

Equine veterinarian knowledge and perceptions of ticks and tick-borne diseases in the United States

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Abstract

Ticks pose a significant threat to horses, as they can cause harm and transmit diseases. This study aimed to assess the experiences, knowledge, and practices of equine veterinarians regarding ticks and tick-borne diseases (TBDs) in the United States. A survey was conducted, covering topics such as tick biology, identification, prevention, and veterinary education. The results revealed variations in veterinarians' knowledge on ticks and TBDs, highlighting the need for improved tick control options, enhanced education, and comprehensive resources for tick and TBD prevention. The study emphasizes the importance of accurate tick identification for effective diagnosis and treatment of TBDs in horses. The limitations of the study include potential response bias and a limited sample size. To address these issues, collaborations between academia, industry, and the human medicine community are recommended to strengthen veterinarian training and education on ticks and TBDs. This research provides valuable insights for developing continuing education programs that focus on tick-borne illness prevention in horses.

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Summary

Background. Ticks can harm horses and transmit diseases, making them a growing concern for owners and veterinarians. Veterinarians play a crucial role in providing advice on tick prevention and control. Yet, no research has examined their perspectives on equine ticks and tick-borne disease (TBD).

Objectives. The objective was to assess the experiences, knowledge, and practices of equine veterinarians related to fundamental aspects of tick biology and identification, tick bite prevention, and TBD in the United States.

Study Design . This project surveyed equine veterinarians in the United States (U.S.) about their knowledge of ticks and TBD affecting horses using nonprobability convenience sampling. The survey questions were grouped into six categories: respondent demographics, knowledge of ticks and TBDs, tick control option availability, tick and TBD frequency on horses, and veterinary education and information availability.

Methods. Data were analyzed using descriptive statistics, chi-square analysis, and t-tests. The sample was divided into Northeast and U.S. veterinarians, and a significance level of $P < 0.05$ was set. The study aimed to inform continuing education development for veterinarians by assessing their knowledge, practices, and perceptions of ticks and TBDs.

Results. The results indicate that while equine veterinarians are aware of the importance of TBDs in equine health, knowledge on ticks and TBDs vary significantly.

Main Limitations. Limitations for the current study include potential response bias and a limited sample from many states.

Conclusions. There is a need for increased tick control and prevention options, as well as more animal-specific resources for tick and TBD prevention. Veterinarians and horse owners require greater education and comprehensive information to prevent tick-borne illnesses in horses. Collaborations between academia, industry, and the human medicine community are suggested to build capacity for training veterinarians.

Clinical Relevance

- Equine veterinarians had limited knowledge on ticks and TBDs, with less than half of them correctly identifying tick species and their associated diseases.
- The lack of knowledge and confidence in identifying tick species may impact equine health as accurate identification is crucial for diagnosing and treating TBDs.
- Inadequate training of veterinarians on ticks poses a challenge in educating horse owners about tick-borne pathogens.

Introduction

Human and animal tick encounters are increasing across the United States (Eisen and Eisen 2018, Divers et al. 2018), driven by the encroachment of endemic tick species into new regions and the introduction of non-native tick species (Sonenshine 2018). Ticks are common ectoparasites of horses (Duell et al. 2013, Sundstrom et al. 2021). Tick bites can cause systemic reactions, irritation, and dermal trauma to horses (Chang et al. 2000). Some species of Ixodid hard ticks can transmit pathogens to horses that cause diseases such as Lyme borreliosis, anaplasmosis, and equine piroplasmiasis (Chang et al. 2000, Butler et al. 2005, Pusterla and Madigan 2013, Onyiche et al. 2019). These diseases, and other tick-associated conditions like gotch ear and tick paralysis, are of rising concern to horse owners and equine veterinarians in many areas of the United States (Butler et al. 2005, Divers et al. 2018).

Horse industry surveys have shown that veterinarians are an important source of information on equine health and care (Hockenhuil et al. 2013, Lofgren et al. 2016, Hartmann et al. 2017, Carroll et al., 2018). Veterinarians were the third most important source of welfare information for horse owners in Pennsylvania (author ETM, unpublished data). Because equine practitioners are regularly consulted on health topics, veterinarians are likely an important pathway to deliver information on tick bite prevention and tick-borne diseases (TBDs) to horse owners and caretakers and must be prepared to discuss optimal strategies for tick prevention and control for their animals.

