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# RISK-BASED DISEASE MANAGEMENT IN THE FIGHT AGAINST TO BOVINE TUBERCULOSIS; AREA PRIORITIZATION

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## ABSTRACT

*In this study, regional distribution of bovine tuberculosis disease in Turkey over a period of 10 years was investigated using Office International des Epizooties data. The number of outbreaks of the geographical regions put together in Microsoft Excel programme. Descriptive statistics and Correlation analysis was used in the study. Six disease-specific evaluation criteria were determined to explain the disease factors. In Turkey, the number of outbreaks ($r=0.693$; $p=0.000<0.01$) was found to be significant. But the relationship of the number of outbreaks of the disease with the number of animals per km² (animal density) was found to be (-.016) insignificant ($P>0.05$). The rusults of present study to demostrate that epidemiologic data analysis was first implemented to disease management programme. Thus if the risk area determined, cost of controlling of the disease programme will be reduced and effective contol programme must be implemented to the high risk area. This study recomended that the disease outbreaks management will be planned firstly high risk areas with a risk based disease managemnet plan. This approch will be decreased the disease outbreaks and the public cost of the disease will be reduced in near future.*

**Keywords:** Bovine tuberculosis, Risk management, Area prioritization, Correlation, Disease control, Public cost

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## Contribution/ Originality

This paper's is one of very few studies which have investigated to disease management by prioritizing disease areas in developing country. The paper contributes that relationship between the number of outbreaks of the disease at the provincial level and the animal density was found to be insignificant.

## 1. INTRODUCTION

Studies for struggling with bovine tuberculosis disease have important objectives such as increasing animal health and welfare, protection of human health, ensuring food safety, increasing the efficiency of bovine animals, decreasing the burden of tax on taxpayers since it is a disease with compensation and elimination of the remaining losses on breeders. That the disease has a zoonotic feature and the effects of the agent on human health are not known sufficiently increase the public awareness on a global scale, and struggle for the control of the disease is increasingly gaining importance [1, 2]. Risk-based disease management approaches in the control of epidemics have increasingly come to the forefront in recent years [3-6]. That struggle with bovine tuberculosis requires risk-based approaches can be seen when scientific studies performed on two basic issues regarding the risk of the disease are analyzed. White and Benhin [7] is reported that bovine tuberculosis disease is repeated in the same areas and another one is the studies on the role of animals in the spread of the disease [8, 9].

Within the scope of the studies on eradication of animal epidemic diseases in Turkey, 1978-dated regulation was abolished in 2009, and the Bovine Tuberculosis Regulation in line with the European Union Legislation was issued [10]. The procedures regarding the determination of the methods of struggle for the conduct of the eradication program of the disease, detection of the disease, infected areas, procedures of after slaughtering, transportation operations, detection of arylic, agent from bovine tuberculosis were regulated by the new procedures and principles in the regulation [10]. Most of the developed countries use applications such as testing, disposal and pasteurization of milk in the eradication of the disease [11].

Knowing disease-specific risks in epidemics is regarded extremely important in struggling with the disease and is reported to provide significant declines in the number of outbreaks [6, 12, 13]. Therefore, scientific studies indicating the risk of the disease are important. Many investigations have been made in this field [14-17]. However, eradication is a long-termed process that requires serious planning in terms of public finance.

The Ministry of Food, Agriculture and Livestock, General Directorate of Food and Control have reported that new methods are needed in struggling with the disease, and the struggle with bovine tuberculosis was not successful due to budgetary possibilities, therefore, this struggle is planned to be maintained regionally in the struggle strategy carried out in Turkey under new legislation in 2015 in the Animal Diseases Struggle and Animal Movements Control Circular [18]. Therefore, this study was conducted considering the studies on the evaluation of disease risks at the regional level in the disease prevention strategies related to animal health [10].

