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Risk factors for occupational brucellosis among veterinary personnel in Turkey

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ABSTRACT

Veterinarians and veterinary technicians are at risk for occupational brucellosis. We described the risk factors of occupational brucellosis among veterinary personnel in Turkey. A multicenter retrospective survey was performed among veterinary personnel who were actively working in the field. Of 712 veterinary personnel, 84 (11.8%) had occupational brucellosis. The median number of years since graduation was 7 (interquartile ranges [IQR], 4–11) years in the occupational brucellosis group, whereas this number was 9 (IQR, 4–16) years in the non-brucellosis group ($p < 0.001$). In multivariable analysis, working in the private sector (odds ratio [OR], 2.8; 95% confidence interval [95% CI], 1.55–5.28, $p = 0.001$), being male (OR, 4.5; 95% CI, 1.05–18.84, $p = 0.041$), number of performed deliveries (OR, 1.01; 95% CI, 1.002–1.02, $p = 0.014$), and injury during *Brucella* vaccine administration (OR, 5.4; 95% CI, 3.16–9.3, $p < 0.001$) were found to be risk factors for occupational brucellosis. We suggest that all veterinary personnel should be trained on brucellosis and the importance of using personal protective equipment in order to avoid this infection.

1. Introduction

Brucellosis is one of the most important zoonotic diseases worldwide, and it is still endemic in some areas

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including Central Asia, the Middle East, Latin America, and the Mediterranean countries (Seleem et al., 2010; Godfroid et al., 2011). *Brucella melitensis*, *B. abortus*, and *B. suis* are well-known causative agents of brucellosis in humans (Franco et al., 2007). Human brucellosis is an important indicator of disease in animal populations and humans are usually infected with *Brucella* spp. originating from animals (World Health Organization, 2006).

Veterinarians and veterinary technicians have a higher risk of becoming infected with brucellosis due to repeated contact with infected animals. Contact with excretions from infected animals, particularly milk and abortive materials, and inhalation of droplets in the air are the primary transmission routes for occupational brucellosis. Practices that involve handling sharp objects (needles, knives) and needle-stick injuries are common in veterinary practice (Leggat et al., 2009; van Soest and Fritschi, 2004; Weese and Faires, 2009), and veterinary personnel are at risk of accidental exposure to livestock *Brucella* vaccines (Ashford et al., 2004; Berkelman, 2003). The animal vaccine strains are defined among possible pathogens for occupational brucellosis in veterinarians (Young, 1995). In non-occupational brucellosis, the major transmission routes are consumption of raw or unpasteurized milk and other dairy products.

The Animal Brucellosis Control and Eradication Project was initiated in Turkey in 1984. The strains S19 and Rev. 1 vaccines are used for control of brucellosis in cattle and small ruminants; however, brucellosis is still endemic in Turkey (Yumuk and O'Callaghan, 2012). The incidence of human brucellosis in Turkey is 26 per 100,000 (Ministry of Health of Turkey, 2004). The risk factors for laboratory-acquired brucellosis among medical health care workers have been described previously (Ergönül et al., 2004; Sayin-Kutlu et al., 2012). Some case series including veterinary personnel (Ataman-Hatipoglu et al., 2005; Buzgan et al., 2010; Demiroglu et al., 2007; Kaya et al., 2006; Yuce et al., 2006), and *Brucella* serologic prevalence among veterinarians were reported previously (Ergönül et al., 2006; Otlu et al., 2008). However, the risk factors for occupational brucellosis among veterinary personnel were not described in detail. In this retrospective study, we describe the risk factors of occupational brucellosis among veterinarians and veterinary technicians who were actively working in the field.

2. Materials and methods

2.1. Study setting and subjects

The study was conducted between July 2011 and December 2011 among veterinary personnel in 24 out of 81 provinces of Turkey where brucellosis was known to be endemic (Fig. 1). In Turkey, there are about 15,000 veterinarians, of whom about 4000 take place in our study area. The number of veterinarians is equally distributed between the public and private sector, and 15% to 20% of the veterinarians are female. We aimed to contact 15% of the actively working veterinarians in these provinces. The planned sample size of 600 was a minimal sample based on previous studies on the *Brucella* serologic prevalence in professionals in Turkey. In our study we contacted to 595 veterinarians, which is almost 15% of the veterinarians working in 24 out of the 81 provinces of Turkey. Because of the fact that veterinarians and veterinary technicians are equally at risk in their professional activities, the both groups were included in the study. The study was conducted by the members of an occupational infectious diseases study group. The questionnaire was prepared by the group members who were working in different provinces of Turkey and administered in their own provinces. The group members visited the veterinarians and veterinary technicians in their workplaces. The workplaces were randomly selected and enrollment was ended as the target sample size was reached. During their visits group members administered the questionnaire to the veterinary personnel who were present at that time. The study was approved by the Medical Ethics Committee of Pamukkale University.

