



# Brucellosis Awareness and Knowledge: A Single Center Study From Eastern Anatolia

## Bruselloz Farkındalığı ve Bilgi Düzeyi: Doğu Anadolu'dan Tek Merkez Çalışması

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### ABSTRACT

**Aim:** Brucellosis is a zoonotic disease prevalent in Turkey. The aim of this study is to assess the knowledge level about brucellosis and to lay the groundwork for necessary preventive measures.

**Materials and Methods:** This study was conducted over a six-month period at a single state hospital's infectious diseases outpatient clinic. Volunteers who met the inclusion criteria completed a questionnaire. Participation was grouped into those involved in animal husbandry, healthcare workers, and others. Scores were assigned based on responses to the questionnaire.

**Results:** The study included a total of 400 participation, of which 191 (47.8%) were female and 209 (52.2%) were male. The most common occupation was animal husbandry [88 (22%)]. The majority of participation [246 (61.5%)] resided in the provincial capital. Healthcare workers exhibited the highest awareness of brucellosis (93.1%). Seminars were identified as the most important source of information for healthcare workers (72.2%), while personal experience with the disease was most common among those involved in animal husbandry (15.4%). University graduates demonstrated higher awareness levels. Those who had experienced brucellosis, seminars, the internet, and television were identified as more accurate sources of information.

**Conclusion:** In the face of increasing global zoonotic diseases, raising awareness within the framework of the one health concept is essential. Measures such as vaccination, isolation, and waste control should be emphasized for brucellosis prevention in animals. The importance of consuming pasteurized dairy products should be emphasized. Correct information should be disseminated through platforms such as seminars, the internet, and television.

**Keywords:** Brucellosis, livestock, One Health

### ÖZ

**Amaç:** Bruselloz zoonotik bir hastalıktır. Türkiye endemik bölgede yer almaktadır. Amacımız bruselloz hakkında bilgi düzeyini ölçmek ve önlem amacıyla gereken faaliyetler için zemin hazırlamaktır.

**Gereç ve Yöntem:** Çalışma altı aylık periyotta tek merkez devlet hastanesinde enfeksiyon hastalıkları polikliniğinde, dahil edilme kriterlerini karşılayan gönüllülerle anket doldurularak yapıldı. Katılımcılar hayvancılıkla uğraşanlar, sağlık çalışanları ve diğerleri olacak şekilde gruplara ayrıldı. Anket sorularına verilen cevaplara göre puanlama yapıldı.

**Bulgular:** Çalışma 191'i (%47,8) kadın, 209'u (%52,2) erkek toplam 400 kişi ile yapıldı. En sık meslek grubu 88 (%22) kişi ile hayvancılıkla uğraşanlardı. En sık katılım 246 (%61,5) kişi ile il merkezindendi. Sağlık çalışanlarında (%93,1) brusellozu duyma oranı en yüksekti. Sağlık çalışanlarında en önemli bilgi kaynağı seminerler (%72,2), hayvancılıkla uğraşanlarda ise hastalığı geçirmek (%15,4). Puanlama sonucunda sağlık çalışanları en farkında olan grup olarak tespit edildi. Üniversite mezunlarının farkındalığının daha yüksek olduğu tespit edildi. Brusellozun bilgi kaynakları arasında hastalığı geçiren kişiler, seminerler, internet ve televizyon daha doğru kaynaklar olarak tespit edildi.

**Sonuç:** Küreselleşen dünyada artan zoonotik hastalıklarla mücadele için Tek Sağlık kavramı çerçevesinde farkındalığın artırılması gerekmektedir. Hayvanlarda brusellozu önlemek amacıyla gereken aşılama, izolasyon önlemleri, atık kontrolü tedbirleri anlatılmalı ve enfekte hayvan bildirimleri eksiksiz yapılmalıdır. Süt ve süt ürünlerinin pastörize edilmeden tüketilmemesi gerektiği vurgulanmalıdır. Doğru bilginin aktarılması için seminer, internet ve televizyon gibi platformlar kullanılmalıdır.