In this study, the high-risk areas in the province and district level for the disease were determined by using the 2005-2014 bovine tuberculosis epidemiological data of the Office of International Epidemics (OIE) with a risk-based approach which is an important step of the new approaches in the strategy for struggling with epidemic diseases considering the changes of the methods conducted in the epidemic diseases control in recent years in the world. It was aimed to make a contribution to the reduction of the public cost of the disease in the subsequent processes by introducing the methods that should be applied for selecting the priority area or areas from these areas specified with their reasons.

## 2. MATERIAL AND METHOD

The 2005-2014 Office of International Epidemics (OIE) bovine tuberculosis outbreak data for Turkey were used in this study [4]. The 10-year outbreak data of provinces were combined in Microsoft Excel program. The number of bovine animals of 2014 at provincial levels Turkish Statistical Institute (TUIK) and the surface areas of provinces data were obtained from the Turkish Statistical Institute [19, 20].

In this study, the scope of area prioritization studies in the risk-based disease management was determined as following;

2.1. Monitoring the change in the number of outbreaks in a 10-year period across Turkey, at provincial levels (Epidemiological risk evaluation). Problem: repetition of the disease in the same residential areas [7].

2.2. Determination of the incidence of the disease by years in a 10-year period across Turkey, at provincial levels (Epidemiological risk evaluation). Reason: the repetition of the disease in the same residential areas [7].

2.3. Regional distribution of high-risk provinces (economic risk evaluation and animal transports). Reason: High cost of struggling with the disease [8, 9].

2.4. Distribution of the disease in high-risk provinces by months (biological risk evaluation), Reason: Investigation of the etiologic risk sources of the disease (pastureland relation, wildlife, etc.) and being able to make changes in programs for struggling with the disease [14-17].

2.5. The border neighbourhood with high-risk provinces or countries (technical and economic struggle) Reason: Literature data on the fact that animal movements are important in the disease, studies for the planning of transportations out of transportations for slaughtering,

2.6. The presence of animals that are sensitive to the diseaseat the 1st degree in high-risk provinces (economic risk evaluation) Reason; Determination of the number of animals that need to be tested for disease control, and determination of the cost of testing.

The area prioritization studies in risk-based disease management require the employment of a large number of researchers and include high costs. Therefore in this study, first 4 items were evaluated, item 4 was partially evaluated, and items 5 and 6 were excluded from the scope of this study.

The descriptive statistics of the study (Mean, Median, Standard Deviation, Minimum, Maximum, Difference between Change Interval and Interquartile Range, Standard Error) were produced using SPSS 20 package program [21]. The Pearson correlation test was used in the evaluation of the relationships between variables.

The total number of bovine animals was divided by the surface areas of the provinces in determining the number of animals per $km^2$. The relationships between the number of outbreaks and incidence of the disease, between the number of outbreaks and number of animals, and between the number of outbreaks and the number of animals per $km^2$ were investigated using the correlation test in this study.

The number of outbreaks of the geographical regions including the provinces was calculated using the provincial outbreak data across Turkey. These data were aligned, and areas with a high level of risk were determined.

The geographic regions and the provinces as a part of them included in the study were encoded by the following order.

2.2.1. The Marmara Region provinces: Edirne, Kırklareli, Tekirdağ, İstanbul, Kocaeli, Yalova, Sakarya, Bilecik, Bursa, Balıkesir, Çanakkale (11 provinces).

2.2.2. The Black Sea Region Provinces: Rize, Trabzon, Artvin, Sinop, Tokat, Çorum, Amasya, Samsun, Zonguldak, Bolu, Düzce, Karabük, Bartın, Kastamonu, Bayburt, Giresun, Gümüşhane, Ordu (18 provinces).

2.2.3. The Mediterranean Region Provinces:Adana, Osmaniye, Antalya, Burdur, Hatay, Isparta, İçel, Kahramanmaraş (8 provinces).