Equine veterinarians should know about ticks and TBDs to serve their clientele best. However, there has been no research on veterinarian perspectives focused on ticks and TBDs that affect horses. This survey aimed to assess the experiences, knowledge, and practices of equine veterinarians related to fundamental aspects of tick biology and identification, tick bite prevention, and tick-borne disease in the United States. This survey's results can inform continuing education development for veterinarians and augment horse owner and caretaker knowledge.

Materials and Methods

Survey Design

This project was part of a more extensive survey designed to question two general cohorts – equine veterinarians and equine caretakers/owners. Nonprobability convenience sampling was used to access information from as many producers as possible. A survey questionnaire was created using Qualtrics (Provo, UT), and the questions were reviewed and approved by the Pennsylvania State University Institutional Review Board (IRB, STUDY00016457). The survey was then pilot tested on a sample audience to check for continuity of questions and any potential errors. The survey was distributed via email (Penn State Extension equine list) and social media (Facebook) to veterinarians across the United States and was accessible from April-July 2021. Several online equine and agriculture publications also promoted the survey.

The survey questions aimed at veterinarians were grouped into six categories: respondent demographics, knowledge of ticks and TBDs, availability of tick control options, frequency of ticks and TBDs on horses, and availability of veterinary education and information on equine ticks and TBDs. The target population for this study included anyone at least 18 years of age who was a veterinarian that evaluated horses in their practice.

Data Analysis

Because not all respondents completed every question, the N for each question is presented with the data. For demographic data of veterinarians, the data are presented as frequencies. Likert scale question scores were either reported as the average \pm SD or the median (IQR) if the data were normally or not normally distributed, respectively. For concepts such as the overall concern and perceived risk of ticks, the average score across more than one question was calculated. For example, the overall concern with ticks was averaged from the rating of the veterinarian's concern for Lyme disease, anaplasmosis, piroplasmosis, tick paralysis, and skin conditions in patients. For the knowledge section of the survey, a point was given for each correct answer. The knowledge score was then calculated by summing up the number of correct answers (with a highest possible score of 10). Chi-square analysis was conducted to determine differences in the frequency of various yes/no questions regarding tick control and frequency of tick presence in veterinarian practices.

Due to the sample size, respondents were grouped into Northeast veterinarians versus veterinarians from all other US regions. For some questions, respondents were divided by the region of the United States from which they were based. Regions were previously defined by the "Tick Bite Data Tracker" from the Centers for Disease Control and Prevention (CDC), National Center for Emerging and Zoonotic Infectious Diseases, Division of Vector-Borne Diseases: Northeast, Southeast, Midwest, South Central, and West (Figure 1). T-tests and Mann-Whitney U tests were conducted to compare the average score for questions between Northeast and US respondents when the data were normally and not normally distributed, respectively. A paired t-test was conducted to determine the difference in the available frequency of education and the desired frequency of education. The significance level was set to $P < 0.05$.

Results

Demographics

A total of 76 equine veterinarians from across the United States began the survey (Figure 2). A majority (52.6%; 39/74) of respondents graduated from veterinary school from 2006-2020. The highest percentage of veterinarians taking the survey were from the Northeast (40.8%; 31/76), followed by the West (26.3%; 20/76).

The number of horses cared for in an average year was reported as follows: 20.0% (15/75) of veterinarians cared for 1-100 horses; 29.3% (22/75) cared for 101-200 horses; 13.3% (10/75) cared for 201-300 horses; 8.0% (6/75) cared for 301-400 horses; and 29.3% (22/75) for more than 400 horses (Figure 3).

Knowledge of Ticks and TBDs

Only 38.7% (24/62) of veterinarians responded correctly that nymphs and adults were the most likely life stages of blacklegged (*Ixodes scapularis*), lone star (*Amblyomma americanum*), and American dog ticks (*Dermacentor variabilis*) to be found on horses compared to the other possible answers. Over 20% (13/62) of respondents thought only adult ticks were the most likely life stage and 6.5% (4/62) thought only nymphs. Over 11 and 17% (7/62 and 11/62, respectively) of veterinarians thought larvae or larvae and adults were the most common, respectively (Figure 4).