**Anahtar Kelimeler:** Bruselloz, hayvancılık, Tek Sağlık

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## INTRODUCTION

Brucellosis is a zoonotic disease primarily hosted by animals including cattle, sheep, goats, and pigs, with humans serving as incidental hosts<sup>1</sup>. Brucellosis is caused by Gram-negative, facultative, intracellular *Coccobacilli* belonging to the *genus brucella*. There are basically four types that cause the disease in humans, *Brucella abortus*, *Brucella melitensis*, *Brucella suis* and *Brucella canis*<sup>2</sup>. The most common species in Turkey is *Brucella melitensis*, which is found in goats and sheep. Between 150,000 to 250,000 human brucellosis cases are reported globally each year<sup>3</sup>. The Mediterranean basin countries are among the regions where the disease is endemic, and Turkey is situated within this region<sup>4</sup>. In our country, it is most frequently observed in Southeastern and Eastern Anatolia<sup>5</sup>.

The routes of transmission to humans often involve the consumption of raw or unpasteurized milk and dairy products, direct contact of skin or mucous membranes with infected animal tissues and fluids, or inhalation of infected aerosols<sup>6</sup>. *Brucella* species can survive for 2-6 weeks in raw milk, 6 weeks in cream at 4 °C, 30 day in ice cream, and 15-100 days in fresh cheese. Contamination can be prevented by boiling milk and dairy products, as well as thoroughly cooking meat. Human-to-human transmissions are rare. The clinical symptoms include fever, chills, headache, myalgia, arthralgia, night sweats, fatigue, anorexia, and weight loss. Depending on organ involvement, symptoms may develop in the relevant region<sup>7</sup>.

Diagnosis of brucellosis involves blood, tissue, and bone marrow cultures, along with serological tests such as rose bengal, wright tube agglutination, and coombs agglutination. Due to its intracellular location, treatment is challenging, necessitating the use of combination antibiotics for at least six weeks. Prolonged organ involvement may require an extended treatment duration<sup>8</sup>.

The concept of One Health, which highlights the necessity of various professional groups working together to combat the increasing zoonotic diseases in a globalizing world, signifies the holistic approach of addressing humans, animals, and the environment together. To control brucellosis in animals, screening should be performed, susceptible animals should be vaccinated, and the infected animals should be slaughtered. Controlling brucellosis in animals is essential for mitigating the disease in humans. Pasteurization processes and class II and III biosafety cabinet precautions should be taken in laboratories<sup>9</sup>.

The aim of our study was to assess the level of knowledge regarding brucellosis, a prevalent disease in the region, and to pave the way for essential preventive measures based on the findings obtained.

## MATERIALS AND METHODS

### Selection and Description of the Cases

This study was conducted with individuals in the infectious diseases outpatient clinic at a single-center hospital between October 1, 2023, and March 31, 2024. Participants who were literate and voluntary were included in the study. A cross-sectional study was conducted employing a survey methodology. Participants were requested to complete the survey within approximately 10-15 minutes. The person's identity was kept confidential. Non-voluntary people were not included in the study. Informed consent was obtained from all participants who volunteered for the study. The study was conducted after obtaining the necessary permissions from Ağrı İbrahim Çeçen University Ethics Committee (decision no: E-95531838-050.99-83962, date: 06.10.2023).

### Technical Information

The survey comprised 20 questions assessing participants' demographic information, status, and knowledge of brucellosis. Additionally, individuals engaged in animal husbandry were presented with a supplementary form containing 12 questions. The survey results were summarized out of 17 full points, with 1 point given for correct answers and 0 points given for wrong answers and answers without information. Participants were categorized into groups such as healthcare workers, livestock workers, and others.

### Statistical Analysis

Based on a power analysis utilizing 2017 brucellosis incidence data, the sample size was determined to be 384 individuals, and ultimately, 400 participants were included in the study. Descriptive statistics, including mean or median values for continuous variables and number (n) and percentage (%) values for categorical variables, were utilized for data presentation. The Shapiro-Wilk test assessed the normality of numerical variables. For normally distributed variables, independent group t-tests were employed for between-group comparisons, while the Mann-Whitney U and Kruskal-Wallis tests were utilized for variables not adhering to normal distribution. Categorical variables were compared using the chi-square test. Statistical analyses were conducted using the SPSS 26 Windows version program, with results considered statistically significant at  $p < 0.05$ .

