Sleep deprivation is a common condition among health professionals and has historically been viewed as a rite of passage rather than as a potential health and patient hazard. Recent research has started to shift the frame of reference surrounding the importance of sleep as associations between sleep deprivation and medical errors have gained attention. Prolonged working hours and sleep deprivation also pose substantial risk to both patient care and the health of health-care providers. Veterinary house officers are a particularly vulnerable population both in terms of their limited ability to dictate their working environment and in the rapid accumulation and assimilation of knowledge expected of them.

Among resident physicians, extended working hours and demanding on-call schedules have been shown to have the potential to result in psychomotor impairment comparable to a blood alcohol concentration of 0.04% to 0.05%. Additionally, resident physicians in the US are at an increased risk of motor vehicle accidents after working extended-duration shifts, with 19% of emergency medicine residents reporting being involved in a motor vehicle accident caused by falling asleep. Percutaneous injuries are also more common among interns after working a night shift, with 31% of self-reported incidents citing fatigue as a contributing factor. Similarly, cognitive function is impaired with sleep deprivation; a study evaluating the effect of reducing interns’ work hours on serious medical errors in intensive care units found a 22% higher rate of serious errors among interns working a traditional schedule with extended shifts compared to those working an interventional schedule with no extended shifts and reduced weekly work hours.

In addition to physical and cognitive risks directly associated with exhaustion, burnout is a sig-
niﬁcant problem facing veterinary medicine as a profession.11–13 Both work-related and personal factors likely contribute to the development of burnout among veterinarians.11–13 A survey of internal medicine resident physicians found that those meeting criteria for burnout were signiﬁcantly more likely to cite insufﬁcient sleep and extended working hours as major sources of stress.14 In a survey investigating well-being among veterinarians, serious psychological distress was associated with hours worked per week and was more common among those who often worked evening shifts; conversely, reduced working hours were among factors associated with increased well-being.15

The National Sleep Foundation recommends 7 to 9 hours of sleep for young adults and adults on the basis of a systematic literature review, and a joint consensus statement of the American Academy of Sleep Medicine and the Sleep Research Society indicated that adults should obtain a minimum of 7 h of sleep/night to promote optimal health.16,17 Because sleep quantity and quality may be intrinsically linked to working hours and on-call responsibilities, all of these factors may have important implications for the well-being, health, and education of veterinary house officers. Thus, the objective of this study was to evaluate working hours, on-call responsibilities, and sleep patterns among a large and diverse population of veterinary house officers at multiple academic teaching hospitals. A secondary objective was to evaluate perceptions of fatigue among veterinary house officers. We hypothesized that veterinary house officers would report poor sleep quantity and quality and clinically relevant levels of fatigue and that these ﬁndings would be associated with reported working hours and on-call responsibilities. We also hypothesized that sleep patterns and fatigue would vary by specialty. In reporting baseline sleep patterns, fatigue, work hours, and on-call responsibilities, we hoped to more clearly deﬁne sleep patterns and associated deﬁcits among veterinary house ofﬁcers and identify potential areas for targeted interventions.

Materials and Methods

Study population

The study population comprised small animal rotating interns, large animal interns, specialty interns, and residents from various specialties who were undergoing postgraduate training at academic institutions accredited by the AVMA. House officer email addresses were obtained from a gatekeeper at each institution, and surveys were distributed by an administrator or one of the authors (JBM) such that house officers did not receive the email invitation from a perceived supervisor (eg, faculty). The invitation email explained the purpose of the study and instructed house ofﬁcers that their participation was voluntary and would not affect their performance and responses would be collected anonymously. To eliminate perceived pressure to participate, house ofﬁcers under the direct supervision of the principal investigator (VFS) were excluded from the study. Responses were collected beginning in October of 2020, and weekly reminders were distributed for a total of 4 weeks. This study was approved by the North Carolina State University Institutional Review Board.

Survey

A 62-item questionnaire consisting of predominantly 4- and 5-point Likert scales was created to elicit objective information regarding demographics, postgraduate position, specialty, working hours, on-call responsibilities, sleep patterns, perceived effects of fatigue, and other potential factors contributing to wellness (Supplementary Appendix S1). Study data were collected and managed by use of electronic data capture tools hosted at the principal investigator’s institution (REDCap version 10.2.3, Vanderbilt University). Participants were asked to share subjective information regarding perceived caseload, sleep quality, and the effects of fatigue on technical skills, clinical judgment, and ability to empathize within the previous 4 weeks. Participants were asked to recall information including average working hours, sleep quantity, and demographic information. Both subjective and objective data were utilized in statistical analysis.

