A survey of risk factors for digit injuries among dogs training and competing in agility events

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OBJECTIVE
To identify potential risk factors for digit injuries in dogs training and competing in agility events.

DESIGN
Internet-based, retrospective, cross-sectional survey.

ANIMALS
1,081 dogs training or competing in agility events.

PROCEDURES
Data were collected for eligible animals via retrospective surveys distributed electronically to handlers of dogs participating in agility-related activities. Variables evaluated included demographic (handlers) and signalment (dogs) information, physical characteristics of dogs, and injury characteristics. A separate survey of dogs competing in similar agility-related activities but without digit injuries was also administered. Multivariable logistic regression was used to develop a model for assessment of risk factors.

RESULTS
Data were collected from 207 agility dogs with digit injuries and 874 agility dogs without digit injuries. Factors associated with significantly increased odds of injury included Border Collie breed (OR, 2.3; 95% confidence interval [CI], 1.5 to 3.3), long nails (OR, 2.4; 95% CI, 1.3 to 4.5), absence of front dewclaws (OR, 1.9; 95% CI, 1.3 to 2.6), and greater weight-to-height ratio (OR, 1.5; 95% CI, 1.1 to 2.0). Odds of injury decreased with increasing age of the dog (OR, 0.8; 95% CI, 0.76 to 0.86).

CONCLUSIONS AND CLINICAL RELEVANCE
Results should be cautiously interpreted because of potential respondent and recall bias and lack of review of medical records. Nevertheless, results suggested that retaining healthy dewclaws, maintaining lean body mass, and trimming nails short for training and competition may decrease the likelihood of digit injuries. Research to investigate training practices, obstacle construction specifications, and surface considerations for dogs competing in agility activities is indicated. (*J Am Vet Med Assoc* 2018;252:75–83)

In 2014, 3,684 agility trials (competitions) for dogs took place in the United States under the auspices of the American Kennel Club, with 1,223,660 entrants.[1] The popularity of these competitions has consistently increased over the past 20 years, with growth in the number of trials, competing dogs, and handlers. Furthermore, other organizations in the United States and worldwide (United States Dog Agility Association, North American Dog Agility Council, United Kingdom Agility International, and others) also support this growing sport. As the number of dogs and handlers in the sport has increased, the veterinary profession has begun to evaluate the specific types of injuries affecting dogs training and competing in agility activities. Efforts have been directed specifically at characterizing the most common injuries, risk factors, treatment options, and prognosis for return to athletic function.

According to results of a prior international survey of 3,801 dogs,[2] handlers indicated that approximately one-third (32%) of agility dogs experienced at least 1 injury during their competitive career, with slightly over a quarter (27.6%) of those dogs experiencing > 1 injury. The most commonly reported sites of injury in affected dogs were the shoulders, back, neck, and phalanges.[2–4] Injuries to the phalanges or paws have been estimated to represent 13% to 24% of total injuries in agility dogs.[2,3] Digit injuries, including luxations and fractures, affect all breeds of dog[5] and are common in sporting dogs.[6] These injuries are especially prevalent in racing Greyhounds and affect specific limbs because of the repetitive traumatic nature of counterclockwise racing.[7–9] In dogs training and competing in agility events, specific tasks (eg, traversing the A-frame contact obstacle) have been found to be significantly associated with digit injuries.[4,10] However, other risk factors for injury in this population of sporting dogs are currently unknown. Therefore, the objectives of the study reported here were to investigate potential risk factors for agility-related digit injuries in agility dogs and to characterize these injuries when present. We hoped to accumulate data to contribute toward an evidence base that could inform the design of future prospective clinical studies.

Materials and Methods

Sample

Survey participants consisted of handlers of dogs that participated in agility competitions of any level with access to the internet and who were willing and able to complete a survey in English. Participation was not restricted on the basis of geographic location, type of dog, or agility venue in which the dog and handler participated.