## RESULTS

A total of 400 people who met the inclusion criteria were included in this study. Of the participants, 191 (47.8%) were women and 209 (52.2%) were men, and the mean age was 35.7 ( $\pm 12$ ) years. 33 (8.2%) participants had no formal education, 97 (24.3%) were primary school graduates,

49 (12.2%) had completed middle school, 89 (22.3%) were high school graduates, and 132 (33%) were university graduates. Regarding occupation, 88 (22%) participants were involved in animal husbandry, 86 (21.5%) were housewives, and 64 (16%) were blue-collar workers. In Table 1, the demographic data of the participants are provided by dividing them into groups.

It was determined that the most frequent application was from the city center with 246 (61.5%) participants, followed by Diyadin district with 47 (11.8%) participants, and Taşlıçay district with 25 (6.3%) participants. The participants' places of residence are listed in Table 2. Participants' answers to the survey questions are presented in Table 3.

Among the participants, 86.3% had heard of brucellosis. The rate of hearing about brucellosis was higher among

healthcare (93.1%) and livestock workers (90.9%) ( $p=0.000$ ). When information sources were compared between the groups, it was found that the most significant source of information for healthcare professionals (72.2%) was learning through seminars ( $p=0.000$ ). The most important source of information for those involved in animal husbandry (15.4%) was learning about the disease through experience ( $p=0.000$ ). The rate of knowledge about animal-to-animal transmission was higher among those engaged in animal husbandry (43.2%) ( $p=0.000$ ).

It was found that individuals involved in animal husbandry were more likely to believe that yogurt (38.6%) and Kashar cheese (23.9%) were contaminated ( $p=0.027$ ,  $p=0.042$ ), compared to other groups. Additionally, healthcare workers

**Table 1. Demographic data of participants**

Groups	All participants	Husbandry	Healthcare workers	Others
<b>n (%)</b>	400 (100%)	88 (22%)	29 (7.3%)	283 (70.7%)
<b>Age mean (ss)</b>	35.76 ( $\pm 12$ )	38.98 ( $\pm 12.2$ )	23.83 ( $\pm 6.8$ )	35.98 ( $\pm 11.7$ )
<b>Gender (n, %)</b>				
Female	191 (47.8%)	31 (35.2%)	19 (65.5%)	141 (49.8%)
Male	209 (52.2%)	57 (64.8%)	10 (34.5%)	142 (50.2%)
<b>Education (n, %)</b>				
No education	33 (8.2%)	9 (10.2%)		24 (8.5%)
Primary school	97 (24.3%)	40 (45.5%)		57 (20.1%)
Middle school	49 (12.2%)	12 (13.6%)		37 (13.1%)
High school	89 (22.3%)	22 (25%)	12 (41.4%)	55 (19.4%)
University	132 (33%)	5 (5.7%)	17 (58.6%)	110 (38.9%)
<b>Occupation (n, %)</b>				
Animal husbandry	88 (22%)	88 (100%)		
Housewife	86 (21.5%)			86 (30.3%)
White-collar	64 (16%)			64 (22.7%)
Blue-collar	62 (15.5%)			62 (21.9%)
Student	32 (8%)			32 (11.3%)
Healthcare worker	29 (7.3%)		29 (7.3%)	
Retired	8 (2%)			8 (2.9%)
Unknown	31 (7.7%)			31 (10.9%)

**Table 2. Residence of participants**

Groups	All participants	Husbandry	Healthcare workers	Others
<b>n (%)</b>	400 (100%)	88 (22%)	29 (7.3%)	283 (70.7%)
City center	246 (61.5%)	33 (37.5%)	26 (89.8%)	187 (66.1%)
Diyadin	47 (11.8%)	18 (20.5%)	1 (3.4%)	28 (9.9%)
Taşlıçay	25 (6.3%)	13 (14.8%)	1 (3.4%)	11 (3.9%)
Hamur	22 (5.4%)	9 (10.2%)		13 (4.5%)
Doğubayazıt	19 (4.7%)	3 (3.4%)		16 (5.7%)
Eleşkirt	15 (3.7%)	6 (6.8%)		9 (3.2%)
Tutak	11 (2.8%)	6 (6.8%)		5 (1.8%)
Neighboring province	9 (2.3%)		1 (3.4%)	8 (2.8%)
Distant province	6 (1.5%)			6 (2.1%)