Statistical analysis

All analyses were performed by use of a statistical software package (SPSS version 27.0; IBM Corp). Response counts and percentages for nonmissing data were determined for each item on the questionnaire. When responses were analyzed by specialty, only disciplines with 10 or more respondents were included in the analysis. Age was categorized into ranges and treated categorically for comparison (eg, ≤25, 26 to 29, 30 to 34, and ≥35). Categorical responses of interest were compared across demographic variables and specialties by use of χ² tests, and a Bonferroni correction was applied to correct for compounding family-wise error. The Bonferroni correction reduced the P value for detecting statistically signiﬁcant differences from P ≤ 0.05 to P ≤ 0.0011 when responses were evaluated by specialty and to ≤0.013 to 0.002 for the remaining subscale analysis on the basis of the respective degrees of freedom for each comparison. Thus, the level of signiﬁcance was set at P ≤ 0.001 when responses were evaluated by specialty and to ≤0.013 to 0.002 for all sub-scale analyses. Odds ratios with 95% CIs were calculated to determine relative difference. Comparisons of average reported sleep quantity (between on and off clinics, weekdays and weekends) were performed by use of a Student t test with signiﬁcance set at P ≤ 0.05. A Pearson correlation coefﬁcient was calculated to determine the level of correlation between working hours and sleep quantity, with signiﬁcance set at P ≤ 0.05.

Results

A total of 303 house ofﬁcers from 9 institutions responded to the survey. Demographic information
of respondents is shown (Table 1), as is a summary of responses by specialty (Table 2). Distribution of respondents by reported specialty is also shown (Figure 1). The most commonly represented specialties were small animal surgery (n = 34), small animal rotating interns (32), small animal internal medicine (30), emergency and critical care (28), and radiology (22).

Caseload

Two hundred forty-one respondents reported having clinical or patient care responsibilities for >75% of the year. The estimated number of cases seen during an average clinic week by specialty is shown (Table 3). Sixty-eight percent (206/303) of respondents reported feeling that their caseload was adequate and seemed appropriate for their professional development, 27% (82/303) reported that their caseload was too high and impaired their ability to learn from their cases, and 5% (15/303) reported that their caseload was too low to facilitate their training.

Working hours

Most house officers went into the clinic an average of 5 d/wk (33% [99/302]), 6 d/wk (34% [104/302]), or 7 d/wk (32% [95/302]). There was
a significant association between specialty and the average number of days reporting to the clinic, with small animal surgery residents (OR, 9.17; 95% CI, 3.93 to 21.43; \( P < 0.001 \)), large animal surgery residents (OR, 64.91; 95% CI, 3.81 to 1107.03; \( P = 0.004 \)), and large animal internal medicine residents (OR, 7.66; 95% CI, 2.41 to 24.32; \( P < 0.001 \)) more likely to work 7 d/wk and small animal interns more likely to work 6 d/wk (\( P < 0.001 \)). The majority of house officers (58% [174/302]) reported spending 11 to 13 hours in the clinic on an average weekday, with 25% (76/302) reporting averages of 8 to 10 hours and 15% (44/302) reporting \( \geq 14 \) hours in the clinic on an average weekday. When analyzed by specialty, emergency and critical care residents were more likely to spend \( \geq 14 \) hours in the clinic (OR, 5.76; 95% CI, 2.34 to 14.18; \( P < 0.001 \)).

On an average weekend day, 48% (146/302) of house officers reported spending 2 to 5 hours in the clinic, although 15% (44/302) reported spending \( \geq 14 \) hours in the clinic on an average weekday. When analyzed by specialty, emergency and critical care residents were more likely to spend \( \geq 14 \) hours in the clinic (OR, 5.76; 95% CI, 2.34 to 14.18; \( P < 0.001 \)).

