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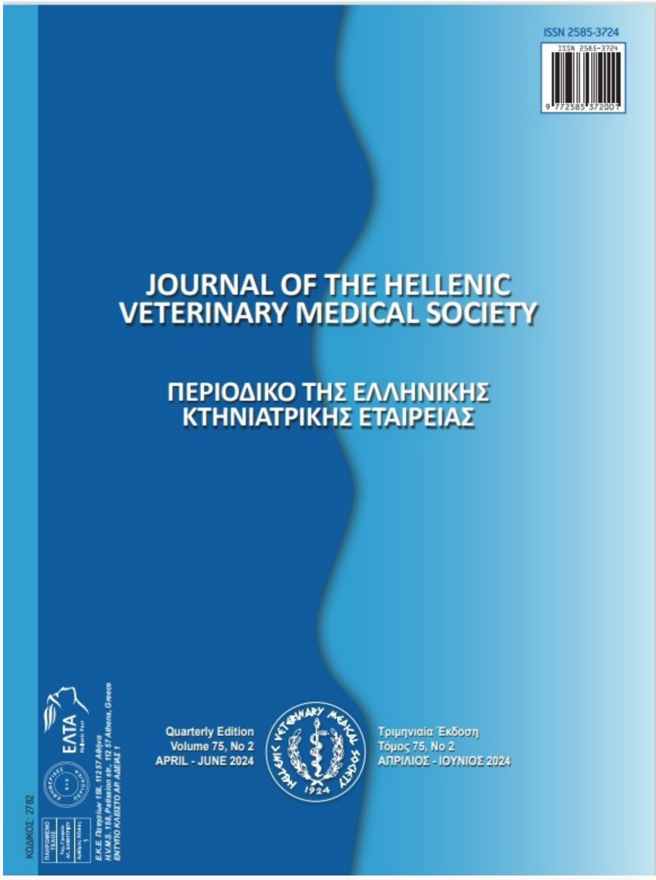


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*OB Ince, Y Paksoy, A Sait*

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Research article
Ερευνητικό άρθρο

# Risk assessment about effectiveness of biosecurity implementations on horse properties in Turkey

**O.B.Ince[1*], Y. Paksoy[2], A. Sait[3]**

[1]*Necmettin Erbakan University, Veterinary Faculty, Department of Virology, 42310, Eregli, Konya, Turkey*

[2]*Necmettin Erbakan University, School of Higher Education Horse Breeding and Coaching Program, Eregli, 42310 Konya, Turkey*

[3]*Pendik Veterinary Control Institute Directorate, Viral Diagnostic Laboratory, Pendik, 34890 İstanbul, Turkey*

**ABSTRACT**: The present study was performed by conducting interviews with 382 horse owners and managers between April 2019 and March 2022 to examine biosecurity implementations on non-commercial horse properties in Turkey and the attitudes and behaviors of horse owners toward viral horse diseases and explain the procedures that visitors should follow. Data were collected with a semi-structured questionnaire. While collecting data from horse owners, 548 nasal swabs were taken from horses on properties to detect equine viral arteritis infection. Correlations between property-level variables and biosecurity implementations in horses were analyzed by logistic regression. Swap samples were investigated for equine arteritis virus antigen by PCR. While 341 (89.27%) of horse owners and managers reported that they applied biosecurity procedures to check the health of newly arrived horses on the property, 125 (32.72%) stated that they applied isolation as a standard procedure upon the entry of horses to the property. On properties where isolation was not routinely applied, the main reason for isolating horses was an illness that emerged on other properties (n=78). Few participants (n=44) checked new horses for fever or other clinical symptoms of infectious disease. Only 54 (14.14%) horse managers reported that they applied visitor procedures. Within the general framework, 301 (78.79%) of horse properties were visited by a horse specialist, but 51 (13.35%) reported the biosecurity procedure for these visits. The obtained findings simplify a better insight of property owners' effective decision-making processes behind horse health discretions and can meet feedback to the sector stakeholders on influential biosecurity implementations.