<b>Table 3. Answers to survey questions</b>				
<b>Groups</b>	<b>All participants</b>	<b>Husbandry</b>	<b>Healthcare workers</b>	<b>Others</b>
<b>n (%)</b>	400 (100%)	88 (22%)	29 (7.3%)	283 (70.7%)
<b>Heard of brucellosis</b>	345 (86.3%)	80 (90.9%)	27 (93.1%)	238 (84.1%)
<b>Information source</b>				
Respondents	265 (100%)	65 (24.5%)		182 (68.7%)
Seminar	29 (10.9%)	1 (1.5%)	18 (6.8%)	15 (8.2%)
Relatives	62 (23.4%)	13 (20%)	13 (72.2%)	46 (25.3%)
Public	122 (46%)	32 (49.2%)	3 (16.7%)	90 (49.6%)
Family	21 (7.9%)	4 (6.2%)		17 (9.3%)
I had the disease	18 (6.8%)	10 (15.4%)		8 (4.4%)
Internet, TV	12 (4.6%)	5 (7.7%)	2 (11.1%)	5 (2.7%)
Public education	1 (0.4%)			1 (0.5%)
<b>Does it cause disease in humans?</b>				
Yes	273 (68.3%)	59 (67%)	21 (72.4%)	193 (68.2%)
No	11 (2.8%)	4 (4.5%)		7 (2.5%)
No idea	116 (29%)	25 (28.4%)	8 (27.6%)	83 (29.3%)
<b>Is it transmitted from animals to humans?</b>				
Yes	252 (63%)	61 (69.3%)	23 (79.3%)	168 (59.4%)
No	11 (2.8%)	3 (3.4%)		8 (2.8%)
No idea	137(34.3%)	24 (27.3%)	6 (20.7%)	107 (37.8%)
<b>Is it transmitted between animals?</b>				
Yes	96 (24%)	38 (43.2%)	7 (24.1%)	51 (18%)
No	28 (7%)	4 (4.5%)	6 (20.7%)	18 (6.4%)
No idea	276 (69%)	46(52.3%)	16 (55.2%)	214 (75.6%)
<b>Can it be transmitted between people?</b>				
Yes	70 (17.5%)	18 (20.5%)	11 (37.9%)	41 (14.5%)
No	90 (22.5%)	22 (25%)	7 (24.2%)	61 (21.5%)
No idea	240 (60%)	48 (54.5%)	11 (37.9%)	181 (64%)
<b>Which animals transmit it?</b>				
Cattle, sheep, goat	258 (64.5%)	59 (67%)	20 (69%)	179 (63.3%)
Poultry	19 (4.7%)	6 (6.9%)	4 (13.9%)	9 (3.2%)
Bee	4 (1%)	1 (1.1%)		3 (1.1%)
Aquatic	20 (5%)	5 (5.7%)	1 (3.4%)	14 (4.9%)
No idea	124 (31%)	26 (29.5%)	7 (24.1%)	91 (32.2%)
<b>Ways of transmission</b>				
Raw milk	223 (55.8%)	44 (50%)	22 (75.9%)	157 (55.5%)
Raw dairy products	191 (47.8%)	40 (45.5%)	17 (58.6%)	134 (47.3%)
Yogurt	116 (29%)	34 (38.6%)	11 (37.9%)	71 (25.1%)
Kashar cheese	64 (16%)	21 (23.9%)	2 (6.9%)	41 (14.5%)
Animal waste	94 (23.5%)	21 (23.9%)	11 (37.9%)	62 (21.9%)
Abort material	72 (18%)	18 (20.5%)	10 (34.5%)	44 (15.5%)
Undercooked meet	97 (24.3%)	19 (21.6%)	12 (41.4%)	66 (23.3%)
Laboratory	34 (8.5%)	4 (4.5%)	7 (24.1%)	23 (8.1%)
No idea	113 (28.3%)	27 (30.7%)	4 (13.8%)	82 (29%)
<b>Symptoms</b>				
Fever	120 (30%)	21 (23.9%)	18 (62.1%)	81 (28.6%)
Sweating	120 (30%)	32 (36.4%)	7 (24.1%)	59 (20.8%)
Muscle/joint pain	183 (45.8%)	44 (50%)	18 (62.1%)	120 (42.4%)
Back pain	84 (21%)	28 (31.8%)	10 (34.5%)	45 (15.9%)
Jaundice	30 (7.5%)	6 (6.8%)	4 (13.8%)	20 (7.1%)
No idea	178 (44.5%)	34 (38.6%)	9 (31%)	135 (47.7%)