Veterinarians are the point of contact to diagnose and treat diseases and conditions exhibited by horses, including tick-associated conditions. However, while 75.0% (45/60) of veterinarians could identify a blacklegged tick adult correctly, only 51.8% (29/56) of veterinarians correctly identified that blacklegged ticks were associated with Lyme disease (Table 1). Gulf coast ticks (*Amblyomma maculatum*) and American dog ticks were correctly identified by 56.9% (33/58) and 53.3% (32/60) of respondents, respectively. However, only 11.3% (7/54) and 29.0% (18/57) of respondents correctly associated these two species with tick paralysis, respectively. Over 32% (20/55) of respondents incorrectly thought that lone star ticks were also associated with tick paralysis in horses. On the other hand, a similar percentage of respondents correctly associated Gulf Coast ticks (33.9%, 19/54) and American dog ticks (26.8%, 15/57) with piroplasmiasis. However, veterinarians were more likely to associate Gulf Coast ticks with no diseases or conditions (47.9%, 23/54) over the other species. Lone star ticks were correctly identified by 64.5% (40/62) of respondents. Interestingly, only 12.7% (7/55) of all veterinarians were very confident that they could correctly identify a tick to species and 45.5% (25/55) were not confident at all. More respondents were confident in correctly correlating ticks with region-specific tick-associated conditions (26.3%; 15/57), but most were only somewhat confident (36.8%, 21/57) or not confident at all (36.8%; 21/57).

Availability of Tick Control Options

Overall, 58.6% of veterinarians responding felt insufficient tick control options were available. Fewer veterinarians in the Northeast felt that there were enough control measures compared to the other combined regions (9.5% vs. 32.4%, respectively; $P=0.03$). Most veterinarians (79.7%; 47/59) across all regions have recommended tick control to clients, but fewer veterinarians (61.4%; 35/57) were interested in a new passive method of tick control. Respondents considered tick research important (mean = 4.33 out of 5, with 1 being not important and 5 being very important). These opinions on new methods and tick research did not differ between the Northeast and the other combined regions.

When veterinarians were asked to respond to topics that they wished they knew more about ticks and tick control for horses, the most common responses were related to preventing bites. Choosing the best repellents or products for tick bite prevention was the most common response (73.3% of responses, 44/60), followed by tick prevention on the farm and (61.7% of responses, 37/60), and products or options available for tick prevention on the farm (61.7% of responses, 37/60) (Figure 5). Only 25.0% of respondents (15/60) wished to know more about finding ticks/conducting tick checks.

Veterinary Education and Information on Equine Ticks and TBDs

While 73.7% (42/57) of veterinarians responded that clients have asked them for information regarding ticks, only 28.6% (16/56) said they had any coursework on ticks in vet school (Table 2). Furthermore, 68.4% (39/57) of veterinarians were concerned about ticks on horses in their care, but 59.3% (35/59) of veterinarians did not feel that enough information was provided to vets on TBDs and tick bite prevention (and an additional 15.3% (9/59) of respondents did not know if enough information was provided). Similarly, over 53% (31/58) of responding veterinarians thought there was not enough information available for horse owners and caretakers on tick bite prevention and TBDs in horses. These responses were not different by

U.S. region.

When asked about the frequency of education that veterinarians receive on TBDs for horses, the average from all respondents was between every year and every 2-3 years, with 34% (20/59) of veterinarians receiving continuing education yearly, 42% (25/59) receiving continuing education every 2-3 years, and almost 24% (14/59) receiving continuing education infrequently (more than every 3 years) or never receiving continuing education on this topic. Regionally, the education frequency was higher in other regions of the United States compared to the Northeast ($P=0.025$). In contrast, over 52% (31/59) of veterinarians indicated that they would prefer to receive yearly education. The desired education frequency did not differ between the Northeast and the other regions of the United States. There was a significant difference between the current frequency at which continuing education is offered and the desired frequency of education, with more veterinarians preferring a higher frequency of education ($P=0.009$).

When searching for information regarding ticks, tick prevention, and tick control, over 39% (30/76) of all respondents received information from veterinary organizations and groups, followed by information from continuing education offerings (29.0%, 22/76; Table 3). There were similar responses when veterinarians were asked about references for TBDs, specifically. Veterinarians most often found information on TBDs from veterinary organizations or groups (30.3%, 23/76). Alternatively, 27.6% (21/76) of veterinarians referred to colleagues and the same percentage received information about TBDs from continuing education offerings. University Extension-led education on ticks, tick prevention, and tick control and TBDs were used by 19.7% and 18.4% of veterinarians, respectively.

