

Risk factors associated with work-preventing musculoskeletal discomfort in the upper extremities of bovine practitioners

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OBJECTIVE

To identify risk factors associated with work-preventing musculoskeletal discomfort (MSKD) in the upper extremities (defined as neck, shoulders, upper back, arms, elbows, wrists, and hands) of bovine practitioners.

SAMPLE

116 members of the Western Canadian Association of Bovine Practitioners.

PROCEDURES

Data from a previously described cross-sectional survey of western Canadian bovine practitioners underwent further analysis. The survey, developed to glean information about MSKD in bovine practitioners, was a modified standardized Nordic questionnaire that included questions regarding personal and work characteristics and incidence and location of MSKD during the preceding 12 months along with perceptions about most physically demanding tasks. Logistic regression was used to identify factors associated with work-preventing upper extremity MSKD.

RESULTS

18 of 116 (15.5%) respondents indicated they had experienced work-preventing upper extremity MSKD during the preceding 12 months. The final multivariable regression model indicated that practice type (mixed animal vs primarily [$> 50\%$] bovine; OR, 3.20; 95% CI, 0.96 to 10.67), practitioner height (OR, 0.93; 95% CI, 0.87 to 0.99), and number of veterinarians in the practice (OR, 1.32; 95% CI, 1.05 to 1.66) were significantly associated with the odds of work-preventing upper extremity MSKD.

CONCLUSIONS AND CLINICAL RELEVANCE

Results suggested that reproductive examination of cattle was not a significant risk factor for upper extremity MSKD in bovine practitioners. Further research into the effects of biomechanical, organizational, and psychosocial workplace factors on the development of MSKD in bovine practitioners is necessary to help inform prevention strategies to foster career longevity in this increasingly diverse practitioner group. (*J Am Vet Med Assoc* 2020;257:410–416)

In 1996, Dr. Ronald Ailsby, a Canadian orthopedic surgeon who had treated a number of bovine practitioners with shoulder and neck pain, hypothesized that performing reproductive examinations on large animals was associated with injury to the cervical plexus.¹ Since then, several epidemiological studies of musculoskeletal injuries and discomfort (aches or pain in muscles, bones, or tissues) in veterinarians have been conducted in the United States,^{2–6} Australia,⁷ New Zealand,^{8,9} Europe,^{10–12} Turkey,¹³ and western Canada,^{14,15} with 3 of those studies^{2,7,14} focusing specifically on MSKD of veterinarians who work with cattle. Although the scope varied among those studies,^{1–15} the prevalence of MSKD among large ani-

mal veterinarians was consistently high, with the lifetime prevalence of MSKD ranging from 47% to 71% among large animal veterinarians in the United States.^{2,4,6} In a New Zealand study,⁸ the mean prevalence of any type of MSKD during the preceding 12 months was 100% (95% CI, 96% to 100%) among large animal veterinarians. In many studies, the region comprised of the neck and upper extremities (defined as neck, shoulders, upper back, arms, elbows, wrists, and hands) was the most common or second most common body region affected by MSKD in veterinarians.^{4,6,8,11}

On average, each bovine practitioner in western Canada performs $> 8,000$ reproductive examinations/y, generally in the fall or early winter for beef cattle and year-round for dairy cattle.¹⁴ In cattle, reproductive examination is conducted primarily for determination of pregnancy status and is generally performed by manual insertion of the practitioner's arm into the rectum with or without an ultrasound probe, or insertion

ABBREVIATIONS

MSKD	Musculoskeletal discomfort
SNQ	Standardized Nordic questionnaire
WCABP	Western Canadian Association of Bovine Practitioners

of an ultrasound probe into the rectum by use of an ultrasound handle extender, which eliminates the need for the practitioner to insert their arm into the rectum. Regardless of the method used for reproductive examination, bovine practitioners are exposed to repetitive and forceful nonneutral postures, or ergonomic hazards.¹⁵ Manual insertion of an arm into the rectum of a cow requires high force initially to pass through the anal sphincter and then nonneutral postures must be assumed to maintain body stability against the movements of the animal.¹⁵ There is evidence that awkward (nonneutral) postures, high forces, and repetitive movements can contribute to MSKD or injuries.^{16,17}