**Table 3. Continued**

Groups	All participants	Husbandry	Healthcare workers	Others
<b>Can contamination be prevented by boiling milk?</b>				
Yes	162 (40.5%)	32 (36.4%)	16 (55.2%)	114 (40.3%)
No	27 (6.8%)	9 (10.2%)	2 (6.9%)	16 (5.7%)
No idea	211 (52.7%)	47 (53.4%)	11 (37.9%)	153 (51%)
<b>Can brucellosis be treated?</b>				
Yes	276 (69%)	62 (70.5%)	21 (72.4%)	193 (68.2%)
No	4 (1%)	3 (3.4%)		1 (0.4%)
No idea	120 (30%)	23 (26.1%)	8 (27.6%)	89 (31.4%)
<b>Is there a vaccine for animals?</b>				
Yes	142 (35.5%)	48 (54.5%)	11 (37.9%)	83 (29.3%)
No	7 (1.8%)	2 (2.3%)	1 (3.4%)	4 (1.4%)
No idea	251 (62.8%)	38 (43.2%)	17 (58.6%)	196 (69.3%)
<b>Is there a vaccine for humans?</b>				
Yes	82 (20.5%)	25 (28.4%)	6 (20.7%)	51 (18%)
No	19 (4.8%)	2 (2.3%)	4 (13.8%)	13 (4.6%)
No idea	299 (74.8%)	61 (69.3%)	19 (65.5%)	219 (77.4%)

demonstrated greater awareness of contamination risks in laboratory environments (24.1%) ( $p=0.004$ ).

It was found that individuals working in animal husbandry (54.5%) were significantly more knowledgeable about animal vaccination ( $p=0.000$ ), whereas healthcare professionals (13.8%) were more aware of the absence of vaccines for humans ( $p=0.031$ ).

The answers to supplementary survey questions from participants involved in animal husbandry are presented in Table 4.

After scoring the answers provided by participants, the average score for healthcare workers was determined to be  $8.66 \pm 0.9$  out of 17 points,  $7.16 \pm 0.4$  for those engaged in animal husbandry, and  $6.26 \pm 0.2$  for the other group. A comparison between the groups revealed that healthcare workers (median 9) achieved higher scores compared to the other groups (median 6) ( $p=0.012$ ).

Analyzing the impact of educational status on survey scores, it was found that university graduates (median 8) attained higher scores compared to high school graduates (median 7) and middle school graduates (median 4) ( $p=0.020$ ,  $p=0.000$ ), which indicated a significant difference.

When examining the influence of the information source on brucellosis on survey scores, individuals whose relatives had brucellosis (median 9), those who had the disease themselves (median 11), those who obtained information from media sources such as the internet and television (median 9), and those who attended seminars (median 10) tended to score higher compared to those who learned about the disease from their family (median 6) ( $p=0.009$ ,  $p=0.000$ ,  $p=0.040$ ,  $p=0.003$ ). Moreover, individuals with relatives affected by brucellosis (median 9), those who had the disease themselves (median 11),

and those who attended seminars (median 10) achieved higher scores than individuals who learned about the disease from public awareness (median 7) ( $p=0.001$ ,  $p=0.000$ , and  $p=0.001$ , respectively).

## DISCUSSION

Brucellosis, which is endemic in our country, continues to be a serious public health problem. In the study by Hull et al.<sup>10</sup> in 2018, the incidence of human brucellosis in Turkey was determined as 49.5 per 1,000,000, which was above the world average. According to 2017 Ministry of Health data, the incidence of brucellosis in Ağrı was 19 per 100,000<sup>11</sup>. The aim of our study was to measure the level of knowledge about brucellosis and to prepare the ground for the necessary activities for prevention.

