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Evaluation of Disease Risk Variables in the Control of Bovine Tuberculosis

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***Abstract*—**In this study, due to the recurrence of bovine tuberculosis, in the same areas, the risk factors for the disease were determined and evaluated at the local level. This study was carried out in 32 farms where the disease was detected in the district and center of Samsun province in 2014. Predetermined risk factors, such as farm, environmental and economic risks, were investigated with the survey method. It was predetermined that risks in the three groups are similar to the risk variables of the disease on the global scale. These risk factors that increase the susceptibility of the infection must be understood by the herd owners. The risk-based contagious disease management system approach should be applied for bovine tuberculosis by farmers, animal health professionals and public and private sector decision makers.

***Keywords*—**Bovine tuberculosis, disease management, control, outbreak, risk analysis.

I. Introduction

BOVINE tuberculosis is a disease with social and economic consequences that directly affect human and animal health, food safety, sustainable food production and international trade. The disease has important economic implications for farmers, including direct financial costs (testing, disposal and forced slaughter), and the additional costs of replacing slaughtered animals, labour and biosecurity. The disease is zoonotic and its effects on human health are not well understood [1], [2] but public awareness and control efforts are increasing on a global scale.

Bovine tuberculosis is linked to a large number of risk factors, some of which are related to the farm system and business structure and also the management of the disease is difficult and costly. They have been investigated by many researchers, including Cheeseman et al. [3] and De Lisle et al. [4]. In a study conducted by Humblet et al. [5], the disease risk factors were classified at animal, herd and the regional/ national levels.

Risk-based disease management approaches have emerged for the control of disease epidemics [6]-[8]. The management of epidemics is realized on a local, regional, national, and global scale. Bovine tuberculosis recurs in the same areas and studies on the effects of animal movements on the disease [9]-[11] indicate that the control of the disease should commence at the local level.

The risks that need to be managed in epidemic disease control are at the micro- and macro-levels [12]. The risks at local level require micro-level study and those at the regional and national levels require macro-level study. The disease risks at the local level are classified as animal, farm and environmental risks but it is not possible to control diseases independently of economic and social conditions at the local level [13], [14].

The number of outbreaks of bovine tuberculosis in Turkey increased by approximately 5.5 times in 2013 compared with 2006 [14] and the situation requires an urgent investigation of the disease risks and applications of risk-based disease management systems.

This study aimed to contribute to the control of bovine tuberculosis by establishing both the importance of risk evaluation methodology of the disease at the local level in Turkey and the methodology of risk evaluation. The specific objective was to determine the level of the various risks on farms where bovine tuberculosis has been observed, with an expected flow-on effect of creating risk awareness at the farm level, reducing the number and size of outbreaks through timely intervention, and reducing the costs to producers and the level of public spending on outbreaks.

II. Materials and Methods

The study data consist of survey data from the farms of origin of animals that had bovine tuberculosis detected in the meat of their cattle that has been slaughtered in abattoirs in Samsun Province in 2014. The study was carried out on 32 of the 41 affected farms (78%) [15].

The coordinates for Samsun Province in the square grid system (ArcGIS 10.2 software based on numerical data layer provinces Turkey) are 41°17′25″:40°50'12″N and 36°20′01″E: 37°10'29″. The study was carried out at the district level (Alaçam, Ayvacık, Bafra, Canik, Çarşamba, Havza, Kavak, Ladik, Tekkeköy, Vezirköprü, 19 Mayıs) and involved 32 of 33 new outbreaks [15]. The sample size was determined to be 30 at the 5% confidence interval.

In the present study, some of the risk variables for bovine tuberculosis reported by Humblet et al. [5] were used. The risk variables used in the present study were separated into three groups (farm, environmental, and socio-economic).

Risks at the farm level were determined by asking the landholders 14 questions about farm management practices (Table I). For the determination of the risks at the environmental level, eight questions were developed (Table II). Assessment of economic and social risks was determined via six questions (Table IV). Overall, 28 questions were posed to farmers.