Reproductive examination is consistently proposed as a major contributor to MSKD in large animal veterinarians on the basis of survey results.^{6,9,13} In a survey¹⁸ of Utah veterinarians, 40 of 43 (93%) respondents who frequently performed reproductive examinations on large animals (cattle and horses) reported MSKD that they attributed to that task. However, epidemiological studies have yielded equivocal results regarding the role of reproductive examination of large animals on the incidence of musculoskeletal injuries and MSKD in large animal practitioners. In a study⁸ of New Zealand veterinarians, the self-reported number of reproductive examinations performed each year was associated with the self-reported number of work-preventing musculoskeletal events, but a consistent dose-response relationship was not established. In a study⁷ of Australian bovine practitioners, obstetric procedures including reproductive examinations accounted for most serious injuries (ie, injuries that required hospitalization or prevented the practitioner from working), although only 17% of injuries associated with reproductive examination were attributed to overexertion or strain. Results of a study² of members of the American Association of Bovine Practitioners indicated that although MSKD was most commonly reported for the arm and shoulder predominately used for reproductive examinations, the amount of exposure (ie, number of reproductive examinations performed) was not predictive of the likelihood of MSKD, and the severity of MSKD was not reported. In a study¹¹ of German veterinarians, reproductive examination was associated with a small and nonsignificant increase in the odds of self-reported work-preventing injuries to the hand, wrist, and elbow. Only a study⁶ of California practitioners identified a significant, albeit small, dose-response relationship between the self-reported percentage of time spent performing reproductive examinations and the self-reported incidence of MSKD.

Our research team recently published a descriptive analysis¹⁴ of bovine veterinarians in western Canada. In that study,¹⁴ we quantified the prevalence of MSKD among survey respondents, described the effect of MSKD on veterinary work-related activities, and identified the most physically demanding tasks for further investigation. One hundred nineteen of 133 (89.5%) respondents indicated that they had ex-

perienced MSKD in the preceding 12 months, with the most commonly affected body regions being the shoulder (85/133 [63.9%]), lower back (75/133 [56.4%]), and neck (68/133 [51.1%]).¹⁴ Thirty-five of 133 (26.3%) respondents reported MSKD that interfered with regular work activities in the 12 months preceding the survey.¹⁴ One hundred two of 357 (28.6%) respondents indicated that reproductive examination was 1 of the top 3 most physically demanding tasks that they engaged in at work.¹⁴ A secondary analysis of those data revealed that practitioners who were female, less experienced, worked in larger practices, and engaged in primarily mixed-animal work were more likely to have MSKD of the shoulder.¹⁵

The purpose of the study reported here was to identify individual and work-related risk factors associated with work-preventing MSKD of the upper extremities of bovine practitioners working in western Canada. We hypothesized that the cumulative workload associated with reproductive examinations would be a significant predictor of MSKD in the upper extremities of survey respondents.

Materials and Methods

Participant recruitment and data collection

All study procedures were reviewed and approved by the University of Saskatchewan Biomedical Ethics Board. This study represented further analysis of data obtained from a previously described survey.¹⁴ Methods used for survey development and data collection are described elsewhere.¹⁴ Briefly, 262 practicing and retired practitioners who were members of the WCABP were targeted for survey participation. The survey was initially mailed to potential participants in the spring of 2017 via the WCABP quarterly newsletter. The Dillman method¹⁹ was used to send an additional 3 targeted mailings of the survey to potential participants at addresses provided by the WCABP. Survey participation was voluntary, and data were collected between March and August 2017.