Frequency of Ticks and TBDs of Horses

Veterinarians were asked to rank concern regarding specific TBD conditions on a Likert scale, with 1 being the most concerning and 6 being the least concerning. Veterinarians were primarily concerned with Lyme disease and anaplasmosis (mean = 2.0 for each, respectively). There were no differences among regions for either tick-borne disease. There was less concern for piroplasmiasis (mean = 4.0) and tick-associated skin conditions (mean = 3.0). There was a trend towards a higher concern of piroplasmiasis in the northeastern states, but it was not statistically significant. There was less concern for tick-borne skin conditions in the Northeast than in other regions of the United States ($P=0.016$). Overall, most equine veterinarians removed three or more ticks from horses per year (81.7%, 49/60; Table 4) and only 5% (3/60) of veterinarians never removed a tick, although the “0 tick” response was exclusively from the Midwest region. Nearly 70% (15/22) of veterinarians removed six or more ticks in the Northeast region. This was significantly more than the combined responses of the remaining regions (Mann-Whitney U; $P=0.030$), where most veterinarians reported removing less than five ticks per year. However, the frequency of body checks for ticks did not differ between the Northeast and the combined responses from the remaining regions. Seventy-five percent (42/56) of responding veterinarians removed ticks from horses, and 51.8% (29/56) of veterinarians responded that clients had brought in ticks that had been removed from a horse. Interestingly, neither response differed among U.S. regions.

Equine veterinarians were asked to click on locations on an image representing an equine body that best represented where ticks were most frequently removed (Figure 6). Responses from the Northeast and Midwest were grouped and responses from the Southeast and South-Central were grouped; this was done to combine regions where tick species presence and abundance would be similar. Veterinarians in the Northeast and Midwest most frequently removed ticks from under the jaw, the hind legs, and by the elbow/between the front legs (Figure 6A). In the Southeast and South-Central regions (Figure 6B), ticks were commonly collected from the ears, between and on the front legs, on the flank, between the hind legs, and on the horse’s sides. In the West region, veterinarians removed ticks scattered on the ears, crest, under the jaw, limbs, flank, belly, and between the back legs (Figure 6C).

The frequency of diagnosis of any TBD (anaplasmosis and Lyme disease) in horses was higher in the Northeast than in other regions of the country ($P=0.001$). However, there were no differences in the confidence of veterinarians to accurately diagnose TBDs based on disease signs, tick identification, and knowing which tick transmits diseases in the Northeast versus other regions of the United States. Over 28% (16/57) of

veterinarians responded that they had diagnosed a horse with tick-borne paralysis, and over 25% (15/59) for piroplasmosis. Cumulatively, most veterinarians have found a tick on a horse being treated for a tick-borne disease (75%; 42/56). Finding a tick was more frequent in the Northeast (90.5% of respondents) compared to other regions (65.7% of respondents) ($P=0.038$). Fewer veterinarians reported clients removed ticks and brought them to the provider (51.8%; 29/56) and this did not differ among regions. However, most veterinarians across all regions (73.7%; 42/57) responded that clients ask them for tick information, and even more veterinarians recommend tick control (79.7%; 47/59). Overall, veterinarians reported that clients were willing to spend an average of \$141.53 a year on tick control for their horses, and this did not differ among regions.

Discussion

Horses are susceptible to multiple TBDs transmitted by Ixodid hard ticks in the U.S. As the distribution of ticks of medical and veterinary concern shifts, it will become increasingly important for veterinarians to have a working knowledge of ticks and TBDs of their region. This survey aimed to assess equine veterinarians' current knowledge and perceptions regarding ticks and TBDs. The results indicate that while equine veterinarians are aware of the importance of TBDs in equine health, knowledge of ticks and TBDs vary significantly as was found with small mammal veterinarians (Crist et al. 2022).

Notably, while 75% of veterinarians could identify a blacklegged tick adult, only half of them correctly identified that blacklegged ticks were associated with Lyme disease. Less than half of respondents correctly associated Gulf Coast ticks and American dog ticks with tick paralysis. Additionally, most veterinarians were not confident in correctly identifying a tick. This is not surprising considering nearly three-quarters of respondents stated they did not have a course related to ticks in veterinary school. Awareness and concern for parasites but lack of knowledge about the system has been found previously with *Onchocerca cervicalis* and equine veterinarians in the UK (Mansell and Behnke 2022). This lack of veterinarian confidence in identifying tick species may impact equine health as accurate identification is crucial for diagnosing and treating TBDs.