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Descriptive statistical data (frequency and percentages) were used in the study. The SPSS 20 software package [16] was used for this purpose.

In this study, four distances were determined taking into account the distance from the farms where the disease was previously identified. 1-50 m was deemed a very short distance, 51-100 m as a short distance, 101-200 m as a middle distance, and 201 m and above as distant.

The potential threat posed by wild animal species was also assessed.

III. Results and Discussion

A. Farm Level Risks

The descriptive statistics for the risks at the farm level are provided in Table I.

B. Environmental Risks

The descriptive statistics for the environmental risks are given in Table II.

TABLE I
FARM LEVEL RISKS FOR BOVINE TUBERCULOSIS IN SAMSUN PROVINCE, TURKEY

1 Primary activity of the farm	Stock	Milk	Mixed		Total
Frequency	1	2	29		32
Percentage (%)	3,1	6,3	90,6		100,0
2.Farm (barn) system	Closed	Semi-open	Open		Total
Frequency	25	6	1		32
Percentage (%)	78,1	18,8	3,1		100,0
3.Age range of the sick animals	Until 5 years	6-10years	11 years and above		Total
Frequency	7	23	2		32
Percentage (%)	21.9	71.9	6.3		100,0
4. Use of shared pasture and water	Own	Shared			Total
Frequency	11	21			32
Percentage (%)	34.6	65.6			100
5. Manure holding period (days)	1-30	31-60	61 and above		Total
Frequency	26	3	3		32
Percentage (%)	81.3	9.4	9.4		100
6.Distance of the closest cattle farm (m)	Very short1-50 m	Short51-100 m	Middle101-200 m	Far>200 m	Total
Frequency	23	3	3	3	32
Percentage (%)	71.9	9.4	9.4	9.4	100
7. The number of close cattle farms.	0-5	6-10	11-15	16 and above	Total
Frequency	3	20	8	1	32
Percentage (%)	9.4	62.5	25	3.1	100
8.Breeding of goats on the farm	Yes	No			Total
Frequency	3	29			32
Percentage (%)	9.4	90.6			100
9.Biosecurity precautions on the farm	Yes	No			Total
Frequency	2	30			32
Percentage (%)	6.3	93.8			100
10.Use of farm tools/equipment shared with other farms	Yes	No			Total
Frequency	3	29			32
Percentage (%)	9.4	94.6			100
11.Purchasing of cattle and goats before the diagnosis of the disease	Yes	No			Total
Frequency	8	24			32
Percentage (%)	25	75			100
12.Separation of the farm from other farms with fence or wall	Yes	No			Total
Frequency	24	8			32
Percentage (%)	75	25			100
13.Bovine tuberculosis outbreak before	Yes	No			Total
Frequency	10	22			32
Percentage (%)	31.3	68.8			100
14.Total number of animals on the farm	Average	Max	Min	Skewness	Kurtosis
	31.25	245	1	17.054	3.789

The presence of badger, which is one of the most important risk sources listed among the environmental risk variables [17]-[19] was determined in the vicinity of outbreaks. The rates of observation of potentially disease transmitting wild animal species [20], [21] are provided in Table III.

TABLE II
ENVIRONMENTAL RISKS FOR BOVINE TUBERCULOSIS IN SAMSUN PROVINCE, TURKEY

1.Badger sighted in the vicinity of the farm-pasture	Yes	No	Total
Frequency	16	16	32
Percentage (%)	50	50	100,0
2.Immediate announcement of disease outbreaks in the shared pasture/watering point	Yes	No	Total
Frequency	27	5	32
Percentage (%)	84.4	15.6	100,0
3.Shared use of pasture/water after the disease outbreak	Yes	No	Total
Frequency	8	24	32
Percentage (%)	25	75	100
4.Holding biological waste for more than one month in the environment	Yes	No	Total
Frequency	6	26	32
Percentage (%)	18.8	81.3	100
5.Knowledge of tuberculosis on farms in vicinity before disease occurrence on your farm	Yes	No	Total
Frequency	15	17	32
Percentage (%)	46.9	53.1	100
6.Do your goats and kids use the same pasture and watering point as cattle	Yes	No	Total
Frequency	7	25	32
Percentage (%)	21.9	78.1	100