Survey design

The survey was cross-sectional in nature. It consisted of 25 questions on personal characteristics (ie, anthropometric indices, sex, handedness, and general musculoskeletal health), work experience, and commonly performed tasks. The survey asked respondents to focus on the preceding 12 months and estimate the number of bovine reproductive examinations performed per year and percentage of practice time apportioned to dairy, beef, equine, other large animal, and small animal patients. A modified SNQ²⁰ was used for assessment of MSKD during the preceding 12 months at the following body regions: neck, shoulders, upper back, elbows, wrist or hands, lower back, hips or thighs, knees, and ankles or feet. For each body region, respondents were asked to respond to the following 3 questions: "Have you at any time in the last 12 months had trouble (ache,

pain, discomfort)?”, “Have you at any time in the last 12 months been prevented from doing your normal work (at home or away from home) because of the trouble?”, and “Have you at any time in the last 12 months been prevented from doing bovine tasks because of the trouble?”

Variable definitions

For the present analysis, the outcome (dependent) variable of interest was whether the respondent had been prevented from doing normal or bovine veterinary work in the preceding 12 months because of any upper extremity (defined as neck, shoulders, upper back, elbows, wrists, and hands) trouble (ie, MSKD). Combining those body regions was necessary owing to the fairly low number of respondents who reported interruption of work activities because of MSKD at any specific body region. Moreover, combining those body regions was considered appropriate because common injuries to the arms have pain referral patterns that include many or all of the body regions defined as part of an upper extremity.^{21–23}

Survey data were used to estimate several new variables. For example, responses to the survey questions “Indicate the average number of rectal examinations you perform per year” and “If you use ultrasound, what percentage of time do you use an extension (handle extender)?” were used to estimate the number of manual reproductive examinations and number of ultrasound handle extender-assisted reproductive examinations performed per year. The numbers of reproductive examinations performed for beef and dairy cattle reported by individual respondents were used to infer the primary cattle type with which a respondent worked. A variable called palpation arm was created to determine whether performing reproductive examinations with the dominant or nondominant arm affected the prevalence of MSKD.

Statistical analysis

Logistic regression was used to identify risk factors associated with work-preventing upper extremity MSKD for respondents. The logistic regression model was built by purposeful selection of covariates as described.²⁴ Briefly, each potential independent variable was assessed in a univariate logistic regression model, and variables with values of $P < 0.25$ were included in a multivariable logistic regression model, which was further reduced by assessing significance, interactions, confounding status, and best fit as well as the biological plausibility of the remaining variables. Both continuous and categorical variables were included as covariates in the multivariable logistic regression model. During multivariable model building, data for continuous covariates were categorized, and the resulting categorical variable was substituted for its parent (continuous) variable in the model. If the categorical variable did not

improve the level of significance for the risk factor in question, it was removed and replaced by the parent variable. The Spearman correlation coefficient (ρ) was used to assess for multicollinearity between covariates. For any independent covariate pair with a $\rho > 0.50$, only the covariate that best represented the population was evaluated in the multivariable model. The final model included only covariates with values of $P < 0.05$ and covariates that improved the overall model fit regardless of their P values. The Hosmer-Lemeshow test was used to assess how well competing models fit the data. The likelihood ratio test was used to evaluate for potential interactions between covariates in the final model. Potential confounding between the independent covariates retained in the final model and those that were offered to but removed from the final model was assessed by comparison of the adjusted and crude (unadjusted) ORs for the primary (retained) covariate; confounding was defined as a $> 15\%$ difference between the adjusted and crude ORs. Results were reported as the ORs and associated 95% CIs. All analyses were performed with commercially available statistical software.^a

Results

Respondents

Completed and partially completed surveys were received from 133 of the 262 veterinarians targeted for participation, which corresponded to a survey response rate of 51%. Responses from retired veterinarians and those who reported that they had not performed any reproductive examinations in the past year or provided the mean number of reproductive examinations performed per year over the duration of their careers were removed from the analyses. Analyses included only data from 116 respondents who reported that they had performed reproductive examinations during the 12 months prior to survey completion.