***Keywords*:** Biosecurity; Equine; Equine viral arteritis; Risk assessment

*Corresponding Author:*
Omer Baris Ince, Necmettin Erbakan University, Veterinary Faculty, Department of Virology, 42310, Eregli, Konya, Turkey
E-mail address: incebaris@gmail.com, baris.ince@erbakan.edu.tr

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## INTRODUCTION

The importance of biosecurity implementations concerning animal health is gaining increasing attention at the national and international levels. Biosecurity measures are essential for maintaining the herd's health and providing nationwide protection against the outbreak of a disease (Wenzel and Nusbaum, 2007; Dalton et al., 2022; Crew et al., 2023). Biosecurity involves the measures to be taken to limit the spread of the disease agent among infected and susceptible animals, determine the adverse impacts of the disease on human and animal health and the environment, eliminate the possibility of the occurrence of the identified risks, or control the damages that will occur in case of risks (Morley, 2002; Brennan and Christley, 2012).

These implementations are achieved by measures including health checks of animals and isolating symptomatic animals, vaccinating susceptible animals, and reducing the use of antimicrobials (Gunn et al., 2008; Crew et al., 2023). The implementation of biosecurity implementations to visiting person and vehicles, as well as animals, is extremely important, against the possibility of increasing the spread of the disease due to mobility between and within stud farms. The majority of biosecurity enforcement measures address non-specific disease threats rather than focusing on a specific pathogen agent, and biosecurity is considered an everyday good practice to avoid significant impacts when disease invasions occur (Crew et al., 2023). It is accepted that biosecurity implementations preventing the interaction between people and animals on the property have the potential to reduce the risk of a possible disease and the spread of the disease (Denis-Robichaud et al., 2019). Although competent authorities and veterinarians recommend implementing biosecurity implementations, it may take time for breeders to adopt them (Shortall et al., 2017; Crew et al., 2023; Moya et al., 2023). As is known, visitor protocols generally cover processes such as changing clothes and equipment, washing hands, and foot baths. As far as we know from the literature, it has been reported that implementing isolation procedures to horses that have just entered the horse property or are suspected of being infected protects against equine influenza virus (EI) and herpes virus infections from which horses suffer (Kohn et al., 2006; Gildea et al., 2011; Taylor et al., 2008; Firestone et al., 2011). Biosecurity implementations for newly arrived horses involve a series of recommendations, such as the control of clinical disease symptoms, isolation and quarantine measures (Nishiura and Satou, 2010; Ivens, 2015; USDA, 2018).

Social cognitive theories (e.g., the Theory of Planned Behavior, the Health Belief Model,) include risk perceptions and behavioral intention and the components of the action phase for behavior change and provide significant pieces of proof the predictive validity of self-efficacy in the implementation of preventive health behaviors (Bandura, 2001; Taylor et al., 2020; Anisman and Kusnecov, 2022). These models report that risk perceptions, such as seriousness, sensitivity, and vulnerability, may impact the individual's thoughts to engage in preventive health behaviors (Ferrer and Klein, 2016; Spence et al., 2019). Social psychological decision models such as the Reasoned Action Approach stress the effect of social pressures on decision-making (Fishbein and Ajzen, 2010; Sok et al., 2016). Previous experiences, psychological impacts, demographic structure, and norms are among other risk factors affecting preventive health behaviors against diseases among horse owners and farmers (Schemann et al., 2013; Rosanowski et al., 2012; Ritter et al., 2017; Spence et al., 2019; Golding et al., 2023). Considering the effect of these factors on the decisions influencing health behaviors, many practices, especially the perception of the effectiveness of biosecurity implementations, are effective in adopting preventive behaviors by horse owners.