TABLE III
WILDLIFE SPECIES POSING A POTENTIAL RISK OF BOVINE TUBERCULOSIS TRANSMISSION IN SAMSUN PROVINCE, TURKEY

Animal species	Number of the farms	% of total farms
Wolf	6	18.8
Fox	21	65.6
Bear	1	3.1
Pig	12	37.5
Deer	1	3.1
Jackal	8	25.0
Lynx	-	-
Marten	8	25.0
Mole	13	40.6
Total of farms	32	

All the animals in Table III, except for lynx, were seen in the vicinity of the farms where the disease occurred; foxes at 65.62% and moles at 40.62% were seen most frequently.

C. Economic and Social Risks

The descriptive statistics for the economic and social risks are provided in Table IV.

TABLE IV
ECONOMIC AND SOCIAL RISKS FOR BOVINE TUBERCULOSIS IN SAMSUN PROVINCE, TURKEY

Risk factor					
1.Number of days your business was interrupted due to the disease	Not interrupted	60 days	61-120 days	121 days and more	Total
Frequency	8	10	7	7	32
Percentage (%)	25	31.3	21.9	21.9	100,0
2.Received compensation for losses due to the disease	Yes	No			Total
Frequency	20	12			32
Percentage (%)	62.6	37.5			100,0
3. Replaced the animals removed from the herd with the compensation payment.	Yes	No			Total
Frequency	14	18			32
Percentage (%)	43.8	56.3			100
4. Disease affected daily life and neighborhood relationships	Yes	No			Total
Frequency	9	23			32
Percentage (%)	28.1	71.9			100
5. Effect of the disease on business activity	Same as before	Good	Worse than before	Very bad	Total
Frequency	6	12	12	2	32
Percentage (%)	18.8	37.5	37.5	6.3	100

When the descriptive statistics for economic and social risks of the disease were examined at the macro level, 75% of the farms had their business interrupted for 60 days or more.

The age of animals is an important risk factor for bovine tuberculosis, and old animals are much more sensitive to the disease than young animals [22], [23]. In the current study, 71.9% of diseased animals were 6 years of age and over, which lends support to the findings of [22] and [23]. The incidence of the disease increases as a result of close contact in the closed farm system [24]. Since 78.1% of the farms where the disease emerged in this study were closed farms, it is regarded as one of the predisposing factors of the disease. Herd size is a risk factor [25]-[27]. The average number of animals on the farms included in the present study was 31. However, the findings of this study are inconclusive as to whether the disease depends on herd size. The role of wildlife in the disease has been reported [28], [29]. The sighting of wild animals reported to be reservoirs of the disease in the vicinity of disease outbreaks was investigated in this study. Wolf, fox, bear, pig, deer, jackal, marten, and mole were reported to have been seen in the vicinity of farms or watering points. This situation suggests the need to determine the prevalence of the disease in local wildlife and to increase the disease risk awareness of the farmers.

The role of badgers in bovine tuberculosis has been documented [30], [31]. The rate of sighting of badgers in the vicinity of disease outbreaks was 50% in the present study. For this reason, it is necessary to investigate the presence of the disease in badgers seen in the vicinity of outbreaks in Turkey.

Mycobacterium caprae, the agent of tuberculosis in goats, is reported to be relevant to tuberculosis in cattle [32] in the European Union regulations (Directive 97/12/EC). The rate of raising goats and kids at the site of outbreaks or in the vicinity

of outbreaks was 9.4% in the present study. The rate of sighting of goats and kids in shared pastures and watering points was 21.9%. The link between goats and the disease needs further investigation and farmers need to be educated about this subject.

IV. Conclusion

In the present study, risk factors to be evaluated at the local level in bovine tuberculosis were determined, and the linkage of these risks to the disease outbreaks was examined. Local descriptive data were examined in the context of the risks of bovine tuberculosis on a global scale and it is concluded that it would be beneficial to expand the study to other provinces of Turkey where outbreaks of the disease regularly occur in high numbers.