2.2. Surveying the risk factors for brucellosis

Data was collected through a structured questionnaire that was conducted by face-to-face communication in the offices of the veterinary personnel who were working in food, agriculture, and livestock provincial directorates, veterinary control and research institutes, veterinary faculties, and the private sector. A questionnaire form that was used in our previous studies was modified for use in this study (Ergönül et al., 2006; Sayin-Kutlu et al., 2012). The questionnaire included questions about demographic details, profession, duration of work, department, working with cattle or sheep, use of personal protective equipment (gloves, gowns or other protective wear and masks or goggles), and compliance with safety precautions. We asked about risky practices (vaccine administration, assistance in calving or lambing, and intervention in abortion, preterm delivery, and manual removal of retained placentas) within the last six months. If the respondent had brucellosis, we asked about the risk factors 6 months before the diagnosis. Questions related to the possible source of infection and the possible reasons for development of brucellosis; its signs, symptoms, and their durations; prophylaxis; final outcomes; complications; long-term complaints; and treatment schedules were asked. Questions about exposure to *Brucella* vaccines by needle-stick injuries or splashes to skin or mucosal surfaces among veterinary personnel were included. Infectious disease specialists, who were members of an occupational infectious diseases study group, administered the questionnaires.

2.3. Definitions

The diagnosis of brucellosis which occurred during professional career was based on the self-report of the veterinary personnel. In addition to this, a case of brucellosis was defined as an individual having clinical symptoms and isolation of *Brucella* spp. or *Brucella* agglutination titre >1:160 or at least a fourfold increase in titre within 10 to 14 days. The responder who did not recall or have their details of laboratory investigations referring to brucellosis was excluded from the study. Occupational brucellosis was defined among veterinarians or veterinary technicians who

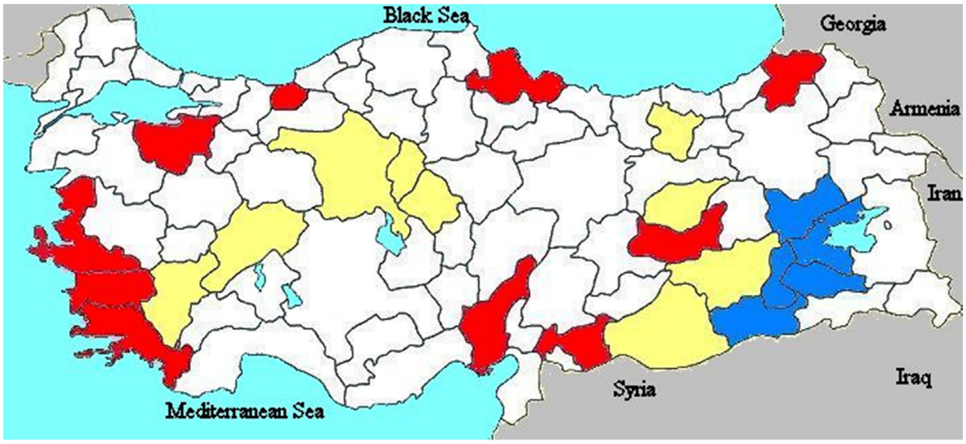

Fig. 1. Incidence density of human brucellosis in the 24 provinces selected for the study and occupational brucellosis prevalence among veterinary personnel in this study. Red, incidence of human brucellosis <10/100,000; yellow, incidence of human brucellosis 10 to 30/100,000; blue, incidence of human brucellosis >30/100,000. Occupational brucellosis prevalence among veterinary personnel (red, 14%; yellow, 9.5%; and blue, 11.3%). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

had brucellosis and no history of ingestion of unpasteurized dairy products, no family history of brucellosis, no domestic animals that could transmit brucellosis, and no suspicion of non-occupational transmission of infection. Family history was also considered because of the potential commonality of food consumption within the family.