There is a perceived need for an increase in the number of tick control options and on-animal tick bite prevention options. While most veterinarians have recommended tick bite prevention measures to clients, over 58% of veterinarians felt that there were not enough tick control options available. Most respondents wished to know more about tick bite prevention, products and options for tick prevention, and the best repellents for tick bite prevention. It was not surprising that the desire for more control options was higher from respondents from the northeastern states. Unfortunately, recent studies have demonstrated that permethrin, a commonly used active ingredient in arthropod repellent sprays for horses, is ineffective at preventing tick activity on horses at percentages tolerated by horses (Poh et al. 2023). Veterinarians also reported that, on average, clients were willing to spend just over \$140 for tick control. This is similar to the ~\$157.00 homeowners reported being willing to spend (Gould et al. 2008; adjusted to 2023 dollars). There is a need to develop effective, user-friendly, and economical tick control options, validate methods and tools currently available for use on or with horses, and provide information on these tools to veterinary professionals.

The availability of animal-specific resources regarding ticks and TBDs is limited, resulting in a greater emphasis for veterinarians to treat horses rather than prevent tick bites. Despite the concern of more than two-thirds of veterinarians surveyed about ticks on horses under their care, a significant majority of over 59% felt inadequate information was available to them on TBDs and tick bite prevention. Similarly, almost the same percentage of respondents believed that horse owners and caretakers also lacked sufficient information on these topics. These findings emphasize the need for greater education and training for veterinarians on ticks and TBDs and accessible and comprehensive information for horse owners and caretakers to prevent tick-borne illnesses in horses.

The inadequate training of veterinarians on ticks, particularly in the northeastern United States, poses a challenge in educating horse owners about tick-borne pathogens. Ticks are a significant concern for clients seeking veterinary care for their animals, but a considerable number of veterinarians reported that they did not receive adequate training on this topic during their veterinary education. This issue is particularly

concerning in the northeastern United States, where the burden of TBDs affecting horses is high (USDA 2017, Thompson et al. 2022). Surprisingly, most veterinarians did not receive training on ticks in veterinary school. A previous study on *B. burgdorferi* in horses in Germany suggested that horse owners should be educated by veterinarians, but this can only happen if veterinarians themselves are adequately trained (Gall and Pfister 2006).

The importance of providing veterinary professionals with comprehensive knowledge on ticks and TBDs for effective prevention and treatment calls for various initiatives, including continuing education and partnerships within a One Health framework. To effectively prevent and treat TBDs, it is crucial to enhance the knowledge of veterinary professionals on ticks and TBDs. One way to achieve this goal is by providing continuing education to veterinarians. However, there is a need for more comprehensive approaches to enhance the knowledge and resources of veterinary professionals in TBDs. A recent study by Crist et al. (2022) suggested building capacity for training veterinarians through collaborations between academia, industry, and the human medicine community. Such partnerships would enable the sharing of knowledge, resources, and expertise that could strengthen the understanding and treatment of TBDs in the veterinary community. For example, human medicine practitioners can share information on the latest diagnostic tools and treatment approaches, while industry players can contribute funding and expertise in product development.

While the current study has limitations, including potential response bias and a limited sample from many states, the results of this survey highlight the importance of continued education and training for equine veterinarians on ticks and TBDs, as well as the development of effective and user-friendly tick control options. It also underscores the need for accessible and comprehensive information on tick bite prevention and TBDs for veterinarians, horse owners, and caretakers. Further research should be conducted to assess the impact of increased education and training on the knowledge and practices of equine veterinarians, as well as the development of new tick control options and their effectiveness. Future research should expand to better compare regional differences. Given the burden of ticks and TBDs on the equine community, it is especially vital for veterinarians to be prepared and knowledgeable on these topics. However, our results demonstrate that both initial and continued education and training for veterinarians on ticks, TBDs, and tick control options are required to adequately address, prevent, and treat TBDs that affect horses.

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Table 1. Equine veterinarian responses to the question “ Match the tick species with the disease/condition associated with that tick” given as a percent of total respondents and n responding in parentheses. Correct answers are in bold.