Logistic regression findings

The demographics of respondents and univariable logistic regression results were summarized (Table 1). Eighteen of 116 (15.5%) respondents reported that they had experienced work-preventing upper extremity MSKD during the preceding 12 months. Variables eligible for consideration in the multivariable logistic regression model included age, sex, height, body mass index, palpation arm, practice type, number of reproductive examinations performed per year, years of experience, and number of other veterinarians in the practice. There was a strong positive correlation ($\rho > 0.60$) between sex and height. Because height appeared to be more significantly associated with the outcome than did sex, only height was evaluated in the multivariable model.

Number of reproductive examinations performed per year did not contribute significantly to work-pre-

Table 1—Summary of univariate logistic regression analyses of risk factors associated with work-preventing MSKD of the upper extremities within the preceding 12 months as reported by 116 bovine practitioners in western Canada who responded to a survey on the topic between March and August 2017.

Variable	Category	No. of respondents*	No. of respondents with work-preventing MSKD of an upper extremity	Unadjusted OR (95% CI)	P value
Age	—	115	18	0.97 (0.92–1.01)†	0.12
Sex	Male	83	7	Referent	< 0.01
	Female	32	11	5.69 (1.96–16.48)	
Height	—	116	18	0.92 (0.87–0.96)‡	< 0.01
Palpation arm	Nondominant side	67	8	Referent	0.22
	Dominant side	49	10	1.89 (0.69–5.21)	
Body mass index	Normal	40	8	Referent	
	Overweight	49	5	0.46 (0.14–1.52)	0.20
	Obese	26	5	0.95 (0.27–3.31)	0.94
Perception of overall health	Excellent	34	4	Referent	
	Very good	60	9	1.32 (0.38–4.67)	0.66
	Good or fair	22	5	2.21 (0.52–9.34)	0.28
Years of experience	—	116	18	0.96 (0.92–1.01)†	0.10
No. of other veterinarians in the practice	—	113	17	1.19 (0.98–1.45)§	0.08
Median No. of reproductive examinations/y	< 8,950	58	12	Referent	—
	≥ 8,950	58	6	0.44 (0.15–1.27)	0.13
Practice type	> 50% bovine	78	8	Referent	—
	Mixed	38	10	3.13 (1.12–8.73)	0.03
Cattle type	Primarily beef	82	13	Referent	—
	Primarily dairy	33	5	0.95 (0.31–2.91)	0.93

Variables with a value of $P < 0.25$ were eligible for inclusion in a multivariable logistic regression model.

*The number of respondents varies among variables because some respondents chose not to provide information for some variables. †Per 1-year increase. ‡Per 1-cm increase. §Per 1-veterinarian increase. ||Includes reproductive examinations performed manually and by use of an ultrasound handle extender.

— = Not applicable.

Table 2—Results of multivariable logistic regression modelling of risk factors associated with work-preventing MSKD of the upper extremity within the preceding 12 months as reported by the survey respondents described in Table 1.

Variable	Category	Adjusted OR (95% CI)	P value
Height	—	0.93 (0.87–0.99)	0.04
Veterinary colleagues	—	1.32 (1.05–1.66)	0.02
Practice type	> 50% bovine	Referent	—
	Mixed	3.20 (0.96–10.67)	0.06

Hosmer-Lemeshow test for model fit, $P = 0.850$.

See Table 1 for remainder of key.

venting upper extremity MSKD for the survey respondents, nor did it appear to significantly contribute to the fit of the final model or act as a confounder. The final best-fit multivariable logistic regression model included practice type, height, and the number of other veterinarians in the practice (**Table 2**). Although practice type had a $P > 0.05$, it contributed to a higher Hosmer-Lemeshow result and improved the fit of the model; thus, it was identified as the primary risk factor in the final model. No significant interactions were identified among the 3 variables included in the final model. Height and number of other veterinarians in the practice were identified as confounders to practice type, albeit in opposite directions. Height confounded practice type by 41% away from the null, and number of other veterinarians in the practice confounded

practice type by 31% toward the null. No other confounders were identified.