The non-risk-based approach to the management of contagious diseases is unsustainable in the long term, even if successful in the short term. The results of the present study demonstrate the importance of awareness of disease risk. Thus, if the risks associated with the disease at the farm level are minimized, a reduction of incidences of the disease should follow. Findings of the present study regarding the economic and social risks of the disease suggest that despite its high public costs, the farmers reported that they were not sufficiently compensated for the losses incurred due to the disease.

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References

[1] J.M. Grange, *Mycobacterium bovis* infection in human beings, Tuberculosis 2001, 81, 71–77.
[2] P.D.O. Davies, Tuberculosis in humans and animals: Are we a threat to each other? J. Royal Soc.Med. 2006, 99(10), 539-540.
[3] C.L. Cheeseman, J.W. Wilesmith, F.A. Stuart, P.J. Mallinson, Dynamics of tuberculosis in a naturally infected badger population, Mammal Rev, 1988, 18, 16–71.
[4] G.W. De Lisle, R.G. Bengis, S.M. Schmitt, D.J. O'Brien, Tuberculosis in free ranging wildlife: Detection, diagnosis and management, Rev. Sci. Tech. Off. Int. Epizoot, 2002, 21, 317–334.
[5] M.F. Humblet, M.L. Boschıroli, C. Saegermen, Classification of worldwide bovine tuberculosis risk factors in cattle: a stratified approach, Vet. Res, 2009, 40: 50, DOI:10.1051/vetres/2009033
[6] OIE. Risk Analysis – a Decision Support Tool for the Control and Prevention of Animal Diseases, Resolution No. XXIII, 70 GS/FR – Paris.2012.
[7] J. Rushton, A Value Chain Approach to Animal Disease Risk Management (July 1, 2011). Food and Agriculture Organisation Animal Production and Health Series, No. 4. 2011.
[8] M.I. Percedo, I. González, P.R, Chávez, C. Delgado, M.A. Abeledo, Territorial risks analysis by transboundary animal diseases in Cuba, Rev. Salud Anim, 2013, 35 (2): 116-125.
[9] P.L.C. White, J.K.A. Benhin, Factors influencing the incidence and scale of bovine tuberculosis in cattle in southwest England, Prev. Vet. Med, 2004, 63: 1–7.
[10] M. Gilbert, A. Mitchell, D. Bourn, J. Mawdsley, R. Clifton-Hadley, W. Wint, Cattle movements and bovine tuberculosis in Great Britain, Nature, 2005, 435, 491–496.
[11] R. Gopal, A. Goodchild, G. Hewinson, De la Rua-Domenech., Clifton-Hadley. Introduction of bovine tuberculosis to north-east England by bought in cattle, Vet. Rec, 2006, 159, 265–71.
[12] M. Buchanan-Smith, Early warning systems: contrasting micro and macro approaches. Appropriate Technology 1996, 23, 21–22.
[13] T.J.D. Knight-Jones, J. Rushton, The economic impacts of foot and mouth disease – What are they, how big are they and where do they occur? Prev Vet Med 2013, 112: 161– 173.
[14] B. Şentürk, The Evaluations of Contagious Animal Diseases Eradication in Turkey, Harran Üniv. Vet. Fak. Derg 2015, 4(2): 90-93.
[15] Anon, 2014 yılı çalışma raporu, T.C. Samsun Valiliği, Gıda Tarım ve Hayvancılık İl Müdürlüğü, 2015.
[16] SPSS, SPSS for Windows, Version 20. SPSS Inc. New York, 2013.
[17] R. Sobrino, J. Vicente, O. Aurtenetxe, J.M. Garrido, C. Gortázar, Bovine tuberculosis in a badger (*Meles meles*) in Spain. Vet. Rec 2008, 163: 159–160.