The introduction of a disease important to the horse industry (e.g., equine flu, strangles) to a naive population will have economic consequences. Morever, horses are of relevance in the spillover of zoonotic and emerging diseases from wildlife to human, and in non-communicable diseases. Additionally, risk factors such as climate change and antimicrobial resistance threaten the health of both horses and humans. Horses are an influential factor in maintaining human and environmental health and should be included in the roadmap to achieve One Health. The possible economic cost of the disease necessitates an understanding of animal healthcare implementations and biosecurity strategies used in this sector. Sometimes, breeders find biosecurity implementations unnecessary and expensive, and routine biosecurity implementations at the farm level cannot always be optimally evaluated (Dorea et al., 2010; Nöremark and Sternberg, 2014). On the other hand, prioritizing measures based on property characteristics can help improve the actual implementation of on-property biosecurity measures. Horse owners may want to discuss different biosecurity measures separately to justify their economic investments and effective use of time in biosecurity strategies. However, strategies applied in different situations seem difficult/are difficult in terms of obtaining predictions for the preventive impact of individual measures.

Equidae animals in Turkey (except the racing industry) have started to be registered within the framework of the regulation (microchip processes) since 2022 to more effectively monitor the movements and diseases of these animals within the framework of harmonization with the European Union acquis. The regulation covers the identification of equids in each age group individually, the method to be used in identification, the type and characteristics of the material, the technical specifications of the numbering system, the registration of the animals identified and the enterprises and their owners, the establishment and operation of a computer-aided database, the exchange of information and data about the identified animals and the enterprises they live in, the monitoring and control of the movements of equids in the system, and the control and inspection of the identified animals and enterprises. As a result of the literature review, the fact that a comprehensive study investigating biosecurity implementations on horse properties had not been conducted in Turkey before constituted the starting point of the present research.

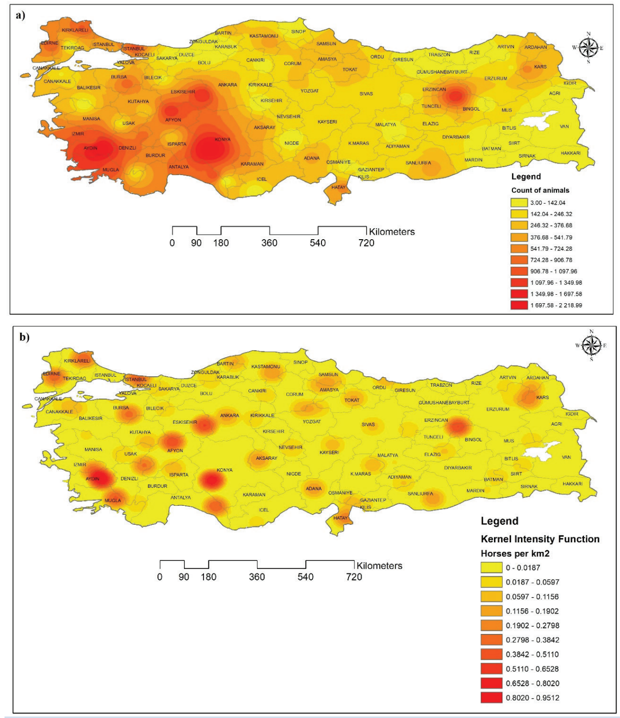


**Fig. 1.** Study area (a) Inverse Distance Weighting Interpolation map, b) Gaussian edge corrected kernel intensity function of the number of equids (n=25203) per km$^2$ in Turkey)

## MATERIAL AND METHODS

### Study area and design

A cross-sectional study was performed on non-commercial horse property owners in Turkey between April 2019 and March 2022. Individuals who owned or cared for horses or donkeys, mules, and ponies (herein referred to as 'horses') were included in the sample if they met the inclusion criteria. In Turkey, there are 6571 households and a total of 25203 equids registered to the TURKVET system (horses, donkeys, mules, ponies) (MFA, 2021). Race horses are not included in this number. Race horse records are kept by the Turkish Jockey Club. Approximately 3625 (55.16%) of these households have a single Equidae animal. Since the focus of the study was on non-commercial horse properties, properties with one animal were excluded from the sampling list (n=3625). The remaining properties formed the sample data (as non-commercial horse properties, n= 2946) (Fig.1). These properties may themselves be part of the family business activity (cattle and small ruminant industry). Sample selection calculation was performed using the "epiR" (Stevenson, 2023) and "sparr" (Davies and Marshall, 2023) packages in the R version 4.3.0 program. The study was carried out on 382 horse properties. Farm sampling was carried out using a stratified randomised sampling method with province and farm size as strata based on the Neyman proportional allocation method (Bankier, 1988). The epidemiological program WinEpiscope 2.0 was used to compute the sample size on each selected property using a random sampling method (Sergeant, 2017). The study was performed in accordance with the STROBE statement (https://www.strobe-statement.org). While collecting data from horse owners, 548 nasal swabs were taken from horses on the property to detect EVA infection. The interviews conducted with a semi-structured questionnaire (SSQ) investigated horse owners' previous experiences, perceptions and resulting behaviors, as well as communication about EVA. Definitions of the terms used throughout the SSQ were included in the study to help the participants and ensure the standardization of responses.