Discussion

Results of the present study indicated that practice type was the primary risk factor for work-preventing upper extremity MSKD for bovine practitioners in western Canada. The odds of reporting work-preventing upper extremity MSKD in the preceding 12 months were 3.2 for practitioners who worked in mixed-animal practices, compared with practitioners who spent > 50% of their practice time working with cattle. That finding was unexpected and contrary to results of other studies.^{3,4,8} Unlike those other studies,^{3,4,8} the present study did not include any veterinarians who worked with small animals exclusively; therefore, that finding may be associated with a healthy-worker effect specific to the respondents of this survey. In the descriptive analysis¹⁴ of the survey data, many respondents reported that, as their careers progressed, they had reduced the amount of time spent working with cattle and spent more time in mixed animal practice because of MSKD. It is possible that veterinarians who devote > 50% of their time to bovine practice late into their careers are able to do so because they remain healthy, whereas those with musculoskeletal injuries or MSKD may decrease the amount of time they spend working with large animals and transition into mixed animal or small ani-

mal practice. Another explanation for the apparent healthy-worker effect observed in this study was that, as respondents gain experience, they learn adaptations for performing physically demanding tasks to decrease their risk of injury. Regardless, the results of the present study were similar to findings of a previous analysis¹⁵ in which the odds of MSKD of the shoulder within the preceding 12 months for mixed animal veterinarians were 2.83 (95% CI, 1.01 to 7.93) times those for primarily bovine veterinarians.

The present study indicated that the odds of work-preventing upper extremity MSKD decreased as the respondent's height increased. This was expected because bovine practice is very physical, and the physical aspect of the work takes a toll on individuals with small statures who may have less physical strength than taller individuals. Moreover, reproductive examination of cattle generally represents a higher reach for short individuals relative to taller individuals. Any flexion or abduction $> 60^\circ$ of the upper portion of the arm is defined as an awkward position by the CDC National Institute for Occupational Safety and Health, and such awkward positions have been shown to be associated with shoulder disorders.¹⁷ Although there was a strong correlation between height and sex in this study, we chose to retain height in the multivariable model because it resulted in slightly better fit for the model and we felt it represented respondent size more comprehensively than did sex. However, sex may be an important risk factor for work-preventing MSKD because, in 1 study,²⁵ the prevalence of MSKD was greater for women than for men when identical tasks are performed. In western Canada, female veterinarians are more likely than male veterinarians to work part-time,²⁶ and part-time workers may have more flexibility to take time off work for musculoskeletal injuries or MSKD than full-time workers, which may manifest as an increased likelihood for reporting work-preventing MSKD. In the present study, only 32 of 115 (28%) respondents identified themselves as female. Sex may have been a stronger predictor of work-preventing upper extremity MSKD had female veterinarians represented a greater proportion of the respondents.

In the present study, the odds of work-preventing upper extremity MSKD increased as the number of veterinarians in a respondent's practice increased. This was not surprising because, if a practitioner has colleagues with whom they can share their workload, they may be more likely to take time off to rest and recover from MSKD. Conversely, veterinarians who work in small practices in rural areas where access to veterinary services is limited may feel obligated to continue working even though they may be experiencing MSKD.

The mean number of reproductive examinations (both manual and ultrasound handle extender-assisted examinations) performed per year was not a significant predictor of work-preventing upper extremity MSKD for the bovine practitioners of the present study. Thus, we rejected our hypothesis that

the cumulative workload associated with reproductive examinations would be a significant predictor of work-preventing upper extremity MSKD for survey respondents. That finding was consistent with results of 2 other studies^{2,8} in that, although veterinarians who perform reproductive examinations of large animals have a high prevalence of MSKD, there did not appear to be a significant dose-response relationship between the number of reproductive examinations performed and incidence of MSKD. However, in a study⁶ of California veterinarians, the odds of MSKD increased by 2% for every 1% increase in the percentage of time spent performing reproductive examinations (OR, 1.02; 95% CI, 1.01 to 1.03). The veterinarians of that study⁶ worked primarily with dairy cattle; thus, the study population was likely more homogeneous in terms of reproductive examination requirements and conditions (eg, an ultrasound handle extender is generally not used for reproductive examination of dairy cattle) than was the population of the present study. In the present study, the majority (82/115 [71%]) of respondents worked primarily with beef cattle.