2.4. Data analysis

Data were analyzed using Stata Statistical Software, version 11.0 (Stata Corporation, College Station, TX, USA). Comparisons of median for continuous variables were made using non-parametric Kruskal–Wallis test, and categorical variables were compared using the chi-square test or Fisher's exact test for association. Multivariable analysis by logistic regression was performed. All the statistically significant variables in univariate analysis, if not collinear, were selected, and backward elimination was performed. Collinearity was assessed by examining variance inflation factors (VIFs). VIFs > 10 indicate high collinearity. Variables with $p < 0.05$, private practice versus public institutions and universities; gender; number of years since graduation; being involved in delivery; injury during *Brucella* vaccine administration were included in the model. However, occupation (either veterinarian or veterinary technician) and because of their importance in protection use of protective equipment including mask, gown, and gloves were also included in the model, although they had p values greater than 0.05 and logistic regression was applied. Backward elimination of the statistically significant variables was performed. Statistical significance was set at $p < 0.05$.

3. Results

A total of 748 veterinarians and veterinary technicians were surveyed including 595 veterinarians and 153 veterinary technicians. The response rate was high, but 5 participants withdrew from the study. Because of incomplete information, 6 questionnaire forms were excluded. A total of 737 participants were included in the analysis. Of the 737 participants, 643 (87%) were male, and 94 (13%) female. The age range was between 18 and 64 years. Of these, 550 (74.7%) were working at public institutions, 138 (18.7%) in the private sector, and 49 (6.6%) at a university.

Of these 737 participants, 25 non-occupational brucellosis cases were excluded from the analysis because they involved a history of ingestion of unpasteurized dairy products ($n = 21$), family history of brucellosis ($n = 3$), or suspicion of non-occupational transmission of infection ($n = 1$). Of the 712 veterinarians and veterinary technicians, 84 (11.8%) had occupational brucellosis. The demographic characteristics and univariate analysis of risk factors of occupational brucellosis are presented in Table 1.

According to the reports of the cases with occupational brucellosis, contact with infected animal excretions such as placentas, aborted fetuses and newborns, and excretions in conjunction with delivery, milk, or colostrum were the most common transmission routes. A total of 51 (61%) cases had experienced contact with infected animal excretions, including 16 cases of contact and inhalation and 6 cases of contact and percutaneous injury together. The inhalational route and percutaneous injury alone were reported in 5 and 2 cases, respectively. One veterinarian reported laboratory-acquired brucellosis, but the transmission route of the infection was not clear. Injury during *Brucella* vaccine administration and exposure to livestock *Brucella* vaccines were reported by 25 (30%) veterinary personnel.

In multivariable analysis, working in the private sector (odds ratio [OR], 2.8; 95% confidence interval [95% CI], 1.55–5.28, $p = 0.001$), being of male gender (OR, 4.5; 95% CI, 1.05–18.84, $p = 0.041$), number of performed deliveries (OR, 1.01; 95% CI, 1.002–1.02, $p = 0.014$), and injury during *Brucella* vaccine administration (OR, 5.4; 95% CI, 3.16–9.3, $p < 0.001$) were found to be risk factors for occupational brucellosis (Table 2). Working with cattle was excluded from the multivariable analysis model because of its high correlation with occupational brucellosis.

Table 1
Univariate analysis for occupational brucellosis cases among veterinary personnel.

	Occupational brucellosis ($n = 84$)	No brucellosis ($n = 628$)	p
The continuous variables	Median (IQR)	Median (IQR)	
Median age (years)	30 (27–35)	34 (28–41)	<0.001
Median number of years since graduation	7 (4–11)	9 (4–16)	<0.001
Professional activities			
Delivery number in previous six month	3 (0–20)	0 (0–2)	<0.001
Intervention of abortion or preterm delivery number in previous six month	0 (0–5)	0 (0–0)	<0.001
Manual removal of retained placenta number in previous six month	3 (0–20)	0 (0–1)	< 0.001
The categorical variables	n (%)	n (%)	
Male gender	82 (97.6)	536 (86)	0.002
Professional group			0.880
Veterinarian	68 (81)	503 (80)	
Veterinary technician	16 (19)	125 (20)	
Province			0.253
Red, incidence of human brucellosis < 10/100,000	44 (52)	272 (43)	
Yellow, incidence of human brucellosis 10 to 30/100,000	26 (31)	247 (39)	
Blue, incidence of human brucellosis > 30/100,000	14 (17)	109 (18)	
Work place			<0.001
Private sector	32 (38)	100 (16)	
Public institutions	50 (59.6)	481 (76.5)	
University	2 (2.4)	47 (7.5)	
Features of work			
Working with cattle	84 (100)	537 (85.5)	<0.001
Working with sheep	68 (81)	471 (75)	0.327
Administrative work	1 (1.2)	20 (3.2)	0.496
Working with Pets	1 (1.2)	8 (1.3)	1.000
Working with avian	0 (0)	4 (0.6)	1.000
Research activity	2 (2.4)	64 (10.2)	0.016
Injury during vaccine administration	33 (39)	85 (15)	<0.001
Full adherence to personal protective equipment			
Gloves	50 (59.5)	367 (58.4)	0.959
Gown	38 (45.1)	339 (54)	0.105
Mask	1 (1.2)	39 (6.2)	0.058
Goggles	1 (1.2)	12 (1.9)	1.000