Survey instrument

A retrospective cross-sectional 91-item survey was developed and distributed by means of a commercial internet survey site[a] to facilitate the collection of information on traumatic injuries or other disorders of the digits in dogs training and competing in agility activities (**Supplementary Table S1**, available at: avmajournals.avma.org/doi/suppl/10.2460/javma.252.1.75). The survey was initiated on July 8, 2014, and remained open for approximately 1 month. A separate 29-item survey with similar questions was developed and distributed via another commercial internet survey site[b] for acquisition of data from a control population consisting of dogs that participated in agility activities without digit injuries (**Supplementary Table S2**, available at: avmajournals.avma.org/doi/suppl/10.2460/javma.252.1.75). This survey was initiated on July 21, 2015, and remained open for approximately 24 hours. Use of a different survey site for the control survey was required in view of changes in university policy. The survey appearance to the respondent, order of questions, response options, and other attributes were consistent between surveys. Survey invitations for both surveys were distributed separately through email lists, internet sites, and social media groups focused on dog agility activities, including by means of various relevant Facebook groups. Participation was initiated when an interested individual clicked an embedded hyperlink that directly accessed the appropriate survey. The introduction to each survey instructed respondents that information related to an agility dog of any breed, age, or sex could be submitted. Collection restrictions on the basis of internet protocol address were used to ensure that only 1 control survey/respondent could be completed. Survey participation was allowed regardless of whether the dog returned to agility training or competition after the digit injury was treated. The Institutional Review Board of Washington State University determined that this project satisfied the criteria for exempt research; therefore, further review and oversight were not required.

Survey design

The digit injury survey contained sections related to the nature of the digit injury or problem, a physical description of the dog and its feet, the possible cause and circumstances of the injury, agility training and performance characteristics for the dog, dog signalment, and handler demographic information. Confirmation of the presence of an injury or injuries by a veterinarian was not required. By use of skip logic in the survey programming, an extended survey was provided for handlers of dogs that had undergone amputation because of the digit injury or disorder. These data on amputation are not included in the present report (to be reported separately). The control population survey contained identical questions to those of the digit injury survey with the exception that questions relating to a specific injury or disorder were excluded. Most questions in both surveys were closed-ended with choices indicated by check boxes and the opportunity to indicate "other" and provide a text explanation if an appropriate choice was not available; some questions also included comment boxes so that respondents could provide additional details if desired.

Respondents to both surveys were asked to provide signalment (birth date, sex, breed) and additional information about their dog including height at withers, weight, and body condition score. Body condition was classified as underweight, thin, neither thin nor heavy, heavy, or overweight, with written descriptions and images provided to describe each category. Survey participants were also asked to describe their dog's digit fur (short, trimmed short, medium, or long) and nail length (short, medium, or long) and to indicate whether front or rear dewclaws were present. Images were again provided to clarify descriptive terms. Participants were asked how many years they had been participating in agility activities, how many dogs they had participated with in agility, their gender, and their age. Respondents were also asked to specify the level of competition in which their dog was engaged (novice/beginner, open/intermediate, or advanced/masters) at the time of injury (study population) or at the time of survey response (control population).

In the digit injury survey, respondents were asked questions related to the digit injury or problem, including the nature of the problem (sprain or strain, fracture, arthritis, infection, tumor, or other), affected digit, and anatomic location of the problem on that digit. Survey respondents chose their response from a list of survey options and were able to clarify responses with comments if desired. All problems except infection, tumor, and cyst were classified as traumatic in origin regardless of whether they represented acute or chronic repetitive trauma or injury. For final data analysis, only dogs with traumatic lesions were included. Respondents were also asked to provide information on the date of injury. Medical records of dogs were not requested to confirm the accuracy of handler-reported diagnoses, and handlers were not asked whether the injuries had been reported to a veterinarian. Survey respondents were provided with a labeled anatomic drawing and asked to designate the specific area or areas of the digit that were injured; multiple anatomic areas could be selected.

For dogs with traumatic digit injuries, respondents were asked how the injury occurred (ie, during participation in agility activities, during participation in a different sport, while running or playing, while fighting with another animal, when in a kennel or crate, other, or unknown). If the injury occurred during agility training or competition, respondents were asked to describe the surface on which the injury occurred, environmental conditions, and obstacle specifications (eg, jump height). Respondents were asked whether the injury involved a specific piece of agility equipment (dogwalk, A-frame, teeter, weave poles, pause table, open tunnel, closed tunnel, tire, broad jump, spread jump, or single jump). Questions related to contact obstacles (ie, dogwalk, A-frame, and teeter) included presence or absence of slats, surface of the obstacle, and performance criteria for the dog (eg, running or stopping at the end of the obstacle). On the basis of these responses, each dog was classified as being trained to "stop" or "not stop" at the end of the A-frame. Additionally, for dogs injured during competition, respondents were asked in which venue or type of competition (eg, American Kennel Club or United States Dog Agility Association) the dog was competing at the time. The control population survey did not include these questions relating to injury; only questions requiring a description of contact obstacle performance were included.

Each survey underwent pilot testing with a small group of agility handlers prior to distribution. The results of pilot testing were used to make minor adjustments in survey questions and responses and the sequence of questions. Responses from pilot testing were not included in data analysis.