We were unable to find a relationship between reproductive examination workload and upper extremity MSKD for the bovine practitioners of the present study despite modeling the exposure in multiple ways (ie, as both continuous and categorical variables for the number of reproductive examinations performed per year, percentage of practice time spent performing reproductive examinations, and distinguishing between the number and percentage of reproductive examinations performed manually and by use of an ultrasound handle extender). It is important to note that the median number of reproductive examinations performed per year reported by the respondents included in this study (8,950 reproductive examinations/y; range, 5 to 80,190 reproductive examinations/y) far exceeded that reported by veterinarians of other surveys. In a survey¹¹ of German veterinarians, the maximum number of reproductive examinations performed per year was 2,400, and in a survey⁸ of New Zealand veterinarians, most respondents performed $< 2,401$ reproductive examinations/y. In a survey⁶ of California veterinarians, reproductive examination exposure was measured as the percentage of practice time spent performing reproductive examinations on cattle, rather than the actual number of reproductive examinations performed. Interpretation of a survey² of members of the American Association of Bovine Practitioners is less clear. Respondents of that survey² reported performing a mean of 365 reproductive examinations/d; that translates to $> 95,000$ reproductive examinations/y for a 261-day work year, which seems unlikely for the average bovine practitioner. Given the range and questionable reliability of measures of reproductive examination exposure among studies, a meaningful comparison of the findings of the present study with those of other studies may not be possible. The existing evidence suggests that cumulative exposure to reproductive

examinations might be less important to the development of MSKD than the task itself. That is to say, any exposure to the ergonomic hazards associated with reproductive examination of cattle puts practitioners at risk of developing MSKD. That theory can only be confirmed by means of a longitudinal study, which to our knowledge has yet to be undertaken. Most published studies regarding the association between reproductive examination of large animals and subsequent MSKD in veterinarians are cross-sectional in nature and have not been limited to only large animal veterinarians.

Age is frequently identified as a risk factor for MSKD,¹⁷ but age was not a significant risk factor for work-preventing upper extremity MSKD for the veterinarians of the present study. In the present analysis, age was strongly and positively correlated with years of experience, but neither of those variables significantly contributed to the fit of the multivariable model, nor was either variable identified as a confounder. However, if there was truly a healthy-worker effect present in this population (ie, bovine practitioners successfully adapted to the ergonomic hazards associated with reproductive examination of cattle over time and therefore did not develop MSKD), we would not expect age and years of experience to be significant predictors of upper extremity MSKD.

The present study had many limitations. The survey from which the data were obtained was cross-sectional in nature and did not take into account activity beyond the preceding 12 months. Many respondents provided narratives describing debilitating injuries that they had overcome > 1 year previous to the survey,¹⁴ and that information was not considered in the present study. Survey data were collected between March and August, and the time of year that data were collected might have contributed to recall bias. The majority (82/115 [71%]) of respondents were beef practitioners, and in beef practice, the bulk of reproductive examinations are performed in the fall. Many of the respondents may not have recalled upper extremity MSKD that they experienced several months prior to the survey. The present study was limited by the data collected in the survey. It is likely other factors might have provided more context for the final multivariable model, such as whether a respondent worked full- or part-time. The number of respondents (n = 116) included in this analysis was fairly small, and it is possible our results were affected by type II error, especially given that only 18 respondents reported work-preventing upper extremity MSKD in the preceding 12 months. The small number of respondents with work-preventing upper extremity MSKD may not have accurately reflected the number of respondents who experienced upper extremity MSKD owing to subjective interpretation of the survey questions. The questions asked respondents whether they had been prevented from doing their normal work or bovine tasks, but no further clarification was provided. Some respondents may have interpreted the questions to mean having to completely