[18] R.A. Skuce, A.R. Allen, S.W. McDowell, Herd-level risk factors for bovine tuberculosis: a literature review, Vet. Med. Int 2012, p. 621-210.
[19] A.W. Byrne, P.W. White, G. McGrath, J. O'Keeffe, S.W. Martin, Risk of Tuberculosis cattle herd breakdowns in Ireland: effects of badger culling effort, density and historic large-scale interventions, Veterinary Research 2014, 45,109.
[20] J.S. Nishi, T. Shury, B.T. Eklin, Wildlife reservoirs for bovine tuberculosis (*Mycobacterium bovis*) in Canada: strategies for management and research, Vet. Microbiol 2006, 12: 325–338.
[21] R.S. Miller, S.J. Sweeney, *Mycobacterium bovis* (bovine tuberculosis) infection in North American wildlife: Current status and opportunities for mitigation of risks of further infection in wildlife populations. Stärk KDC, ed. Epidemiology and Infection 2013, 141(7):1357 -1370, doi:10.1017/S0950268813000976.
[22] R.R. Kazwala, D.M. Kambarage, C.J. Daborn, J. Nyange, S.F.H. Jiwa, J.M. Sharp, Risk factors associated with the occurrence of bovine tuberculosis in cattle in the Southern Highlands of Tanzania, Vet. Res. Commun 2001, 25: 609–614.
[23] M. Munyeme, J.B. Muma, K.L. Samui, E. Skjerve, A.M. Nambota, I.G.K. Phiri, Prevalence of bovine tuberculosis and animal level risk factors for indigenous cattle under different grazing strategies in the livestock/wildlife interface areas of Zambia, Trop. Anim. Health Prod 2008,41:345–352.
[24] G. Ameni, A. Aseffa, H. Engers, D. Young, G. Hewinson, M. Vordermeier, 2006. Cattle husbandry in Ethiopia is a predominant factor affecting the pathology of bovine tuberculosis and gamma interferon responses to mycobacterial antigens, Clin. Vaccine Immunol. 2006, 13, 1030–1036.
[25] J.M. Griffin, S.W. Martin, M.A. Thorburn, J.A. Eves, R.F. Hammond, A case control study on the association of selected risk factors with the occurrence of bovine tuberculosis in the Republic of Ireland. Prev. Vet. Med 1996, 27: 75–87.
[26] S. Cleaveland, D.J. Shaw, S.G. Mfinanga, G. Shirima, R.R. Kazwala, E. Eblate, M. Sharp, *Mycobacterium bovis* in rural Tanzania: risk factors for infection in human and cattle populations. Tuberculosis 2007, 87, 30–43.
[27] F.A. Munroe, I.R. Dohoo, W.B. McNab, L. Spangler, Risk factors for the between-herd spread of *Mycobacterium bovis* in Canadian cattle and cervids between 1985 and 1994. Prev. Vet.Med 1999, 41: 119.
[28] S.D. Fitzgerald, J.B. Kaneene, Wildlife reservoirs of bovine tuberculosis worldwide: hosts, pathology, surveillance, and control. http://www.ncbi.nlm.nih.gov/pubmed/23169912 2013, 50(3), 488-99. doi:10.1177/0300985812467472.
[29] M.V. Palmer, *Mycobacterium bovis*: characteristics of wildlife reservoir hosts. Transbound Emerg Dis 2013, 1: 1-13.
[30] J. Krebs, R. Anderson, T. Clutton-Brock, W. Morrison, D. Young, Bovine Tuberculosis in Cattle and Badgers: An Independent Scientific Review MAFF, London, No.PB3423, 1997.
[31] S.J. More, T.A. Clegg, G. McGrath, J.D. Collins, L.A. Corner, E. Gormley, Does reactive badger culling lead to an increase in tuberculosis in cattle? Veterinary Record 2007, 161:208-209.
[32] European Comission Health & Consumers Directorate-General, Directorate G –Veterinary and International Affairs Unit G2 – Animal Health, Working Document on causal agents of bovine tuberculosis, Brussels, SANCO/7059/2013.