Data analysis

Descriptive statistics (mean, SD, and range) were calculated for continuous variables. Categorical variables were summarized in contingency tables. Responses related to digit fur length were categorized as short–trimmed short versus medium-long and analyzed as a dichotomous variable. Responses related to nail length were categorized as short-medium versus long and analyzed as a dichotomous variable. The potential association of each variable with digit trauma was evaluated with the Mann-Whitney rank sum test for continuous variables and with the χ^2 test for categorical variables. Individual χ^2 analyses were performed for each of the most common breeds to evaluate for breed association with digit trauma. For these analyses, each dog was classified as being of the breed of interest or of any other breed. These data were organized in a contingency table of digit injury and control dogs. This process was repeated separately for each breed analyzed. Results of χ^2 tests were considered significant if $P < 0.05$. Variables with a P value < 0.10 in univariate analysis were included in multiple logistic regression analysis to examine the association of those variables with the binary dependent variable of digit trauma (present or absent). Odds ratio estimates and Wald 95% confidence intervals were calculated for each variable in the final model. Manual backward stepwise regression was performed to identify a model to best predict digit injury. All predictor variables with a P value < 0.10 in univariate analysis were entered into the model. The variable with the highest P value > 0.05 was removed, and analysis was repeated. Iterations of this process were continued until the P values of all remaining variables were < 0.05. All statistical analyses were performed with statistical software.[c,d]

Results

Survey respondents

Completed digit injury surveys were received from 253 respondents for 253 dogs. Because of the survey design and associated skip logic, not every respondent was given the opportunity to answer every question, but all surveys were determined to contain sufficient data to contribute to the analysis. Of the 253 dogs with digit disorders, 225 (88.9%) had disorders that were considered traumatic in origin. Fourteen (5.5%) dogs had infections, 13 (5.1%) had neoplastic disorders, and 1 had a bone cyst (0.4%), with no indication from the respondent that these dogs had concurrent or predisposing trauma; these dogs were excluded from the study. Of the 225 dogs with traumatic disorders, 18 with injuries that were reported to include the carpus or tarsus or metacarpus or metatarsus were excluded from analysis. Only data related to the 207 dogs with traumatic digit disorders (first, second, or third phalanx of any digit) were included in further analysis.

There were 1,003 respondents who completed the control population survey. After removal of incomplete and unclear responses (eg, incomplete demographic information or incompatible height and weight designations), 874 surveys for 874 control dogs were retained in the study and analyzed.

Signalment

The reported digit injuries occurred between 1995 and 2014. Median dog age at the time of injury was 5 years (range, < 1 to 14 years; mean ± SD, 5.4 ± 2.9 years). There were 46 breeds represented in the population of 207 dogs with digit injuries and 109 breeds represented in the control dog population of 874 dogs. The most common breeds in the injured population were Border Collie (n = 67 [32.4%]), mixed or unknown breed (23 [11.1%]), Australian Shepherd (22 [10.6%]), and Shetland Sheepdog (10 [4.8%]). The most common breeds in the control population were Border Collie (n = 166 [19.0%]), mixed or unknown breed (90 [10.3%]), Shetland Sheepdog (71 [8.1%]), and Australian Shepherd (64 [7.3%]). In the study population, there were 29 (14.0%) sexually intact male dogs, 63 (30.4%) neutered male dogs, 24 (11.6%) sexually intact female dogs, and 91 (43.9%) spayed female dogs. The median age at which injured dogs were spayed or neutered was 1 year (range,

Table 1—Distribution of digit injuries as reported by dog handlers in an internet-based, retrospective, cross-sectional survey of dogs (n = 207) competing in agility activities.

Foot	Digit 1	Digit 2	Digit 3	Digit 4	Digit 5	No. (%) of dogs
Left front	2	19	17	17	26	**81 (39.1)**
Right front	6	13	24	17	24	**84 (40.6)**
Left hind	0	1	2	7	14	**24 (11.6)**
Right hind	0	1	4	6	7	**18 (8.7)**
Total	**8 (3.9)***	**34 (16.4)**	**47 (22.7)**	**47 (22.7)**	**71 (34.3)**	**207 (100)**

Values represent No. of dogs.
*Only 110 of the 207 dogs were reported to have front dewclaws. Of the dogs with dewclaws, 8 (7.3%) reportedly had injuries to that digit.