miss work, whereas others might have interpreted the questions to mean having to decrease participation in certain tasks but not take time off from work. In the descriptive portion of the survey, 128 of 132 (97%) respondents provided written descriptions of how MSKD had adversely affected their work or life, but only 35 (26%) reported that MSKD adversely affected their work on the modified SNQ portion of the survey.¹⁴ It is likely that the optimal method for conceptualization of the cumulative biomechanical effect of repeated reproductive examinations on upper extremity MSKD in bovine practitioners has yet to be identified. As previously mentioned, reproductive examination of cattle is a seasonal task for beef practitioners and a year-round task for dairy practitioners. Many of the survey respondents described taking extended recovery periods during the summer before pregnancy-check season began in the fall.¹⁴ Ailsby¹ also described a positive effect of seasonal recovery periods for bovine practitioners with shoulder and neck pain. A longitudinal study in which beef practitioners are monitored in terms of exposure to reproductive examination of cattle and symptoms of upper extremity MSKD on a monthly basis is necessary to more objectively measure the seasonal effect of reproductive examination exposure on upper extremity MSKD.

The results of the present study were troubling because the factors included in the final multivariable model are prevalent among recent-graduate veterinarians in North America. Results of a study²⁷ involving data collected from 2008 to 2013 indicated that 80% of graduates from Canadian veterinary schools were women, and women represented 80% of students attending US veterinary schools in 2017.²⁸ Women tend to be shorter than men. On average, US women are > 5 inches shorter than US men.²⁹ The trend of more women than men entering the veterinary profession appears to be holding steady. In the 2018-2019 academic year, 64 of 78 (82%) incoming veterinary students at the Western College of Veterinary Medicine at the University of Saskatchewan were women.³⁰ In a 2014 survey²⁶ of western Canadian veterinary practices, only 23% of food animal practitioners were women, and the number of single-veterinarian practices was in decline. Similarly, a report³¹ of US veterinary market trends between 1990 and 2010 indicated that women were less likely than men to be food animal practitioners and fewer veterinarians (both women and men) were working in rural areas. Thus, our finding that the odds of work-preventing upper extremity MSKD increased as height decreased and also increased for respondents in mixed animal practices with multiple veterinarians appeared to suggest there may be a looming sustainability challenge for rural large animal veterinary practices in North America given current trends in the veterinary profession.

The present study expanded on previously published survey results,^{14,15} and was conducted to investigate risk factors for work-preventing upper extremity MSKD in bovine practitioners. The risk factors identi-

fied were a mix of individual (respondent height) and work-related factors (practice type [$> 50\%$ bovine or mixed animal] and number of veterinarians in a practice) and suggested there is an immediate need for prevention research in this area. To our knowledge, aside from the present study, only 2 other studies^{2,7} have focused on the role of reproductive examination of cattle on musculoskeletal injuries or MSKD in bovine practitioners, and the present study was the only one to use an SNQ and conduct multivariable logistic regression analysis for risk factor identification.

Findings of the present study, along with other published research regarding the physical aspects of bovine veterinary practice, highlight a problem for the veterinary profession that needs to be solved, but the solution is not likely to be found in survey data. Researchers will need to engage with practicing bovine practitioners to measure and identify factors that are a part of their routine work and contribute to MSKD. Such research should investigate biomechanical factors as well as organizational and psychosocial workplace factors, which the results of the present study suggested might be as important as physical workload to the development of upper extremity MSKD. Elucidation of these risk factors will help inform prevention strategies to foster career longevity in this increasingly diverse practitioner group.

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Footnotes

- a. SPSS for Windows, version 25.0, IBM Corp, Armonk, NY.

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