### Visitors and biosecurity implementations

Visitor types were grouped as information on property visitors interacting with horses, called horse specialists, farriers, veterinarians, equine therapists, equestrian trainers and trainers, and visitors other than those. Equine therapists were defined as individuals dealing with services carried out on horses residing on the property. Equestrian trainers included individuals who tried to teach riding, and trainers included individuals who directly dealt with the horse.

A binary variable was created to describe the biosecurity implemented to horses entering the property. The first was general biosecurity implementations, including whether there were any biosecurity implementations related to new horses coming from a property to the property. It was coded as "1" and "0" within the framework of the isolation or control of horses and responses to the questions. The second outcome variable was whether a horse property owner had any biosecurity implementations expressing clinical symptoms of respiratory infection in newly arrived horses. It will be defined here as biosecurity implementations in horses that include clinical symptoms. These implementations include checking newly arrived horses for cough and abnormal discharge from the nose or eyes, consulting a veterinarian, and applying isolation for how many days. General framework of biosecurity implementations on non-commercial horse property is presented in Table 1.

**Table 1** General framework of biosecurity implementations on non-commercial horse property

| Factor | Factor level |
|---|---|
| **Visitor protocols** | |
| | Visitor protocol yes/no |
| | Change clothes |
| | Change into overalls |
| | Clean equipment |
| | Clean-wash the boots |
| | Wash hands |
| | Other |
| **Information about horses** | |
| | No information |
| | Property where the horse had come from |
| | Vaccination history |
| | Other informations |
| | No health check |
| | Discharge from the eyes or nose |
| | Internal parasite treatment |
| | Appetite status |
| | Coughing |
| | Respiration |
| | Pulse |
| | Colic |
| | Rectal temperature |
| | Veterinarian |
| | Farrier |
| | Other informations |
| **Isolation of horses** | |
| | No isolation |
| | 1-3 days |
| | More than 4 days |
| | Other |
| **Property information** | |
| | Property size |
| | Visitor protocol entity |
| | Cleaning protocols |
| | Existence of isolation area |

## Laboratory analysis

While collecting data from horse owners, 548 nasal swabs (OrgaMik, Lot: SBW009) were taken from horses on the stud farm for EAV. The nasal swabs were placed in 5 ml of transport medium phosphate buffered saline (PBS) PBS containing 0.02 IU/ml of amphotericin B, 1mg/ml gentamicin together with 8 IU/ml of streptomycin 8 µg/ml of penicillin, and 10% glycerol) and stored at 4 °C.

### Nucleic Acid Extraction

The nucleic acid was extracted using the GF-1 Viral Nucleic Acid Extraction Kit (Vivantis, Malaysia) according to manufactures procedure. The extracts were kept at −70°C until use.

### Reverse transcription of viral RNA

RevertAid ™ First Strand cDNA Synthesis Kit (First Strand cDNA Synthesis Kit Thermo Scientific, Germany) was used for reverse transcription of RNA and performed according to manufactures procedure.

### Polymerase chain reaction (PCR) technique

The oligonucleotide primers used for PCR were from the 3' end of ORF 1b of the EAV genome. Their sequences were as those described by other studies (St-Laurent et al., 1994).