Of the 712 participants, 122 (17%) reported that they were exposed to the livestock *Brucella* vaccine during vaccine administration; 70 (57.4%) participants were exposed to the S19 strain and 52 participants were exposed to the Rev. 1 strain. The major type of exposure to livestock *Brucella* vaccines was related to needle-stick injuries ($n = 90$, 74%). Splashes of vaccine material to the conjunctiva occurred in 29 (24%) participants. Skin contact was reported in 3 participants. Most of the exposures occurred during the vaccine injection (82%), although in 9 participants the exposure occurred during preparation of the vaccine. Exposure usually occurred while removing the syringe from the bottle of vaccine; splashes of vaccine material to the conjunctiva occurred in these participants. Most of the participants applied water and/or antiseptic to the exposed region of the body. However, 21 (17%) participants reported no antiseptic action following exposure or injury. One or two antibiotics for prophylaxis after exposure were used 17 participants. Doxycycline ($n = 8$) and doxycycline plus rifampicin ($n = 6$) were frequently used for prophylaxis. The duration of prophylaxis ranged from 10 to 28 days. A post-injury wound infection was developed by 4

Table 2
Multivariable analysis for the risk factors of occupational brucellosis among veterinary personnel.

	Odds ratio	95% Confidence interval	p
Male gender	4.5	1.05–18.84	0.041
Private practice versus public institutions and universities	2.8	1.55–5.28	0.001
Injury during vaccine administration	5.4	3.16–9.3	<0.001
Number of the deliveries	1.01	1.002–1.02	0.014

participants who were treated with antibiotics. Those participants who used antibiotics for prophylaxis or treatment did not report brucellosis following exposure. Of the 122 participants, 104 (85%) used gloves during exposure. However, rates of using protective clothing or gowns, masks, or goggles are very low (5.7%, 4%, and 0.8%, respectively). The lack of personal protective equipment was identified as the major reason for exposure by participants (65%). The second most identified cause of exposure was ignoring the risk (35%). Some veterinarians and veterinary technicians reported that exposure to vaccines was due to sudden movements by animals (19%) and the use of multi-dosage vaccine bottles.

4. Discussion

Brucellosis is one of the most frequent zoonotic infections and is also defined as an occupational risk for veterinary personnel (Baker and Gray, 2009; Henderson et al., 1975; Schnurrenberger et al., 1975). In countries where animal brucellosis is under control, the incidence of occupational brucellosis is very low in veterinary personnel (Epp and Waldner, 2012; Jackson and Villarroel, 2012). In a study of brucellosis in Germany that was conducted between 1995 and 2005, the source of infection was identified in 102 out of 245 cases, the proportion of occupational brucellosis was 18%; and there was only 1 veterinarian within this group (Dahouk et al., 2007). Although a mass vaccination program was initiated in animals in 1984, brucellosis is still endemic among animals in Turkey (Yumuk and O'Callaghan, 2012). Veterinary personnel have a high risk for occupational brucellosis because of the increased probability of contact with infected animals and exposure to Brucella livestock vaccines. Previous reports of case series of occupational brucellosis included only a few veterinary personnel; however, our survey included a significantly high number of veterinary personnel with a high rate of occupational brucellosis (11.8%), and defined the risk factors for occupational brucellosis.

Although the survey was performed on a voluntary basis and no incentive was given to participants, the response rate was high in this study. This high response rate can be attributed to the high level of motivation among veterinary personnel in regard to this serious and common health risk. However, 11 participants were excluded, 5 participants withdrew from the study, 4 participants did not remember some important information, and 2 participants provided contradictory information.

According to the reports of cases with occupational brucellosis, contact with infected animal excretions was the most common transmission route (61%). Inhalation and percutaneous injuries were other transmission routes for zoonotic infections, including occupational brucellosis in veterinary personnel (Jackson and Villarroel, 2012). Ergönül et al. (2006) previously showed that the higher rate of percutaneous injuries is a risk factor for brucellosis in veterinarians.