In the study conducted by Alkan et al.<sup>12</sup> in 2022, it was found that 95.6% of individuals living in rural areas had heard about brucellosis. Similarly, Avcı et al.<sup>13</sup> 2017 study reported a rate of 98.5% among residents of a village settlement in Van province. Özen et al.<sup>14</sup>, in 2020, found that 79.6% of hospital employees had heard about brucellosis. In contrast, Akkuş et al.<sup>15</sup> 2011 study reported a lower rate of 66% among individuals engaged in animal husbandry, while Babaoğlu et al.<sup>16</sup> 2017 study found a rate of 65.2% among those living in semi-urban areas. Notably, in the same study, the rate of awareness about brucellosis was significantly higher among high-risk professional groups such as veterinarians, agricultural engineers, and farmers ( $p=0.010$ ). Additionally, awareness of brucellosis increased with the level of education ( $p=0.010$ )<sup>16</sup>. In our study, the rates of having heard about brucellosis were 90.9% among livestock workers, 93.1% among healthcare workers, and 86.3% overall. As a result of the survey scoring, the highest scores were received by healthcare workers, followed by those dealing with animal



<b>Table 4. Husbandry survey questions</b>	
	<b>Husbandry</b>
<b>n (%)</b>	88 (22%)
<b>Owned animals</b>	
Cattle	51 (58%)
Sheep	40 (45.5%)
Others	7 (7.8%)
<b>Use of protective equipment</b>	
Glass	7 (8%)
Glove	67 (76.1%)
Mask	27 (30.7%)
Boot	34 (38.6%)
Apron	22 (25%)
No precautions required	12 (13.6%)
<b>Approach to animal waste</b>	
Bury	10 (11.4%)
Throwing waste to a distant place	29 (33%)
Incinerating waste	28 (31.8%)
Make fertilizer	31 (35.2%)
Throwing waste away	15 (17%)
Giving it to stray animals	6 (6.8%)
<b>What do you do about the membrane that grows after birth?</b>	
Bury	32 (36.4%)
Throwing waste to a distant place	22 (25%)
Incinerating waste	3 (3.4%)
Making fertilizer	1 (1.1%)
Throwing waste away	22 (25%)
Giving it to stray animals	32 (36.4%)
<b>How do you clean up animal waste?</b>	
Water	51 (58%)
Lime	34 (38.6%)
Detergent	10 (11.4%)
<b>Abortion</b>	55 (62.5%)
<b>Separating the animal that had an abortion from the herd</b>	39 (44.3%)
<b>Consuming the milk/meat of an animal that has had an abortion</b>	35 (39.8%)
<b>Giving milk from an animal that has had an abortion to a calf</b>	33 (37.5%)
<b>What do you do to a sick animal?</b>	
Treat it myself	15 (17%)
Call the vet	78 (88.6%)
Slaughter it for its meat	1 (1.1%)
Nothing	2 (2.3%)
<b>Getting vaccinated against brucellosis</b>	60 (68.2%)
<b>What is your reason for not getting the brucellosis vaccine?</b>	
Couldn't find the vaccine	8 (28.5%)
Vaccine side effects	7 (25%)
It doesn't work	4 (14.3%)
Expensive	9 (32.2%)

husbandry. The results were interpreted as those who received training on the subject and those in the risk group were more conscious.

When examining the sources of information about brucellosis, Alkan et al.<sup>12</sup> found that 62.4% relied on information from relatives, neighbors, or families. Avcı et al.<sup>13</sup> reported that 36.4% obtained information from healthcare workers, 24.2% from neighbors, and 19.7% from family members or friends. Özen et al.<sup>14</sup> found that 30.8% received information from friends, relatives, and neighbors, and 20.93% from television, radio, and newspapers. In Babaoğlu et al.<sup>16</sup> study, 45.6% relied on relatives or neighbors. In our study, participants accessed information through various channels, with 46% obtaining it publicly, 23.4% through a relative who had the disease, 10.9% through seminars, 7.9% within the family, and 4.6% through the internet or television. Healthcare professionals primarily relied on seminars, while individuals involved in animal husbandry relied on their own experiences with the disease. In terms of survey scoring, obtaining information from individuals having experienced the disease, learning through seminars, and accessing information via the Internet or television yielded better results compared to learning from public sources or within the family. We believe that in order to raise public awareness and combat misinformation, media platforms such as the Internet and television should be utilized, and awareness-raising events should be organized.

