should be charged to monitor the disease, take the control measures and train the farmers. The medical and technical experts should be well-educated and experienced; it should be close collaboration with universities and international institutes.

Under-reporting of animal diseases is a common problem around the world, including developed countries (3, 10). To minimise this issue, private and government veterinarians and farmers should be educated on abortions, biosecurity and legal requirements; brochures and public service announcements should be produced and circulated to increase disease awareness. Farmers should cooperate with the component authority while combating the disease to gain their confidence. It should also be mentioned that the benefits of the eradication of the disease in the awareness programs. Active surveillance should be conducted as much as possible as well passive surveillance. The information collected from the farmers should be accurately collected using better-designed questionnaires/surveys and the collected and summarised information should be more accurately analysed.

Conflict of Interest

The author declared no conflict of interest.

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Authors' Contributions

Idea / concept: Anıl Demeli, Murat Fındık
Experiment design: Anıl Demeli
Supervision / Consultancy: Murat Fındık
Data collecting: Anıl Demeli
Data analysis and interpretation: Anıl Demeli, Murat Fındık
Literature search: Anıl Demeli
Writing the article: Anıl Demeli
Critical review: Murat Fındık

Ethical Approval

An ethical statement was received from the authors that the data, information and documents presented in this article were obtained within the framework of academic and ethical rules and that all information, documents, evaluations and results were presented in accordance with scientific ethics and moral rules. A permission was granted for publishing Brucella data by Republic of Turkey, Ministry of Agriculture and Forestry (Date: 13.10.2017; number: 604.01.01 / E.2556063).

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