PEV-10: 5'-GAGGATCCCACTTCATCT-3'

PEV-11: 5'-AATGGTCTGCACTGAGGT-3'

The PCR was carried out in a final volume of 50 µl containing 5 µl of the cDNA, 3 µl of MgCl2 (25 mM), 5 µl 10X PCR buffer, 1.25 U Taq DNA polymerase (Promega, USA), 1 µl dNTP mix (0.2 mM each) and 2 µl of each primer (20 pM each). Denaturation, annealing and extension consisted of 40 cycles at 95°C for 1 min, 50°C for 1 min and 72°C for 2 min, respectively. Each PCR product (5 µl samples) was examined on a 1.5% agarose gel containing ethidium bromide in 1X TBE bufer along with 100 bp DNA ladder (Fermentas, Germany).

**Statistical analysis**

Data were obtained from horses during collecting swab samples to obtain general information about risk factors on properties in the study area. The collected data included property-level variables, such as the number of horses in the property (≤2, 3-4, and ≥5 horses) and property size (small (≤3 decares(daa)), medium (4-10 daa), or large (≥10 daa)). Property owners consisted of variables that included ownership patterns such as breeding, hobby-entertainment, reproduction, and horse boarding. The significance of the relationship between the responses received and each of the categorical variables was examined with the chi-square test. On the other hand, the Kruskal-Wallis test was used to reveal the significance of the relationship between the number of horses and the visits/entry-exit variables of veterinarians and horse specialists to the horse property.

The number and percentage of responses were reported for each biosecurity question concerning horse arrivals to the property or visitor protocols. The analysis was performed with univariable logistic regression to examine property-level variables and the correlation between general biosecurity or any biosecurity practice that would identify clinical symptoms of respiratory disease in newly arrived horses. Independent variables with $p \leq 0.25$ in the univariable logistic regression analysis were considered for multivariable mixed-effects logistic regression analysis. Independent variables were checked using Phi and Cramer's V test to avoid collinearity problems. When there were highly correlated variables, they were excluded from the multivariable analysis. The model was evaluated with the Hosmer-Lemeshow test, a fit test (Dohoo et al., 2009). All data collected from the questionnaires and laboratory results were entered in Microsoft Office Excel and Microsoft Office Access 2019. All descriptive statistics were performed using IBM SPSS package version 24 (SPSS Inc., Chicago, IL, USA) and R version 4.3.0 program (R Development Core Team, Vienna, Austria).

## RESULTS

**Questionnaire response**

Of the 382 respondents on horse properties, 343 (89.8%) answered at least one question regarding biosecurity implementations or visitor procedures. The lack of response from the respondents to the SSQ biosecurity section did not differ significantly according to the reason for owners to keep horses (p=0.93) and the size of the premises (p=0.75). On the other hand, the probability of responding to the SSQ biosecurity implementations section by respondents on properties with two and fewer horses was significantly lower than those who responded on properties with more than two horses ($p < 0.01$).

**Laboratory analysis**

To detect EVA infection, 548 nasal swab samples were studied by the PCR method, and all of the samples were found to be negative.

**Visitor procedures and biosecurity**

Whereas 82.46% (315/382) of horse owners reported that a farrier visited their property, 78.79% (301/382) reported that a horse specialist visited their property, and 64.13% (245/382) reported that a veterinarian visited their property, 12 property owners (3.14%) stated that a veterinarian did not visit their property despite the fact that a farrier visited their property. The number of visits by a horse specialist to the property was found to be significant according to the property size (p <0.02) and the number of horses on the property (p <0.01). On the other hand, whereas the number of visits by veterinarians was significant according to the number of horses on the property (p <0.001), the number of visits by farriers was insignificant (p <0.47). The most common reason for veterinarians to visit a horse property involved emergency intervention. While 301 (78.79%) of the properties were visited by horse specialists, 51 (13.35%) reported biosecurity implementations for these visitors.