The main hosts for *Brucella* are animals, such as cattle, sheep, goats, and pigs, and humans are incidental hosts. Transmission occurs between animals, but transmission between humans is rare<sup>1</sup>. According to 2022 data, Ağrı Province is Turkey's fourth-largest province with a meadow-pasture area and it ranks 14<sup>th</sup> in the presence of cattle and 11<sup>th</sup> in the presence of small ruminants<sup>17</sup>. In terms of awareness of zoonotic transmission, Akkuş et al.<sup>15</sup> reported a rate of 49.5%, while Babaoğlu et al. reported a rate of 29.4%<sup>16</sup>. Additionally, Babaoğlu et al.<sup>16</sup> reported animal-to-animal transmission at 19.1%, while Akkuş et al. reported that 36.1% of cases were transmitted from person to person<sup>15</sup>. In our study, the rate was 63% for the awareness of zoonotic transmission, 24% for the transmission between animals, and 17.5% for human-to-human transmission. Notably, awareness of zoonotic contamination was higher among individuals engaged in animal husbandry.

In a meta-analysis conducted by Zhang et al.<sup>18</sup>, the main route of transmission in endemic countries is unpasteurized milk and dairy products, and in developed countries, it has been shown to be more common through contact and inhalation. In a study by Özen et al.<sup>14</sup>, the mode of disease transmission was identified as follows: 49% through the consumption of unboiled milk, 20% through the raw or undercooked consumption of red meat or offal products, 18% through direct contact with animals such as sheep, goats, and cows, and 12% through yoghurt. Furthermore, the study found that the awareness of contamination risk from raw or

undercooked red meat increased with education level ( $p=0.036$ ). In the same study, when participants were asked if the disease could be transmitted through consuming unboiled milk, 35.7% of those with a primary school education or lower, 25% of those with a middle school education, and 47.2% of those with a high school education and above reported contamination ( $p=0.038$ ). In a study by Akkuş et al.<sup>15</sup>, it was reported that 32% of transmissions occurred through contact with raw milk and dairy products during animal birthing, while 44.3% were attributed to the consumption of raw milk and dairy products. In our study, the transmission routes for the disease were identified as follows: consumption of raw milk (55.8%), consumption of products produced from raw milk (47.8%), consumption of raw or undercooked meat (24.3%), contact with animal abort material (18%), direct contact with animal excretions (23.5%), and laboratory exposure (8.5%). Participants who believed contamination could occur with kashar cheese accounted for 16%, while those who expressed concern about contamination with yogurt were 29%. Furthermore, it was observed that individuals working in animal husbandry were more likely to believe they could be infected by consuming yogurt and kashar cheese. Healthcare workers demonstrated higher awareness regarding laboratory contamination. It is important to emphasize that the pathogenicity of the agent diminishes during the production stages of yogurt and kashar cheese, thereby mitigating the risk of contamination<sup>19</sup>. Upon evaluating survey scores for brucellosis awareness, it was noted that university graduates exhibited a higher level of awareness compared to individuals with high school or middle school education.

Animal vaccines are available for brucellosis; however, there is currently no vaccine available for human use<sup>20</sup>. In Özen et al.<sup>14</sup> study, the awareness of animal vaccines was reported to be 5.8%. In our study, we found that 35.5% of participants were aware of animal vaccines, while only 4.8% were aware that there was no vaccine available for humans. Notably, individuals involved in animal husbandry demonstrated higher awareness regarding animal vaccinations compared to other groups. This finding underscores the importance of informing those engaged in animal husbandry about the significance of vaccination in preventing zoonotic transmission. By educating this group about protective measures, we can potentially mitigate the risk of zoonotic disease transmission.

The control of brucellosis in humans entails several measures, including controlling brucellosis in animals, ensuring the pasteurization of milk and dairy products before consumption, and preventing laboratory-borne contamination<sup>21</sup>. Treatment is not recommended for animal brucellosis due to economic concerns and the inability to prevent carriage. Instead, the primary focus of managing animal brucellosis is prevention. Key prevention methods include the use of protective equipment such as gloves, glasses, and aprons, maintaining good hygiene practices, isolating infected animals from the herd, and implementing vaccination programs<sup>22</sup>. All waste from animals giving birth and the feed they come into contact with should

be buried deeply, with unburnt lime poured on it or destroyed by burning. Consequently, animals diagnosed with brucellosis should not be sold. Additionally, new animals introduced to the herd should undergo testing for brucellosis and, if necessary, be vaccinated<sup>23</sup>. In Özen et al.<sup>14</sup> study, 58.3% of participants reported taking contact precautions. In our study, 76.1% of participants believed that gloves should be used as a precaution, while 38.6% thought boots should be used. Only 13.6% expressed the belief that pre-contact precautions were unnecessary.