< 1 to 12 years; mean ± SD, 1.9 ± 2.4 years). In the control group, there were 94 (10.8%) sexually intact male dogs, 335 (38.3%) neutered male dogs, 80 (9.2%) sexually intact female dogs, and 365 (41.8%) spayed female dogs. The median age at which control dogs were spayed or neutered was 1 year (range, < 1 to 10 years; mean ± SD, 1.7 ± 1.7 years).

Digit injuries

Digit injuries were significantly ($P < 0.001$; z statistic = 8.546) more likely to involve the forelimbs than the hind limbs **(Table 1)**. For the hind limb, digits 4 and 5 (lateral digits) were significantly ($P < 0.001$; z statistic = 3.609) more likely to be injured than digits 2 and 3 (medial digits). For the forelimbs, there was no significant ($P = 0.380$; z statistic = 0.877) difference in the likelihood of lateral versus medial digit injury. Overall, digit 5 was the most frequently injured digit and digit 1 (dewclaw) was the least frequently injured digit. Dewclaw injury was reported in 8 dogs (3.9% of all 207 dogs and 7.3% of the 110 dogs reported to have front dewclaws). In the 9 of 207 dogs reported to have rear dewclaws, there were no reports of injury to those digits. Of the 207 survey respondents, 36 were unsure of the anatomic location of the digit injury. For the remaining 171 dogs, lesions affected the proximal phalanx in 63 (30.4%), middle phalanx in 98 (47.3%), and distal phalanx in 69 (33.3%). Respondents could choose multiple anatomic sites of injury.

Injuries were classified as sprain or strain, fracture, arthritis, tendon or ligament injury, dislocation or subluxation, broken or ripped nail, or other injury **(Table 2)**. Respondents were able to select > 1 choice for type of injury; all respondents chose at least 1 type of injury. Fractures and sprains or strains were the most common type of injury reported. The severity of injury was defined by the amount of time that dogs were restricted from activity. Injury was reported to be minimal (< 1 week of restricted activity) for 17 dogs (8.2%), mild (1 to 3 weeks of restricted activity) for 49 dogs (23.7%), moderate (1 to 3 months of restricted activity) for 83 dogs (40.1%), and severe (> 3 months of restricted activity) for 58 dogs (28.0%). There was a significant ($P = 0.021$) difference in lesion severity depending on digit affected. Injuries of digits 2 and 5 were more likely to be classified as moderate or severe (76.2%), compared with injuries to digits 3 and 4 (63.8%), although these percentages were not significantly ($P = 0.08$) different. Severity score was significantly ($P < 0.001$) different between types of injuries. Ligament and tendon injuries had the highest mean severity score, followed by fractures, dislocations, sprains or strains, arthritis, and nail injuries (data not shown). There was no significant difference in injury severity between forelimbs and hind limbs. However, digital fractures were significantly ($P = 0.013$) more likely to be reported in the hind limbs, compared with the forelimbs (21/42 [50.0%] vs 53/132 [40.2%]).

Table 2—Types of digit injuries incurred for the survey respondents in Table 1.

Type of injury	No. of dogs	Percentage of injuries (n = 227)	Percentage of dogs (n = 207)
Fracture	74	32.6	35.7
Sprain or strain	63	27.8	30.4
Torn ligament or tendon	23	10.1	11.1
Broken or ripped nail	22	9.7	10.6
Dislocation or subluxation	19	8.4	9.2
Arthritis	16	7.0	7.7
Other	10	4.4	4.8

The most commonly reported causes of injury for all 207 dogs were participation in agility training or competition (n = 71 [34.3%] dogs) or running and playing (73 [35.3%]). For the remaining dogs, injury occurred because of being caught in an exercise pen (x-pen), kennel, or similar gate (n = 10); during participation in another sport (3); because of disease or other systemic condition (2); when fighting with another animal (2); or as a result of an unknown or unstated cause (44). The most commonly reported cause of injury in Border Collies was participation in agility competition or training (30/67 [44.8%] Border Collies). The likelihood of injury occurring when participating in agility was significantly ($\chi^2 = 4.162$; $P = 0.041$) higher for Border Collies than for other breeds.

For the 71 dogs with digit injuries that occurred during participation in agility activities, 26 (36.6%) injuries occurred when dogs were running on grass, 23 (32.4%) on dirt, 10 (14.1%) on artificial turf, 10 (14.1%) on rubber mats, and 2 (2.8%) on sand. A specific agility obstacle was implicated as playing a role in the acute injury for 37 dogs (52.1% of dogs injured while participating in agility). The A-frame was specified for 17 (23.9%) dogs, dogwalk for 7 (9.9%), open tunnel for 6 (8.5%), jumps for 6 (8.5%), and closed tunnel for 1 (1.4%). For the remaining 34 (47.9%) dogs, respondents were unsure about the cause of the injury (n = 19), stated that the injury occurred while the dog was running between obstacles (12), or stated that the injury occurred in some other manner (3).