### On-call duty

The average number of days on call per month is shown (Table 4). The majority of house officers (45% [135/300]) reported being on call for 8 to 14 d/mo. Of the house officers with on-call responsibilities, 49% (124/255) reported being on call for 7 consecutive days, whereas 21% (53/255) reported 3 to 4 consecutive days on call and 24% (78/255) reported \( \leq 2 \) consecutive days on call. When analyzed by specialty, small animal internal medicine residents were significantly more likely to have on-call responsibilities for 7 consecutive days (OR, 5.08; 95% CI, 3.00 to 19.77; \( P < 0.001 \)). Radiology residents were more likely to report being on call \( < 7 \) d/mo (OR, 7.7; 95% CI, 3.00 to 19.77; \( P < 0.001 \)).

On call, the majority of house officers (65% [167/256]) reported receiving an average of 1 to 2 calls/night, and 18% (45/256) reported receiving an average of 3 to 4 calls/night. Small animal surgery residents were significantly more likely to receive \( \geq 3 \) calls/night (OR, 4.96; 95% CI, 2.25 to 10.93; \( P < 0.001 \)). Of after-hours calls received, 43% (122/285) estimated that \( < 25 \% \) of calls required them to come into the clinic, whereas 23% (66/285) reported that \( > 75 \% \) of calls received required them to report to the clinic. Small animal surgery and anesthesia residents were significantly more likely to report a higher percentage (\( > 50 \% \)) of calls requiring them to come into the hospital (OR, 3.33; 95% CI, 1.55 to 7.16; \( P = 0.002 \); and OR, 75.00; 95% CI, 4.40 to 1279.07; \( P = 0.003 \), respectively).

### Sleep quantity and quality

Average hours of sleep reportedly obtained on week and weekend nights on and off clinics are shown (Figure 2). The overall average number of reported hours slept during a weekday on clinics was significantly less than hours slept during a weekday off clinics (6.0 hours on clinics and 7.5 hours off clinics; \( P < 0.01 \)). Similarly, house officers reported sleeping significantly less during weekends on clinics than during weekends off clinics (average of 6.6 hours on clinics and 7.7 hours off clinics; \( P < 0.01 \)).
Only 4% (10/289) of house officers reported sleeping ≥ 8 hours during a weeknight on clinics versus 59% (169/289) reporting sleeping ≥ 8 hours during a weeknight off clinics. House officers were also more likely to obtain ≥ 8 hours of sleep during weekend nights off clinics compared to weekend nights on clinics (OR, 15.40; 95% CI, 10.25 to 23.13; \( P < 0.001 \)).

Working hours were negatively related to sleep quantity, with house officers who reported working an average of ≥ 14 hours more likely to report only 4 to 5 hours of sleep and those working 8 to 10 h/d more likely to report ≥ 7 hours of sleep (Figure 3; Pearson correlation coefficient, −0.54; \( P < 0.001 \)). House officers who reported sleeping an average of 4 to 5 h/night when on clinics were more likely to describe their caseload as too high (OR, 4.84; 95% CI, 2.74 to 8.56; \( P < 0.001 \)). There was no association between position (resident vs intern), age, gender, year in program, or on-call responsibilities and average hours slept when on clinics (\( P > 0.05 \)).

Perceived sleep quality when on call and off call is shown (Figure 4). House officers were significantly more likely to report poor sleep quality when on call than when not on call (OR, 5.01; 95% CI, 2.44 to 10.32; \( P < 0.001 \) and have a low (< 25%) likelihood of a call requiring them to report to the clinic (OR, 2.18; 95% CI, 12.3 to 3.84; \( P = 0.008 \)). There was no association between quality of sleep on call and the number of consecutive days on call, specialty, year in program, age, or gender (\( P > 0.05 \)).

The majority of house officers (68% [198/290]) reported that their current sleep habits were somewhat or much worse than their sleep habits prior to internship or residency, whereas only 10% (28/290) reported that their current sleep habits were better than their sleep habits prior to their current training program. Only 6% felt that their internship or residency did not interfere with their sleep in the preceding 4 weeks, 39% (114/290) felt that their internship or residency interfered quite a bit with their sleep, and 15% (43/290) felt that their internship or residency interfered with their sleep to an extreme degree. When analyzed by specialty, medical oncology house officers reported experiencing better sleep habits at the time of the survey compared to prior to their training program (OR, 35.60; 95% CI, 8.75 to 144.57; \( P < 0.001 \); conversely, small animal surgery

Figure 2—Hours of sleep per night as reported by respondents (veterinary house officers) in Table 1 when on and off clinics on weeknights (panel A) and weekends (panel B).