In Alkan et al.<sup>12</sup> study, 55.8% of participants reported burying animal waste, while in Babaoğlu et al.<sup>16</sup> study, this figure was 69.3%. In the study by Babaoğlu et al.<sup>16</sup>, 15.9% of participants reported throwing away animal waste. Additionally, the abortion rate in the same study was 40.7%. In the present study, the abortion rate was found to be 62.5%. Waste management practices reported by participants included making waste into fertilizer (35.2%), throwing waste to a distant place (33%), incinerating waste (31.8%), throwing waste away (17%), and burying waste (11.4%). Additionally, 58% of respondents reported treating waste with water, while 38.6% used the liming method. These findings suggest that awareness of waste management may be insufficient, particularly in environments with high abortion rates. There is a need for improvement in waste management approaches for animal waste infected with *Brucella* beyond burying, lime pouring, and burning.

Alkan et al.<sup>12</sup> reported that 40.9% of participants preferred to slaughter and eat infected animals, whereas Avcı et al.<sup>13</sup> found this percentage to be 77.2%. Additionally, in the same study, the veterinarian's infection rate was determined to be 7.6%. In our study, it was found that 44.3% of participants separated infected animals from the herd, while 39.8% consumed the meat or milk of infected animals, and 37.5% fed the milk of infected animals to calves. Only 1.1% preferred to slaughter and eat infected animals. The rate of animals being taken to the veterinarian was found to be 88%. These findings underscore the importance of emphasizing isolation in the fight against brucellosis in animals and avoiding the consumption of infected animals and their products. Collaboration with veterinarians is crucial for implementing correct approaches, notifications, and raising awareness about the current situation.

Alkan et al.<sup>12</sup> reported a vaccination rate of 59.7% in animals, while Avcı et al.<sup>13</sup> reported it as 20%. In our study, the animal vaccination rate was found to be 68.2%. Among participants who did not receive the vaccine, 32.2% cited cost as the reason, 28.5% mentioned difficulty in finding the vaccine, 25% expressed concerns about vaccine side effects, and 14.3% believed the vaccine to be ineffective. The continued endemic status of the disease suggests that vaccination rates remain insufficient. It is crucial to provide necessary information about vaccination and encourage its uptake, while simultaneously ensuring that vaccines are affordable and accessible.

## Study Limitations

The main limitations of our study include the inability to perform parametric analyses due to a decrease in participant numbers when grouping patients. There is a need for future studies with more homogeneous participant groups and larger populations. Additionally, the lack of a standard scale for measuring brucellosis awareness led us to create our survey form based on data from the literature review. Moreover, constraints such as time and financial limitations prevented us from conducting fieldwork, limiting our study to participants who visited the outpatient clinic. As a result, we were unable to provide information regarding seroprevalence.

## CONCLUSION

Under the framework of One Health, the integration of human, animal, and environmental health is essential. To prevent brucellosis in animals, attention should be paid to necessary vaccination, hygiene conditions, isolation measures, waste control, and complete reporting of infected animals. Moreover, it is essential to emphasize the importance of pasteurization for milk and dairy products to prevent transmission. Raising awareness about the disease is paramount to mitigate workforce and economic losses associated with brucellosis. This can be achieved through educational initiatives delivered via various platforms such as seminars, the Internet, and television. It is imperative to prevent the propagation of incorrect attitudes and behaviors through social learning and to provide accurate information to the public.

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## Ethics

**Ethics Committee Approval:** The study was conducted after obtaining the necessary permissions from Ağrı İbrahim Çeçen University Ethics Committee (decision no: E-95531838-050.99-83962, date: 06.10.2023).

**Informed Consent:** Informed consent was obtained from all participants who volunteered for the study.

## Authorship Contributions

Surgical and Medical Practices: E.E., M.K.T., Concept: E.E., Design: E.E., M.K.T., Data Collection or Processing: E.E., M.K.T., Analysis or Interpretation: E.E., Literature Search: E.E., M.K.T., Writing: E.E., M.K.T.

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