Additional information regarding A-frame performance was collected for the 71 dogs with digit injuries that occurred while participating in agility activities and for the 853 control survey dogs. The proportion of dogs trained to decelerate and stop at the bottom of the A-frame was significantly (P = 0.002) higher for dogs with digit injuries, compared with control dogs. Of the 64 dogs with digit injuries for which this additional information was collected, 18 (28%) were trained to run without stopping at the end of the obstacle and 46 (72%) were trained to decelerate and stop at the bottom of the A-frame. Of the 853 control dogs, 418 (49.0%) were trained to run without stopping at the end of the obstacle and 435 (51.0%) were trained to decelerate and stop at the bottom of the A-frame.

Risk factors for digit injury

Dogs of the Belgian Malinois, Border Collie, and Whippet breeds were overrepresented in the digit injury population, and Papillons were underrepresented **(Table 3)**. Dog characteristics that remained significant and positively associated with digit injury after multivariable logistic regression were summarized **(Table 4)**. These dog and handler factors were used to develop a final model of risk factors for digit injury in agility dogs by means of backward stepwise regression. The variables retained in the final model were dog age, breed (Border Collie), dog height, nail length, absence of front dewclaws, handler age, and number of dogs competing in agility events.

Table 3—Results of χ^2 tests for associations between dog breed and digit injuries for the survey respondents in Table 1.

	No. (%) of dogs			
Breed or type of dog	**Dogs with digit injury**	**Control dogs**	**χ^2 value**	***P* value**
Australian Shepherd	22 (10.6)	64 (7.3)	2.066	0.151
Belgian Malinois	5 (2.4)	4 (0.5)	5.579	0.018
Belgian Tervuren	4 (1.9)	22 (2.5)	0.058	0.809
Border Collie	67 (32.4)	166 (19.0)	16.922	< 0.001
Golden Retriever	5 (2.4)	50 (5.7)	3.133	0.077
Labrador Retriever	4 (1.9)	24 (2.7)	0.176	0.675
Papillon	0 (0)	21 (2.4)	3.889	0.049
Pembroke Welsh Corgi	3 (1.4)	16 (1.8)	0.007	0.935
Shetland Sheepdog	10 (4.8)	71 (8.1)	2.164	0.141
Unknown or mixed-breed dog	23 (11.1)	90 (10.3)	0.047	0.828
Whippet	5 (2.4)	0 (0)	16.287	< 0.001

There were 207 dogs with a digit injury and 874 control dogs.

Table 4—Results of multivariable logistic regression analysis evaluating the odds of digit injury for the survey respondents in Table 1.

Variable	**Category**	**Estimate**	**SE**	**Wald χ^2 value**	***P* value**	**OR**	**95% confidence interval**
Dog age	Continuous	–0.2069	0.0317	42.487	< 0.001	0.813	0.764–0.865
Breed	Border Collie	0.8127	0.1987	16.724	< 0.001	2.254	1.527–3.328
	Other	Referent					
Dog weight-to-height ratio	Continuous	0.4071	0.1454	7.843	0.005	1.502	1.130–1.998
Nail length	Long	0.8723	0.3256	7.177	0.007	2.392	1.264–4.529
	Short-medium	Referent					
Front dewclaw	No	0.6216	0.1792	12.040	< 0.001	1.862	1.311–2.645
	Yes	Referent					
Handler age	18 to 39	–0.2367	0.2786	0.722	0.400	0.789	0.457–1.363
	40 to 59	0.4547	0.2110	4.646	0.031	1.576	1.042–2.383
	≥ 60	Referent					
No. of dogs in agility training or competition	Continuous	0.1167	0.0329	12.605	< 0.001	1.124	1.054–1.199

Discussion

The present retrospective survey was primarily designed to identify risk factors for digit injury in dogs training and competing in agility activities. The digits were the third most common site of injury in a study[2] of 1,209 agility dogs whose handlers responded to a 2009 web-based survey[2] and the second most common site of agility-related injury in a study[3] of 38 agility dogs whose handlers responded to a paper survey.[3] In contrast, digit injuries accounted for only 6% of 529 reported agility-related injuries among dogs in a combination paper and internet-based survey study.[4] The present study used a web-based survey tool to obtain information about digit injuries in dogs competing in agility events and their handlers.