Figure 3—Relationship between reported average working hours and sleep quantity of veterinary house officers. The number of reported hours worked per day were negatively associated with sleep quantity (Pearson correlation coefficient, −0.54; \( P < 0.01 \)).

Figure 4—Perception of sleep quality as reported by respondents (veterinary house officers) in Table 1 when on call and when not on call. House officers were more likely to report poor sleep quality when on call than when not on call (\( P < 0.01 \)).
residents were more likely to report that their current sleeping habits were much worse compared to prior to their residency (OR, 4.33; 95% CI, 2.01 to 9.33; P < 0.001). Similarly, when asked to what extent their training program interfered with current sleep habits, radiology residents were more likely to select “not at all,” whereas small animal surgery residents were more likely to select “extremely” (OR, 14.51; 95% CI, 4.33 to 48.60; P < 0.001; and OR, 4.12; 95% CI, 1.75 to 9.69; P = 0.001). Respondents who described their caseload as too high were also more likely to describe their current sleep habits as much worse compared to prior to their current training program (OR, 3.29; 95% CI, 1.89 to 5.73; P < 0.001).

When asked how long house officers felt they could sustain their current sleep habits, 52% (150/290) felt that they could sustain their current sleep habits for 2 to 5 years, 20% (59/290) felt they could sustain their current sleep habits for another year, and 11% (32/290) felt they could not sustain their current sleep habits for another year. There was no association between specialty, year in program, gender, or age and sustainability of sleep habits (P > 0.05).

Fatigue

The majority of house officers reported that over the preceding 4 weeks, fatigue had interfered to some degree with their clinical judgment, technical skills, and ability to empathize. The perceived negative effect of fatigue on ability to empathize was reported most commonly, with 40% (115/288) of house officers reporting that fatigue interfered extremely or quite a bit with their ability to empathize. Perceived negative effects of fatigue on clinical judgment and technical skill were less commonly reported; 16% (44/288) and 13% (38/288) of house officers described fatigue interfering extremely or quite a bit with their clinical judgment or technical skills, respectively. Eighty percent (92/115) of respondents who reported that fatigue negatively interfered with their ability to empathize also reported sleeping < 7 h/night when on clinics; similarly, 80% (66/82) of respondents who reported that fatigue negatively interfered with their clinical judgment or technical skills also reported sleeping < 7 h/night when on clinics.

When evaluating working hours and fatigue, house officers who reported working > 14 h/d were more likely to report that fatigue negatively impacted their clinical judgment, ability to empathize, and technical skill (P < 0.001). During the preceding 4 weeks, 37% (108/290) of respondents reported rarely or never feeling energetic, whereas 65% (190/290) reported feeling worn out often or almost always over the same time period. There was no association between age, gender, year in program, specialty, or primary caregiving responsibilities and energy level or perceived effects of fatigue (P > 0.05).

Discussion

This study demonstrated that there is cause for concern regarding sleep patterns of veterinary house officers, with the majority of interns and residents obtaining substantially less than the recommended quantity of sleep needed for optimal learning and performance.16-19 House officers appeared to perceive this impact on the basis of their negative ratings of current sleep habits, with 31% of respondents reporting that their current sleep patterns would be unsustainable for > 1 year.