2.2.4. The Aegean Region Provinces: İzmir, Manisa, Aydın, Denizli, Kütahya, Afyon, Uşak, Muğla (8 provinces).

2.2.5. The Eastern Anatolia Region Provinces:Ağrı, Ardahan, Bingöl, Bitlis, Elazığ, Erzincan, Erzurum, Hakkâri, Iğdır, Kars, Malatya, Muş, Tunceli, Van (14 provinces).

2.2.6. The Central Anatolia Region Provinces:Aksaray, Ankara, Çankırı, Eskişehir, Karaman, Kırıkkale, Kırşehir, Konya, Nevşehir, Niğde, Sivas, Yozgat, Kayseri (13 provinces).

2.2.7. The Southeastern Anatolia Region Provinces: Adıyaman, Batman, Diyarbakır, Gaziantep, Kilis, Mardin, Siirt, Şanlıurfa, Şırnak (9 provinces).

In this study, provinces with the number of outbreaks above the Interquartile Range were defined as high-risk provinces since the high number of outbreaks increased the risk of disease in the evaluation of the disease at the provincial level.

## 3. RESULT and DISCUSSION

The descriptive statistics of the outbreaks of bovine tuberculosis detected in Turkey between the years of 2005-2014 at the first stage of this study are given in Table 1.

When the data in the table were analyzed, the Median value was found to be 48 outbreaks and the Interquartile Range value was found to be 116 outbreaks. It was determined in this study that the disease was never observed in 10 provinces (12.34%) within 10 years, but it was observed in 71 provinces (87.66%).

The outbreak number and ratios of the disease by regions are given in Table 2.

**Table-1.** Descriptive statistics of bovine tuberculosis outbreaks across Turkey in 2005-2014

| | | | Statistics | Standard Error |
|---|---|---|---|---|
| **Outbreak** | Mean | | 87,54 | 12,682 |
| | 95% Confidence Interval | 62,24 | | |
| | | 112,83 | | |
| | Median | | 48,00 | |
| | Variance | | 11418,738 | |
| | Standard Deviation | | 106,858 | |
| | Minimum | | 1 | |
| | Maximum | | 488 | |
| | Range | | 487 | |
| | Interquartile Difference | | 116 | |

Calculation of OIE data (4)

**Table-2.** Bovine tuberculosis outbreak numbers and proportional distribution by regions

| Regions | Outbreak | Ratio (%) |
|---|---|---|
| Marmara | 1.318 | 21.17 |
| Aegean | 1.233 | 19.81 |
| Black Sea | 1.201 | 19.29 |
| East | 1.077 | 17.30 |
| Central Anatolia | 858 | 13.79 |
| Mediterranean | 478 | 7.68 |
| Southeastern Anatolia | 60 | 0.96 |
| Total | 6.225 | 100.00 |

Calculation of OIE data (4)

When the data in Table 2 were analyzed, it was determined that the disease was observed in a total of 6.225 outbreaks within 10 years across Turkey, and the average annual incidence ratio was 622.5 outbreaks. A 1-2% difference was calculated between these ratios in the Marmara, Aegean, and Black Sea regions.

At the second stage, the incidence of the disease and the number of outbreaks by years in provinces which were above the number of outbreaks of 116, which was the Interquartile range value detected at the first stage, and which were accepted to be high-risk are given in Table 3.

When the data in the table were analyzed, it was seen that Erzincan was on the first rank with 488 outbreaks, and Erzurum was on the sixth rank with 282 outbreaks. In this study in which a 10-year period of the incidence of the disease was evaluated, the incidence of the disease was 100% in the Black Sea region provinces.