Table 2 presents the results of the univariable logistic regression analysis of the correlation between the general biosecurity implementations of horses entering the property and the biosecurity process applied in case of clinical symptoms. The results of the final multivariable logistic regression models show relationships between trait-level variables on the presence of any biosecurity implementations applied to horses entering the property or on biosecurity implementations specifically applied to clinical symptoms of equine respiratory infection. As seen in Table 3, the implementation of the general biosecurity procedure on the property in the final model was significantly

**Table 2** Univariable logistic model the outcome of the association between general biosecurity or clinical symptoms of disease biosecurity implementations and property-level variables

| Level | Variable | Categories | General biosecurity | | | Clinical symptoms of disease biosecurity implementations | | |
|---|---|---|---|---|---|---|---|---|
| | | | OR[a] | 95% CI[b] | P value | OR | 95 % CI | P value |
| Property | Horse number | | n=354 | | | n=341 | | |
| | | ≤2 | Baseline | | 0.01 | Baseline | | 0.0003 |
| | | 3 and 4 | 1.11 | 0.66-1.83 | | 1.37 | 0.78-2.39 | |
| | | ≥5 | 0.33 | 0.14-0.74 | | 0.26 | 0.11-0.58 | |
| | Property size | | n=382 | | | n=331 | | |
| | | small(≤3daa[c]) | Baseline | | 0.002 | Baseline | | 0.0007 |
| | | Medium (4-10 daa) | 2.33 | 1.32-4.09 | | 1.51 | 0.85-2.68 | |
| | | Large (≥10daa) | 0.28 | 0.12-0.66 | | 0.28 | 0.12-0.66 | |
| | Reason for keeping horses | | n=379 | | | n=339 | | |
| | Work | No | Baseline | | | Baseline | | |
| | | Yes | 2.80 | 1.64-4.77 | 0.0002 | 4.14 | 2.14-7.97 | <0.0001 |
| | Hobby | No | Baseline | | | Baseline | | |
| | | Yes | 1.67 | 1.11-2.52 | 0.01 | 0.83 | 0.54-1.29 | 0.43 |
| | Breeding | No | Baseline | | | Baseline | | |
| | | Yes | 1.12 | 0.75-1.68 | 0.56 | 0.68 | 0.44-1.05 | 0.08 |
| | with other animals | No | Baseline | | | Baseline | | |
| | | Yes | 1.66 | 1.06-2.61 | 0.02 | 2.01 | 1.23-3.26 | 0.005 |

[a]OR: Odds ratio.
[b]95 % CI: 95 % Confidence interval of OR.
[c]decare

**Table 3** Results of the multivariable logistic mixed model of property-level variables

| Level | Variable | Categories | General biosecurity | | | | | Clinical symptoms of disease biosecurity implementations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | B[a] | SE[b] | OR[c] | 95 % CI[d] | P value | B | SE | OR | 95 % CI | P value |
| Property | Horse number | ≤2* | | | | | | | | | | |
| | | 3 and 4 | 0.62 | 0.48 | 1.81 | 0.67-4.86 | 0.35 | 0.84 | 0.53 | 2.13 | 0.81-4.96 | 0.08 |
| | | ≥5 | 0.31 | 0.43 | 0.96 | 0.41-2.37 | 0.99 | 0.44 | 0.57 | 1.21 | 0.24-3.66 | 0.56 |
| | Property size | Small (≤3daa[e])* | | | | | | | | | | |
| | | Medium (4-10 daa) | 1.37 | 0.74 | 2.78 | 1.63-4.89 | 0.04 | 0.54 | 0.48 | 1.59 | 0.66-3.95 | 0.05 |
| | | Large (≥10daa) | 0.29 | 0.34 | 0.83 | 0.39-1.92 | 0.49 | 0.37 | 0.51 | 0.99 | 0.36-2.46 | 0.54 |
| | Work | No* | | | | | | | | | | |
| | | Yes | 1.64 | 0.84 | 2.66 | 1.43-5.14 | 0.06 | 2.24 | 1.15 | 3.24 | 0.87-8.15 | 0.45 |
| | with other animals | No* | | | | | | | | | | |
| | | Yes | 0.94 | 0.65 | 1.89 | 0.69-5.31 | 0.77 | 1.08 | 0.49 | 1.67 | 0.54-4.26 | 0.38 |

*Reference category
[a]B: Regression coefficient
[b]SE: Standard Error
[c]OR: Odds Ratio
[d] 95 % CI: 95 % Confidence interval of OR.
[e] decare

related to the number of visits to the property and the size of the property (p<0.001).