In the present study, data were obtained for 207 agility dogs with digit injuries and 874 agility dogs without digit injuries. Of all digit injuries in agility dogs of this study, 79.7% (165/207) of injuries were reported as affecting the forelimbs, consistent with previous observations that vertical forces on the forelimbs of dogs are greater than vertical forces on the hind limbs when dogs move in a straight line.[11] Furthermore, in a study evaluating kinetic parameters during jump landing in dogs, Pfau et al[12] reported peak vertical force of 4.5 X body weight when landing at high speed. In a previous survey,[13] our group found that osteoarthritis was 5 times as likely to affect the metacarpophalangeal versus the metatarsophalangeal joints of dogs competing in agility events, further suggesting that there is a disparity in forces on the forelimbs versus the hind limbs in these athletic dogs. In the present study, injuries were evenly distributed among left and right limbs, indicating that agility dogs perform activities that require random, unpredictable changes of direction.

For decades, digit injuries have been commonly recognized in other types of athletic dogs, including racing Greyhounds and hunting dogs.[6–9,14,15] In 1947 and 1976, Warpole[7] and Prole,[9] respectively, reported that digit or foot injuries comprised approximately 43% of injuries in racing Greyhounds. In 1999, Sicard et al[8] reported that 14% of racing Greyhound injuries affected the toes (240/1,887 injuries). In a review[14] of all reported injuries of racing Greyhounds at all anatomic sites, 40% reportedly affected the left forelimb, 29% the right forelimb, 19% the right hind limb, and 12% the left hind limb. This injury pattern directly reflected the gait pattern expected in a dog racing on the right lead in a counter-clockwise direction.

Dogs are digitigrade animals with digits 2 through 5 thought to be the primary functional and weight-bearing digits because these digits make contact with the ground when the dog is standing. Digits 3 and 4 are considered most important because of their central location within the feet and because they are longer than digits 2 and 5.[5,11] A study[11] examining vertical forces exerted on the foot pads of Greyhounds and Labrador Retrievers indicated that load distribution primarily occurred through the third and fourth digits when a dog walks in a straight line.[11] However, the authors of that study[11] expressed surprise when finding that substantial weight was also placed on digital pad 5 and on the metacarpophalangeal and metatarsophalangeal pads. We suggest that those observations were consistent with results of the present study in which injuries were as likely in digits 4 and 5 as in digits 2 and 3 of the forelimb but injuries to digits 4 and 5 were more likely than injuries to digits 2 and 3 in the hind limbs. These observations are consistent with the possibility that forces applied when dogs are turning at high speed may act as cumulative or repetitive stressors on the most medial and lateral digits and suggests that these digits may be of more importance to athletic function than previously recognized.

In the present study, digit injuries occurred when dogs were actively engaged in agility training or competition in approximately one-third (71/207 [34.3%]) of dogs. Respondents were not asked to specify whether the injury occurred during training or competition. In almost half of these dogs (34/71 [47.9%]), the injury occurred while the dog was running between obstacles or the handlers were unsure of how the injury occurred. The obstacle that was most commonly cited as being associated with injury was the A-frame. This is consistent with previous reports[2,4] of injuries in agility dogs. Of particular interest in the present study was the association of a stopped A-frame performance with a higher risk of digit injury. In navigating the A-frame, dogs approach the obstacle at speed, stride across the apex, and then decelerate sharply to stop at the bottom if a stopped performance is trained. In some agility venues, the A-frame has horizontal slats at the base to increase traction and aid in deceleration. Contact of the dog's feet with the slats during descent may result in repeated concussive forces on the digits and resultant injury; such concussive forces may be less severe if a dog strides across the A-frame without attempting to stop or decelerate at the bottom. A definitive association between injury and the presence of A-frame slats could not be made on the basis of results of the present study. Nonetheless, we suggest that an association between stopped performance on the A-frame and digit injury may have implications for training and equipment recommendations (eg, obstacle slat specifications), especially for dogs that are large and fast. Thus, further investigation is warranted.

Most agility training and competition injuries in the present study occurred when dogs were running on a grass surface. However, it is not possible to know whether this surface predisposes dogs to injuries because there was no control group for comparison. Racing Greyhounds are thought to have an increased incidence of digit injuries when racing on turf, compared with racing on sandy tracks.[15] Other researchers have proposed that the increased caudal paw displacement associated with rapid acceleration on nonvegetated surfaces may predispose to injury.[16] Future studies evaluating the frequency of injuries in dogs competing or training on specific types of surfaces are indicated to inform recommendations for safest running surfaces for agility training and competition.