Previous research has demonstrated the importance of sleep in supporting cognitive health and the ability to learn new information.20 Lack of rapid eye movement sleep is associated with decrements in perceptual learning and memory assimilation, whereas insufficient non–rapid eye movement sleep reduces the ability to perform learned tasks.21 While there is debate regarding what constitutes sleep deprivation, most experts agree that 7 to 8 h of sleep/d is considered healthy for adults and anything less than 5 to 7 hours, even for a single night, is inadequate for optimal function.22 Previous research has demonstrated the importance of sleep in supporting cognitive health and physical and mental health. Previous research has demonstrated that following sleep deprivation, even achieving 8 h of sleep/d for 3 consecutive days is not enough to recover normal levels of cognitive function23; thus, while time off clinics and increased weekend sleep are often viewed as attractive options for restoration of sleep and energy, this imbalanced time allotment is likely insufficient to restore the sleep deficit created by clinical duty for many interns and residents. Furthermore, though sleep quantity appears slightly improved during off-clinic time, the average duration of sleep reported by house officers in this study remains below 8 h/night, both on and off clinics. This suggests that the factors negatively impacting sleep quantity extend into off-clinic time or that house officers may not recognize the importance of obtaining 8 hours of sleep to maximize cognitive function and physical and mental health. A recent study of acute care surgeons from level 1 trauma centers demonstrated that the disruptive effects on sleep from on-call responsibilities extend into the post-call period, with sleep patterns failing to return to baseline until post-call day 3.24 This phenomenon likely extends to other specialists with on-call responsibilities and warrants additional evaluation among veterinary specialists and postgraduate trainees.
While obtaining the minimal amount of recommended sleep is critical, sleep quality is also an important component of healthy sleep habits.20 The majority of house officers in this study reported getting worse sleep compared to prior to their internship or residency, and 95% of respondents felt that their training program interfered with their sleep. Those that reported experiencing better sleep during their training program may overestimate improvement, as the majority of house officers in this category were residents who may have been drawing comparisons to their internship sleep levels. House officers were more likely to report poor sleep when on call, suggesting this may be an important determining factor of sleep quality in this population. Furthermore, anticipation associated with being on call itself may be disruptive to sleep. This is supported by the number of house officers reporting poor sleep quality when on call despite receiving few calls and a low likelihood of needing to report to the clinic. It is possible that even receiving as few as 1 to 2 calls can cause sleep disruption such that it is difficult to fall back asleep, particularly when the calls require critical thinking and decision-making in the face of sleep inertia. The sleep habits of small animal surgery residents appeared to be more affected by their training program compared to those of residents in other specialties, likely due to a high on-call burden with a high proportion of calls requiring them to report to the hospital. This may comprise an important consideration for veterinary students considering potential areas of specialization and may also serve as an important consideration for surgery residency programs when designing on-call structure.

Working hours were negatively related to sleep quantity while on clinics, with the majority of house officers reporting working an average of 11 to 13 h/d while obtaining 6 h of sleep/night. Sleep deprivation and fatigue among trainees has raised significant concern for patient safety in human medicine, resulting in restrictions mandated by the Accreditation Council for Graduate Medical Education in 2003.21 Additional recommendations have been made regarding these mandates in subsequent years, including the following: maximum of 80 h/wk averaged over 4 weeks and maximum duty periods no longer than 16 hours for first-year residents and 24 hours for residents after second year.1-3,18,27,28 In addition, in-hospital on call is limited to not more than every third night, at-home on call is counted toward the 80-hour work week, and first-year residents must have 8 hours off call between duty hours.18,26-28 Although several studies have attempted to evaluate the impact of reduced working hours on preventable medical errors and resident wellness, equivocal and contradictory results have led to disagreement among experts regarding the net benefits of these regulations.29 One clear result of the restriction of resident working hours, however, is the significant financial burden for teaching hospitals, as additional staff is required to maintain clinical coverage.28,30 Additionally, some studies have reported worsened educational outcomes following restrictions on physician trainee hours, which is suspected to be due to reduced clinical exposure.31,32 In a survey of exiting veterinary house officers, only 37% of respondents felt that a mandated restriction of duty hours would be a positive change and 43% were concerned about the detrimental effects that restricted hours would have on clinical experience.28 Approximately two-thirds of house officers in the same study did not feel that they had time to address personal needs, highlighting the complicated and dynamic relationship between working hours, clinical education, and wellness.

Fatigue was commonly reported among house officers in this study, with 40% of respondents reporting that fatigue negatively impacted their ability to empathize. Loss of empathy in health-care professionals has been associated with burnout.33-35 While historical concerns regarding sleep deprivation among physicians have centered on medical errors, the rising awareness of burnout and mental health issues among veterinarians warrants additional focus on the potential impacts of sleep deprivation on mental health among veterinary house officers.

Interestingly, the working hours reported by many house officers in this study were less than the restricted duty hours mandated by the Accreditation Council for Graduate Medical Education. This suggests that veterinary house officer duty hours may be substantially less than those of resident physicians, although the method of duty hour data collection in this study did not facilitate direct comparison between human and veterinary postgraduate trainee working hours. While there is some expectation that the time required for postgraduate veterinary specialty training is extensive, the results of this study indicated that working hours and chronic sleep deprivation may be important challenges to the well-being of veterinary house officers. Improvements in structural support, including but not limited to distribution of on-call responsibilities among more house officers, more flexible scheduling, more frequent protected days off duty, and improved technical support, may have the potential to alleviate some of these challenges and should be further evaluated.