## DISCUSSION

The present study demonstrated the existence of inadequate biosecurity implementations that could protect against infectious diseases horse properties in Turkey. Despite differences in the number of biosecurity implemented and their effectiveness in preventing the spread of infectious diseases to horses on the property, most SSQ respondents had some biosecurity implementations related to the entry of new horses to the property. Although most responding horse owners knew the health history of horses entering the property, few owners physically checked new horses for clinical symptoms of infectious disease. Furthermore, physical examinations for infectious diseases would be ineffective for the general biosecurity strategy without considering the isolation of newly arrived horses (Kohn et al., 2006; Rosanowski et al., 2012). Whereas 20.42% (78/382) of the property owners isolated horses, the isolation period varied between 1-3 days within the opportunities of the property. The current study finding (20.42%) was lower than the value (89%) reported in the study conducted by Rogers and Cogger in 2010 for Thoroughbred farm managers (%89) and the value (50%) reported by Kirby et al. in 2010 for horse riding facilities in Colorado (North America).

Among the findings from the SSQ, the sections on biosecurity questions had a higher non-response rate compared to other sections. The fact that the biosecurity section was not responded by horse property owners resulted in the lack of a complete understanding of the biosecurity practice perception. The participants who do not take their horses out of properties with two or fewer horses may have been hesitant to answer the section on biosecurity implementations, which they think is not relevant to them. On the other hand, it should be noted that horse property owners perceived a lack of biosecurity control in preventing horse diseases but did not feel that their horses would be affected. There is probably a lack of awareness of what horse disease prevention includes or how these can impact an owner's horse (Chapman et al., 2018). Furthermore, differences in the number of horse owners who report being responsible when compared to biosecurity implementations suggest the perception that the terms imply different actions. Visitor procedures on horse properties for possible risks should include biosecurity measures to minimize opportunities for transmission through tool-equipment and human-vehicle (Ivens, 2015; Crew et al., 2023). Disinfection procedures, hand washing, changing clothes, and parking away from the animal contact area can be given as examples (USDA, 2016; Crew et al., 2023). Previous attitudes and behaviors toward actions recommended for biosecurity implementations can impact whether individuals intend to take preventive measures (Ferrer and Klein, 2016; Sok et al., 2016; Ritter et al., 2017; Sok et al., 2018; Anisman and Kusnecov, 2022). Considering the importance of socio-cognitive factors such as beliefs and perceptions, additional studies may be required to reveal how these factors may impact horse owners' intention to be prepared for biosecurity implementations.

While collecting data from horse owners, 548 nasal swabs were taken from horses on the properties to detect EAV infection, and they were investigated for EAV antigen by PCR. According to the test results, they were found to be EAV-negative. It is thought that the reason for this may be related to the infection mechanism and sampling method. On the other hand, it was found to be negative in another study from Turkey (Baydar et al., 2023). On the contrary, EVA seropositivity varied between 8-20% (Ince and Sevik, 2023; Baydar et al., 2023). These heterogeneities between studies can be attributed to numerous factors, such as the analysis method used, the number of animals, sample size, and the lack of periodic screening tests.

The present study had some potential limitations. The fact that the SSQ was conducted through face-to-face interviews carried a risk of social acceptability bias. For example, the recorded prevalence of biosecurity practice measures in the event of any disease on the horse property may cause us to overestimate the actual prevalence of these measures if horse owners give the answers they think are most acceptable rather than the most accurate. On the other hand, horses entering the property may have been subject to misclassification bias, such as interpreting quarantine/isolation. Differences in the horse owner's interpretations of what constitutes quarantine practice may have placed more confidence in quarantine effectiveness than necessary in terms of a biosecurity practice procedure to prevent the spread of horse diseases (Kirby et al., 2010; Rosanowski et al., 2012). As a result, interpretation differences regarding the quarantine processes of horses may emerge as a situation in which misclassification may have occurred in the study. Moreover, since the methodology applied within the general framework of the study was to identify the existing biosecurity implementations that were likely to exist on the property and determine the property-level factors associated with owning the implementations, the effectiveness of the strategies of these implementations was not considered. Additionally, it can be subjective to make a judgment about the effectiveness of the strategies of biosecurity implementations. We did not have sufficient evidence to reach any conclusions.