Disease or condition	Tick Species (N)	Tick Species (N)	Tick Species (N)	Tick Species (N)
	Blacklegged tick (N=56)	Gulf coast tick (N=54)	Lone star tick (N=55)	Am
No disease(s) or condition(s)	12.5% (6)	47.9% (23)	14.6% (7)	25.0
Tick paralysis	27.4% (17)	11.3% (7)	32.3% (20)	29.0

Disease or condition	Tick Species (N)	Tick Species (N)	Tick Species (N)	Tick Species (N)
Lyme disease	51.8% (29)	8.9% (5)	17.9% (10)	21.4%

Table 2. Questions related to tick bite prevention and tick-borne disease concerns and education provided to equine veterinarians during a survey on ticks and tick-borne diseases.

Question

- Do you think there is enough information on tick and tick bite prevention for horses available to veterinarians?
- Did you have coursework during veterinary school related to ticks and tick-borne diseases?
- Do you think there is enough information on ticks and tick-borne diseases in horses provided to horse owners or caretakers?
- Is tick info easy to understand in lay terms?
- How concerned are you about horse(s) that you own, ride, or care for contracting any tick-borne disease?

Table 3. Sources of educational materials about ticks and tick-borne diseases reported by equine veterinarians during a survey on ticks and tick-borne diseases. The numbers in the table represent the percentage of respondents (with the number of respondents in parentheses) who retrieve information on ticks and tick-borne diseases from each source, out a total of 76 respondents for each question.

Education Source	Question
	Where do you get information on ticks, tick prevention, and treatment?
Textbooks	9.2 (7)
Veterinary organizations/groups	39.5 (30)
University Extension	19.7 (15)
Colleagues	22.4 (17)
Continuing Education	29.0 (22)
Conferences or workshops	13.2 (10)
Other	4.0 (3)
I don't get information on ticks and tick-borne diseases	9.2 (7)

Table 4. Equine veterinarian responses to the question “ How many ticks do you estimate you remove from horse(s) in your veterinary care annually per horse?” given as a percent of responses by CDC region.

Region	Number of Ticks	Number of Ticks	Number of Ticks	Number of Ticks	Number of Ticks
	0 ticks	1-2 ticks	3-5 ticks	6-10 ticks	11 or more
Northeast (N=22)	4.3%	8.7%	17.4%	34.8%	34.8%
Midwest (N =10)	20.0%	0.0%	40.0%	20.0%	20.0%
Southeast (N =8)	0.0%	12.5%	50.0%	12.5%	25.0%
South-Central (N =6)	0.0%	33.3%	33.3%	16.7%	16.7%
West (N =14)	0.0%	21.4%	42.9%	21.4%	7.1%
All Regions (N =60)	5.0%	13.3%	31.7%	25.0%	23.3%

Figure 1. The Centers for Disease Control and Prevention “Tick Bite Data Tracker” defined regions (Northeast, Southeast, Midwest, South Central, and West) were used to analyze equine veterinarian responses to survey questions related to ticks and tick-borne diseases.

Figure 2. Total equine veterinarian responses by state to survey questions related to ticks and tick-borne diseases. The color shows number of respondents in each state, with darker colors representing higher response rates and lighter colors lower response rates; white represents 0 respondents.

Figure 3 . The number of horses cared for in an average year as reported by equine veterinarians during a survey on ticks and tick-borne diseases. N=75

Figure 4. Percent of equine veterinarians responding to “What life stage(s) of blacklegged, lone star, or American dog ticks is/are most likely to be found on horses?” in a survey of ticks and tick-borne diseases. The correct answer is in bold. N=62

Figure 5. Topics related to ticks and tick-borne disease that veterinarians wished they knew more about as determined during a survey on ticks and tick-borne diseases. Respondents could select as many options as desired, thus percentage represents the percent of the total number of respondents that completed the question independently for each question (N=58).

Figure 6. Locations on the equine body that best represents where ticks are removed by equine veterinarians from the A) Northeast and Midwest regions (N=33), B) the Southeast and South-Central regions (N=14), and C) West region (N=15). Responses from the Northeast and Midwest and the Southeast and South Central were grouped to combine regions where similar tick species presences and abundance were anticipated. The color scale represents the frequency at which veterinarians found ticks on horses, with blue representing a lower frequency and red representing a higher frequency.