There were several limitations of this study, including the subjective nature of the survey and the inability to directly measure effects of sleep deprivation. Because this study relied on self-reported and subjective data, numeric values (eg, hours worked) may have been influenced by recall bias and may not accurately reflect the clinical scenario of the respondents. In addition, order effect bias may have been present in this study, with the potential for certain questions to sensitize respondents in their answers to subsequent questions. The ultimate number of survey invitations distributed was unknown due to the use of listservs at some participating institutions; thus, we were unable to evaluate response bias. It was possible that the results of this study reflected a response bias toward house officers that perceive or experience worse sleep, leading to an overestimation of the negative findings associated with sleep and fatigue. Additionally, only house officers from...
academic institutions were included, and the reported results may not apply to trainees in private practice or to those in residency programs not evaluated in this study (ie, laboratory animal medicine). To protect the anonymity of participants, responses were not evaluated by institution and it is possible that other institutional factors may have influenced the results. While we concluded that the associations between working hours and on call may be important factors contributing to the sleep patterns of veterinary house officers, causation cannot be determined due to the cross-sectional design of this study.

Despite these limitations, this was the first formal study to investigate and report sleep habits among veterinary house officers. Factors influencing sleep quantity and quality among residents and interns are multiple and interconnected, and effective strategies for intervention are likely to be similarly complex. The controversy surrounding efficacy of work hour restrictions suggests that a multimodal approach is needed. Furthermore, differences between specialties identified in this study implied that both the need for intervention and specific strategies for improvement may vary by specialty. Structuring of on-call responsibilities and the management of overnight patient care should be critically evaluated by programs to ensure that protected opportunity for sleep is maximized and potential sleep disruption minimized.

In cultures such as that of house officers, resilience is often championed and exhaustion may be perceived as weakness. Thus, education of both educator and trainee is an essential component of mitigating unhealthy sleep patterns among house officers. Awareness of what constitutes a healthy amount of sleep and the profound detriments of sleep deprivation is minimal among the general population, and many house officers may not prioritize getting 7 to 8 h of sleep/night even if provided with sufficient time. Targeted programs to provide education regarding healthy sleep habits may be incorporated into intern and resident training programs. Similar education should be considered for faculty participating in house officer training to provide a comprehensive approach to raising awareness of healthy sleep habits and the consequences of acute and chronic sleep deprivation. Further studies are indicated to evaluate the efficacy of specific interventions to improve awareness of healthy sleep habits and to reduce sleep deprivation among veterinary house officers.

While this study supported that veterinary house officers work long hours and experience some extent of chronic sleep deprivation during training, the specific impact of this deprivation on well-being, physical and mental health, education, development of burnout, and patient care remains unclear. Although the findings of this study were arguably expected, we posit that the expectations regarding sleep and fatigue need to shift in light of established research demonstrating the importance of healthy sleep habits for physical and mental health and patient safety. Furthermore, the habits formed during house officer training may shape behaviors throughout one’s profession. Thus, poor sleep habits developed during internship and residency may continue to negatively impact well-being, performance, and physical health of veterinary specialists. Many of the norms regarding work hours and sleep deprivation among house officers are implicitly ingrained in our educational model and enforced upon the next generation on the basis of the experience of the previous generation. We hope that this study will heighten awareness of disturbing sleep patterns among veterinary house officers and stimulate further research into how these trends may be addressed to facilitate improved health, education, and success of veterinarians pursuing postgraduate training.

**Acknowledgments**

No third-party funding or support was received in connection with this study or the writing or publication of the manuscript. The authors declare that there were no conflicts of interest.

Statistical analysis was supported by Dr. Emily Griffith. The authors would like to thank Drs. Steven Marks, Laura Nelson, and Kenneth Royal (North Carolina State University); Dr. Michelle Oblak (University of Guelph); Dr. Penny Regier (University of Florida); Dr. Owen Skinner (University of Missouri); Dr. Selena Tinga (The Ohio State University); Dr. Katya Townsend (Oregon State University); Dr. Mandy Wallace (University of Georgia); and Dr. Rebecca Walton (Iowa State University) for assistance with instrument design and data collection.

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**Supplementary Materials**

Supplementary materials are posted online at the journal website: avmajournals.avma.org