In the present study, results of multivariable analysis indicated dog factors that were significant risks for digit injury included Border Collie breed, younger age, long nail length, absence of front dewclaws, and greater weight-to-height ratio. Border Collies are the most common breed of dog competing in agility, and this breed has been previously reported as having an increased risk of injury[2,4] presumably as the result of their speed, intensity, and focus on task completion. Similarly, injury rate was significantly positively associated with speed in racing Greyhounds.[8] Nonetheless, we were surprised that younger dogs were at increased risk for digit injury in the present study study, especially in view of results of a previous study[3] that suggested there was an increased risk of all types of injuries in agility dogs with increasing age. It is possible that younger dogs are at greater risk of digit injuries because they are less experienced and may engage in less-fluid movement patterns because of inexperience. Long nails as a risk factor for digit injury, as found in the present study, would seem plausible in that longer nails may act as a fulcrum and transfer forces proximally to the digit. Longer nails may also be at risk for catching or jamming on uneven surfaces or the slats of contact equipment.

The dog's weight-to-height ratio was significantly associated with risk of digit injury in the present study, suggesting that overweight dogs are at increased risk for injury. Survey questions asked handlers to estimate their dog's body condition score on a scale of 1 to 5, with pictures provided for guidance. There was no significant difference in the body condition score between control and digit injury dogs, possibly because of the relatively narrow range of choices that were provided, compared with the traditional scale of 1 to 9. We calculated the weight-to-height ratio in an attempt to provide more objective data regarding body condition. Notably, the weight-to-height ratio may be high in dogs with a higher body condition score or in dogs with relatively short legs, such as Pembroke Welsh Corgis. We suggest that the former explanation is more likely because increased height was independently associated with risk of digit injury in the present study and because short-legged breeds were not overrepresented in the study population. An association between increased body mass and digit injury was also not unexpected, because increased body weight has been associated with a variety of athletic injuries in human and veterinary patients. Increased body weight was not a risk factor for injury in a study[8] of racing Greyhounds, most likely because dogs of that breed rarely have a high body condition score. In contrast, many dogs competing in agility are pet dogs and more than a third of the pet dogs in the United States are considered obese.[17]

Digit 1 (the dewclaw) is proposed to be rudimentary and vestigial in dogs. Many veterinarians and dog breeders recommend removal of the dewclaws on the presumption that these digits are at risk of injury and are not important to function. Results of the present study suggest that dewclaws are at low risk of injury in agility dogs, consistent with observations in racing Greyhounds.[7] Of the 8 reported dewclaw injuries in this study, 7 were described as minimal or mild in severity. More importantly, our results suggested that the absence of dewclaws in the forelimb may be a risk factor for injury to other digits. The front dewclaws are proposed to have a functional role in preventing torque on the limb, and as such, their removal may predispose to injury.[18] Video and photographic images of exercising dogs clearly show that the metacarpophalangeal joint undergoes hyperextension when a dog is moving at speed with quick turns. Hyperextension increases the forces on the metacarpophalangeal pads and allows digit 1 to make contact with the running surface. The musculotendinous attachments to the dewclaws, including the extensor pollicis longus and flexor digitorum profundus muscles, allow these digits to grip the surface, stabilizing the foot and decreasing rotational forces on the other digits. The results of the present study support results of prior kinematic studies and are consistent with characterizations of the dewclaws as weight-bearing appendages in Greyhounds.[7] As such, we would advise against elective surgical removal of forelimb dewclaws for dogs training and competing in agility activities.

In the present study, neither survey (digit injury or control) included questions regarding the presence or history of concurrent injuries at anatomic locations other than the digits. Injuries are common in athletic animals and humans, and it is quite likely that many study dogs had sustained additional injuries at some point in their lives. Previous or concurrent injuries may have affected our results, including the risk for digit injuries, but we were unable to assess this from the data collected. Dogs with handlers in the 40- to 59-year-old age group were also at significantly increased risk of digit injury, compared with dogs with handlers between 18 and 39 years of age and with handlers > 60 years of age in this study. It was not clear why this association existed; however, we suggest that it may have been because mid-career handlers have a propensity to handle the fastest dogs, despite declining personal speed and athletic ability. Delayed or inefficient handling may result in dog movements that are less fluid and that may potentially place increased and abnormal forces on the digits. Alternatively, mid-career handlers may initiate training when the dog is younger or train and compete more intensely with their dogs, putting those dogs at increased risk of injury. Similar considerations may explain the observation that handlers with more experience (ie, a greater number of dogs with which they had participated and competed in agility activities) were also more likely to have had dogs with digit injuries. Frequency of training and competition, dog age at first competition, and dog speed were not examined in the present study. Future investigation is indicated to evaluate these additional factors, which will be important in informing the development of optimal training and handling practices.