**Table-3.** The ranking of high-risk provinces and their distribution by regions

| Provinces | Frequency | Outbreak | I * | II ** | Region | III *** |
|---|---|---|---|---|---|---|
| Erzincan | 10 | 488 | 101.009 | 5 | East Anatolia | 0.12 |
| Edirne | 10 | 384 | 162.993 | 1 | Marmara | 0.04 |
| Denizli | 7 | 375 | 228.628 | 4 | Aegean | 0.05 |
| Burdur | 10 | 327 | 198.346 | 3 | Mediterranean | 0.04 |
| Izmir | 9 | 314 | 555.981 | 4 | Aegean | 0.02 |
| Erzurum | 8 | 282 | 665.836 | 5 | East Anatolia | 0.04 |
| Bolu | 10 | 242 | 141.995 | 2 | Black Sea | 0.06 |
| Kırklareli | 10 | 234 | 156.489 | 1 | Marmara | 0.04 |
| Balıkesir | 7 | 223 | 547.469 | 1 | Marmara | 0.03 |
| Elazığ | 10 | 204 | 146.250 | 5 | East Anatolia | 0.06 |
| Çorum | 10 | 202 | 219.284 | 2 | Black Sea | 0.06 |
| Yozgat | 6 | 175 | 247.804 | 6 | Central Anatolia | 0.06 |
| Aydın | 10 | 167 | 343.940 | 4 | Aegean | 0.02 |
| Nevşehir | 9 | 162 | 73.523 | 6 | Central Anatolia | 0.07 |
| Ankara | 10 | 161 | 327.267 | 6 | Central Anatolia | 0.08 |
| Tekirdağ | 9 | 150 | 154.663 | 1 | Marmara | 0.04 |
| Samsun | 10 | 134 | 325.682 | 2 | Black Sea | 0.03 |
| Bartın | 10 | 127 | 53.241 | 2 | Black Sea | 0.04 |
| Manisa | 10 | 122 | 228.415 | 4 | Aegean | 0.06 |

I. *Number of animals

II. **Area code of the province

III. ***The number of animals per km²

At the 3rd stage, the regional distribution of high-risk provinces by the number of outbreaks is given in Table 4.

**Table-4.** Regional and proportional distribution of the number of outbreaks of bovine tuberculosis in high-risk provinces

| Regions | Total number of outbreaks | Ratio (%) |
|---|---|---|
| Marmara | 991 | 22.15 |
| Aegean | 978 | 21.88 |
| Black Sea | 974 | 21.77 |
| East | 705 | 15.76 |
| Central Anatolia | 498 | 11.13 |
| Mediterranean | 327 | 7.31 |
| Southeastern Anatolia* | | |
| Total | 4.473 | 100.00 |

Calculation

*Not rated at 1%

When the data in the table were analyzed, it was determined that 72% (4,473 outbreaks) of a total of 6.225 outbreaks observed within 10 years were observed in 19 provinces. It was determined that the position of the Marmara and Aegean regions in the risk rankings did not change in the rankings of high-risk provinces. However, the number of outbreaks in the three provinces (Erzincan, Erzurum, Elazığ) in the Eastern Anatolia Region was very high.

The result given in Table 5 was achieved when the relationship between the high number of outbreaks of the disease and the incidence of the disease within 10 years was investigated.

**Table-5.** Correlation between the number of outbreaks and the incidence of the disease across Turkey

| | | Number of outbreaks | Incidence of the disease |
|---|---|---|---|
| **Number of outbreaks** | Pearson Correlation | 1 | ,693** |
| | Sig. (2-tailed) | | ,000 |
| | N | 71 | 71 |

Calculation

As a result of the Pearson Correlation test, the relationship between the number of outbreaks and the incidence of the disease (r=0.693; p=0.000<0.01) was found to be significant. It was determined that the disease was never observed in 10 provinces (12.34%) within 10 years, but it was observed in 71 provinces (87.66%).

When the regional distributions of high-risk provinces in the Marmara, Aegean, and Black Sea Regions which were top three in the risk ranking of the disease at the regional level were analyzed, it was determined that the Marmara and Aegean regions were again on the first two ranks.

The relationship between the animal density and the number of outbreaks of 19 provinces where the disease was highly risky was investigated with the Spearman's rho correlation test in this study and presented in Table 6.