Performing deliveries was found to be associated with an increased risk of occupational brucellosis. The risk increased with the number of deliveries performed (OR, 1.01; 95% CI, 1.002–1.02, $p = 0.014$). The risk of occupational brucellosis while performing procedures such as delivery and curettage could be related to the presence of high levels of bacteria associated with the placenta and excretions of infected animals (Doganay and Aygen, 2003; Yumuk and O'Callaghan, 2012). Brucellosis was reported to be significantly associated with assisting during abortion or parturition in endemic countries (John et al., 2010; Mukhtar, 2010).

Working in the private sector was found to be one of the risk factors in multivariable analysis. This could be explained by the examination of higher numbers of animals, which involves a higher risk of exposure to the infection, as has been reported previously (Epp and Waldner, 2012; Jackson and Villarroel, 2012). The proportion of cases in the private sector was also increased by recent privatization policies in Turkey. Veterinary personnel working in private practice are more commonly involved in the treatment of sick animals, whereas veterinary personnel working in the public sector more often work in the area of preventive measures.

Veterinary medicine is still a male-dominated profession in Turkey, unlike in developed countries. In our study, although the proportion of female veterinary personnel was lower (13%), male veterinary personnel were found to be at greater risk of occupational brucellosis than females. Being male was also significantly associated with a low precaution-awareness ranking among veterinarians (Wright et al., 2008). In our study, 91% of male versus 65% of female veterinary personnel were working with cattle ($p < 0.001$). Working with cattle predicted brucellosis perfectly and accordingly was not included in the multivariable analysis.

The median age of the veterinary personnel with occupational brucellosis was younger in our series. Some authors have reported that zoonotic infections were detected more commonly among younger age groups (Gummow, 2003; Jackson and Villarroel, 2012). The rate of full adherence to personal protective equipment, which protects against contact with infected animals or materials, was not lower in the occupational brucellosis group. Approximately half of all participants reported full adherence to the use of gloves and gowns. However, the rates for the use of masks and protective eye equipment were very low (4.8%, and 1.8%, respectively). Wright et al. (2008) reported that veterinarians have a lower rate of hand washing and use of appropriate personal protective equipment in the United States.

The vaccine strains *B. abortus* S19 and *B. melitensis* Rev. 1 are used for control of animal brucellosis in Turkey. These strains may cause brucellosis in humans, although their virulences are low (Blasco and Díaz, 1993; Karakas et al., 2012; Wallach et al., 2008). Of the 712 participants in our study, 122 (17%) reported that they were exposed to the livestock *Brucella* vaccine in their professional lives. Needle-stick injuries and accidental inoculation of livestock *Brucella* vaccines are common in veterinary practice (Langley et al., 1995; Pivnick et al., 1966). The method of exposure to *Brucella* vaccines was needle-stick injuries in 90 (74%) veterinary personnel in our study. The exposure of livestock *Brucella* vaccines to conjunctiva was found more frequently than we expected in our series ($n = 29$, 24%). Ashford et al.

(2004) reported conjunctival exposure of 15% in people who were exposed to the RB51 strain. Facial protection prevents exposure of mucous membranes of the eyes, nose, and mouth to infectious materials (Scheftel et al., 2010). Unfortunately, the participants in our study had a very low rate of using personal protective equipment including masks and goggles. The importance of the inhalation route is known for laboratory-acquired brucellosis (Sayin-Kutlu et al., 2012; Yagupsky and Baron, 2005). Exposure to *Brucella* vaccine strains via inhalation and the associated development of brucellosis may also easily go unnoticed by veterinary personnel working in the field. Exposure via inhalation was reported in two outbreaks by Rev. 1 and S19 strains in vaccine production facilities (Ollé-Goig and Canela-Soler, 1987; Wallach et al., 2008).

We had some limitations in our study. The proportion of veterinary personnel working in the private sector was lower than in the public sector. However, we still had a satisfactory number of veterinary personnel working in the private sector, so that their risk of occupational brucellosis was significantly detected in multivariable analysis. Since this study was retrospective, the recall bias was one of the limitations. We tried to overcome this limitation by performing the survey face to face and thus had the opportunity to detect inconsistencies. Inconsistent responses about the course of the disease, laboratory results, and treatment were excluded from the study.

In conclusion, having a satisfactory sample size, this study emphasize that brucellosis is still an occupational disease among veterinarians in Turkey as an endemic country. Male gender, injury during *Brucella* vaccine administration, working in the private sector, and performing risky procedures such as deliveries were found to be risk factors for the development of occupational brucellosis. We suggest that all veterinary personnel should be trained on brucellosis and how to avoid it through the use of personal protective equipment.

Conflict of interest statement

All authors declare that they have no conflict of interest.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.prevetmed.2014.07.010.

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