Retrospective studies commonly collect data from individual patient medical records provided by veterinarians. However, even in a large multicenter study, it would be very difficult to review individual medical records of injuries specific to agility dogs, to determine risk factors for those injuries, and to identify an appropriate control population given that most practices see only a small number of these dogs. As such, previous studies[2–4,10] of injuries affecting agility dogs have relied on retrospective owner-provided survey data. The present study collected data by means of internet surveys distributed through social media and relevant email lists in an effort to obtain data on a large number of dogs. Minimal information is currently available regarding the accuracy and reliability of data obtained from retrospective owner surveys in veterinary clinical research. Several studies in human medicine found moderate to high levels of agreement between retrospective self-reported data and prospectively collected data on sports injury variables[19–21]; however, accuracy of recall may decline with requests for increasingly detailed data.[19] Parental recollection of adverse health events in children was more accurate in relation to injuries than for illnesses,[22] and minor injuries were most likely to be underreported especially if the interval between injury and reporting was > 6 months.[23,24] One reported advantage of parental reporting, compared with medical records review, was the ability to identify minor injuries that may not have been included in the medical record.[25] In the present study, we did not ask survey respondents whether the described injuries had been reported to a veterinarian, and it is likely that many were not. In a similar survey[6] of gundog injuries, owners reported that they did not seek veterinary care for injuries in > 50% of cases. In a prior survey[2] of agility dog injuries, 60.5% of reported injuries were not evaluated by a veterinarian. As such, this type of study provides a method for obtaining information regarding the effects of injury on athletic performance that may not be obtainable through traditional medical records review. Nonetheless, the results of the present study should be interpreted with caution, including deliberate and careful consideration of the potential for considerable recall bias, especially in view of the long time that had elapsed between injury and survey completion for some study dogs.

It is reasonable to expect that handlers of agility dogs (respondents to both surveys) would have a level of awareness and understanding allowing them to identify when their dog had sustained an injury to a digit of severity sufficient to affect training or competition performance. Competition judges do not allow dogs with obvious lameness to compete, such that it would be difficult for an owner to be unaware that their dog was lame if they were actively involved in the sport. To compete in agility, handlers are required to report their dog's date of birth, breed, and sex for every competition. Competition judges are trained to provide official measurements of each dog (height at withers), and handlers are required to report those measurements to participate in competitions. Handlers work closely with their dogs during training and competitions and should be able to assess length of paw fur, nail length, and presence of dewclaws on the forelimbs and hind limbs. It is reasonable to expect that they know how often they train their dog, the surface on which they train and compete, the venues in which they compete, other sports in which they participate, types of conditioning activities performed, and details of specific obstacles performance.

Self-selection bias is possible with electronic surveys distributed through social media, open email list distribution, and word-of-mouth, compared with explicit invitation addressed to a defined population. The control survey for the present study was implemented approximately 1 year after the digit injury survey and was only available for 1 day. The large number of respondents (> 1,000) in 24 hours prompted closure of the survey at that time. Although the control survey was distributed through some of the same social media sites as the digit injury survey, it may have reached a different population of potential respondents because of the time lag between survey implementation, lack of distribution through agility club email lists, and differences in the length of time each survey was available. However, the demographics of handlers and the signalment of dogs were very similar to reports[2,3] from previous surveys of agility dogs and handlers. As such, we suggest that the study population was likely to be representative of the overall population of agility dogs and handlers.

The results of the present study provided information to guide recommendations for training and management of agility dogs and decrease risk of digit injury. Specifically, we suggest that agility organizations should educate handlers on the importance of retaining healthy dewclaws and keeping nails trimmed short. Weight management and athletic fitness should be emphasized for all agility dogs. These educational efforts should be especially emphasized for handlers of young Border Collies, which appear to be at increased risk of injury. Agility organizations should prioritize and encourage research to investigate training practices, obstacle construction specifications, and surface considerations that may further decrease risk of injury. As recommended by previous researchers, this might best be accomplished by implementing comprehensive injury surveillance systems to "provide a foundation for evidence-based decision making with regard to health and safety issues" within the sport of agility.[10]

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Footnotes

a. SurveyMonkey, Palo Alto, Calif.
b. Qualtrics LLC, Salt Lake City, Utah.
c. SAS 9.3, SAS Institute Inc, Cary, NC.
d. Sigma Stat 3.5, Jandel Scientific, San Jose, Calif.

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