**Table-6.** The relationship between the number of outbreaks and animal density of high-risk provinces

| | | Number of outbreaks | The number of animals per km² |
|---|---|---|---|
| **Number of outbreaks** | Correlation Coefficient | 1,000 | -,016 |
| | Sig. (2-tailed) | . | ,948 |
| | N | 19 | 19 |

Calculation

The relationship of the number of outbreaks of the disease with the number of animals per km² (animal density) was found to be (-.016) insignificant (P>0.05).

Firstly, it is necessary to evaluate the epidemiological data of the disease in the studies on the epidemic disease control. In these evaluations, the repetition of the disease in the same area is extremely important for struggling with the disease. It demonstrates the importance of protection and control measures to be taken in these areas. Bovine tuberculosis is a disease which is repeated in the same areas [7]. Therefore, it is necessary to reveal in which areas the disease is repeated in Turkey. When the outbreak data across Turkey in the period examined were analyzed, the Marmara, Aegean, Eastern Anatolia and Black Sea regions were determined to be high-risk regions by the said order. Furthermore, due to the fact that the relationship between the incidence of the disease across Turkey and the number of outbreaks (r=0.693; p=0.000<0.01) was found to be significant, it is suggested that the determination of risk statuses of the areas where the disease is repeated should be taken into account in the disease control.

Studies demonstrating the role of animal movements in the spread of this disease suggest that different new measures should be introduced in struggling with the disease for the animal movements in provinces and regions with the high incidence of the disease and the number of outbreaks [8, 9].

These study findings demonstrated that the disease peaked during the summer months (July, August) in Turkey, contrary to expectations. These results do not support the findings indicating that the disease increases mainly in January in countries on different continents [5].

When the disease was evaluated in a 10-year period examined across Turkey, and the regions including provinces where the risk of the disease was high (high-risk) were analyzed, the Marmara and Aegean regions came

to the forefront in both cases. On the other hand, the Black Sea and Eastern Anatolia Region are at the top in the risk ranking although there are differences in the ranking for regions ranking 3rd and 4th.

In this study, the fact that the relationship between the number of outbreaks of the disease at the provincial level and the animal density was found to be insignificant suggests that struggling with the disease should be performed in terms of the outbreak control in the disease control studies.

In addition to the determination of the costs and benefits of the disease prevention and control strategy in the outbreak to be carried out in regions determined by evaluating the epidemiological data, in which region or for which regions the sustainability of the disease control in terms of the strategy would be more profitable should be determined. The database of the disease should include sufficient information and should be open to researchers as in developed countries to achieve success in the struggle with bovine tuberculosis in Turkey (https://www.gov.uk/government/publications/2010-to-2015-government-policy-bovine-tuberculosis-bovine-tb/2010-to-2015-government-policy-bovine-tuberculosis-bovine-tb). Discussing the unique scientific basis of the disease and implementing the most accurate decisions at each stage of the programs planned to be carried out will ensure avoiding the high costs of frequently changing programs and can reduce the public cost of the disease.

The second step study is required in making prioritization decisions in the areas featured in the study. These approaches were brought together in a study entitled "The Evaluations of Contagious Animal Diseases Eradication in Turkey" [13]. These were basically listed in four categories as administrative issues the biological and technical feasibility of the disease, economic feasibility and social and political factors [5, 16, 22-24]. Disease control and eradication require multidisciplinary and participatory approaches [6]. It is necessary to evaluate these issues by creating different and common scientific groups for each area determined, and to create short, medium and long-term disease management plans according to the results obtained.

Consequently, in this study, the high-risk areas were determined using the epidemiological data for bovine tuberculosis disease. On the other hand, what the criteria required for the determination of the areas placed near the top are and on what grounds they should be taken into account while taking decision for the prioritization of these areas in the solutions for epidemic diseases, and the scientific method of area identification were demonstrated by being supported with the literature data. Therefore, it is considered that contribution will be provided to the minimization of the national cost of the disease. However, it is thought that urgent measures should be taken for the pasteurization of milk in the areas where disease outbreaks are high by considering the risks to human health in the disease control since it is a zoonotic disease and the information in this regard cannot yet fully be revealed.

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