In the study, large- and medium-sized properties had a higher rate of implementing the biosecurity procedure (change clothes, change into overalls, clean equipment, wash hands etc.) than small-sized and hobby horse properties. The movement of horses among properties was a factor increasing the possibility that properties would have biosecurity procedures. This situation is similar to the findings of other researchers (Ortiz-Pelaez et al., 2006; Traub-Dargatz et al., 2012; Manyweathers et al., 2017; Wiethoelter et al., 2017). Medium-sized properties are likely to have more mare-to-mare interactions and more visits by horse haulers than large- and small-sized properties. Hence, medium-sized properties are likely to be at a higher risk factor for disease emergence and spread than small- and large-sized properties.

In the current study, 78.79% (301/382) of the respondents reported that a horse specialist visited their properties. The rate of property owners reporting that horse specialists visited their properties is lower than those reported in studies from New Zealand and the United Kingdom (Ireland et al., 2011; Rosanowski et al., 2012). While the majority of properties were visited by the horse specialist, only 14.14% had biosecurity procedures related to visitors. This rate is likely to be a risk factor that may facilitate the spread of disease among properties. The findings from this study are similar to the findings of studies carried out in other countries (Rogers and Cogger, 2010; Ireland et al., 2011; Crew et al., 2023).

In the study, 82.46% (315/382) of the respondents reported that their properties were visited by a farrier, while 64.13% (245/382) stated that they were visited by a veterinarian. These rates are partially lower than the findings of other studies (Ireland et al., 2011; Rosanowski et al., 2012). This variability in results may originate from the management system structure in the horse industry between countries or eradication and control programs between countries. On the other hand, the findings of the present study, similar to other research findings, demonstrated that farriers visited the horse property in the highest number (Firestone et al., 2011). In the study, veterinarians were called to the property when a horse entering the property appeared sick. In some cases, reports from horse owners indicated that they established the diagnosis by themselves. As is known, the veterinarian (horse clinician) has the potential to diagnose the disease compared to horse owners (Ireland et al., 2011). Nevertheless, when disease-specific clinical symptoms are absent, health clinicians may misdiagnose the disease and apply the incorrect treatment (Stein, 2022; Al-Shareef et al., 2023).

When there was no risk of an epidemic, limited biosecurity procedures were implemented for the visiting veterinarians on small- and medium-sized properties. The most common requirement on these properties was for the veterinarian to change his clothes. On the contrary, it was important to provide a change of clothes on large-sized properties to reduce the risk of the veterinarian accidentally becoming a disease vector. The vector status of people arriving on properties has historically been underestimated, which is the possible role of humans in the spread of diseases, as indicated in other studies (Christley and French, 2003; Rogers and Cogger, 2010).

The findings of the present study stressed that biosecurity implementations on non-commercial horse properties in Turkey should be improved at the property level. There is currently no plan implemented by the competent authority on properties in Turkey. It is unknown whether the lack of awareness of biosecurity implementations originates from the lack of knowledge on how to implement these implementations or from the fact that property owners do not want to spend time within the framework of possibilities. However, this study stressed the awareness of biosecurity. Establishing education programs on the importance of biosecurity implementations will reduce the risk of a possible epidemic spreading due to the visitor procedure in very few of the horse properties

## CONCLUSIONS

The present study on non-commercial horse properties in Turkey analyzed the problems currently encountered in implementing effective biosecurity implementations and visitor procedures on horse properties, although biosecurity implementations are effective in preventing the spread of diseases. Considering the importance of socio-cognitive factors such as beliefs, behaviors, and perceptions, there is a need for additional research to determine how these factors may impact horse owners' intention to be prepared for illnesses. Socio-psychological factors, such as horse owners' awareness of disease and perceived risk, can impact their willingness to implement disease prevention measures on horse properties.

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## CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

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