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Internet Survey of Participant Demographics and Risk Factors for Injury in Competitive Agility Dogs

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Abstract

Objective The aim of this study was to identify risk factors for an agility dog becoming injured during its career. We hypothesized that certain factors involved with the training, competition, age, sex, age of neuter, body condition, and management could be associated with the risk for injury.

Study Design The outcome of interest in this cross-sectional survey design was injury versus no injury, and an initial univariable analysis screening was performed. All variables with a *p*-value of less than 0.20 in univariable analysis were entered into a multivariable logistic regression model. Manual backward stepwise removal was performed until remaining variables had a *p*-value of less than 0.05.

Results Five-hundred responses were included in the analysis. In the final multivariable model adjusting for all other variables, breed, age, age at neuter, and level of competition remained associated with injury in the study population.

Conclusion These findings support existing literature on the predispositions for injury with certain breeds and competition level. Our study further suggests, however, that there is a need to better understand how health decisions earlier in life may affect the prevalence for injury in the agility competitor, particularly regarding age at neutering and age of the competitor.

Keywords
- canine
- agility
- injury
- risk factors

Introduction

Agility is arguably the most popular canine sport, with over 1 million entries in American Kennel Club agility programmes per year in the United States alone. In 2016, entries for agility competitions exceeded 3 million worldwide.[1] With the increasing numbers of our canine companions participating in this sport, little research has been conducted examining the types and causes of injuries that are commonly sustained while participating in agility activities as well as the risk factors associated with injury.

In 2009, Levy and colleagues examined the types of injuries sustained by dogs participating in agility. This study identified that 33% ($n = 529$) of the surveyed population had sustained an injury with 58% of injuries acquired during competition.[2] Border Collies were found to be the most commonly injured breed, as well as the most commonly represented breed in agility. Injuries were most often classified as involving soft tissue of the shoulder and back regions (20 and 18% respectively). As part of agility competition, numerous obstacles are encountered, and it was found that the A-frame and dog-walk were associated with a majority of

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the injuries sustained (29%). Of the dogs reported to be injured, 50% were considered major, requiring a 6 weeks recovery before initiating sport again.[2] Similarly, marathon sled dogs have a high prevalence of shoulder injuries, requiring their withdrawal from the race, as described by von Pfeil and colleagues in 2015.[3] Although not directly correlated to the same stressors placed upon agility athletes, these dogs are similarly withdrawn for orthopaedic conditions, 30.6% ($n = 101$) were due to shoulder concerns, 12.7% (42) for carpus injuries, 4.5% ($n = 15$) for skeletal hindlimb issues and 2.8% ($n = 9$) for muscular abnormalities. These shoulders injuries were reported to occur more often in teams with slower median speeds.[3] The correlation with reduction in speed and injury is likely to be multifactorial, either resulting from a deterioration in trail conditions or heavy precipitation, or potentially associated with a less conditioned teams with compromised musculoskeletal integrity, leading to increased injury. Course and terrain have also been presumed to be an underlying risk factor in Greyhound injuries as well. Contributing conditions noted in the literature are weather, distance, speed and track conditions that may translate to our agility population as well through differences in course footing, indoor versus outdoor venues and speed of trial completion.[4]

In 2013, Cullen and colleagues first examined potential risk factors for injury in the canine agility population.[5] Similar to Levy, this study indicated that 32% ($n = 1209$) of dogs had sustained at least one injury. According to these studies, risk of injury increased if dogs had previously sustained an injury, had less than 4 years of experience, were a Border Collie or when owners utilized alternative therapies (acupuncture, massage, or chiropractic treatments).[5,6] Sellon and colleagues specifically evaluated digital injuries which occurred in 207 of 1,081 surveyed athletes.[7] It was found that digital fractures are the most common type of digital injury. The second most common form of digital injury is a strain or sprain, followed by the third most common being tendon and/or ligament tears. The greatest variable for increased odds of injury was long nails followed by breed, the absence of front dewclaws and a greater height to weight ratio.[7]

Based upon the previous research that has been performed, our objective of this cross-sectional survey was designed to interrogate risk of injury in agility dogs by examining the effects of breed, experience in the activity, age at time of survey and gender, as well as to examine the other risk factors involved with management and training. Variables that we hypothesized would influence the odds of injury in competitive agility dogs were signalment (sex, age at time of survey, spay neuter status), conditioning (duration and frequency of training and competition) and management practices (including dew claw removal, tail docking).

Materials and Methods

After review by the Cornell University Institutional Review Board, this study was exempted, as information obtained was essentially related to the dogs and not personal information of the respondents. Prior to initiating the survey to respondents, 10 agility competitors were administered the survey and asked about the cognitive clarity of the questions administered. No wording of questions had to be adjusted due to issues of clarity.

We utilized an in-person survey to collect data to identify potential risk factors for becoming injured during an agility dog's career. Handlers volunteered to participate in our retrospective survey at agility competitions across the Midwest and Northeast of the United States of America. Twenty-four agility trials were attended, including two large regional qualifiers, and all handlers participated on a volunteer basis whereby event organizers provided information to participants regarding how to participate in our survey during each day of data collection. The survey team was then approached by handlers looking to complete the survey resulting in a high respondent rate. Surveys were completed in-person by 501 handlers on provided electronic devices at 18 different competitions between January and August of 2015 (https://www.surveymonkey.com/r/W879F2Y). However, due to incomplete information, one survey was excluded from the final count. The survey was web-based and hosted by an online survey service platform, SurveyMonkey Inc., San Mateo, California, United States. Collection restrictions were limited to one survey per handler. Handlers were asked to choose any dog that was currently at the competition, such that, if possible, their body condition score could be properly evaluated by one of the survey proctors. These individuals included three 4th year clinical veterinary students at Cornell University. As the owner's participation was voluntary, their completion of the questionnaire was viewed as consent. The owner could opt out of the survey or refuse to answer questions at any point.

The survey prompted owners to share information regarding an individual dog to collect nominal and numerical data surrounding injury site (forelimb, hindlimb, vertebral column) and other related details (specific location), repeating injuries, sex, age of neuter (before 1 year of age, after 1 year), years of competition, training days per week, level of competition, competitions per year, feeding patterns (commercial raw/cooked, raw/cooked home prepared, commercial dry/wet or mixed), dew claw removal (forelimbs or hindlimbs), tail bobbing or docking, body condition score (underweight, ideal, overweight), supplement use (various categories), body weight, age and breed. If an injury was reported, an additional subset of questions was provided via the survey platform. Such additional information pertaining to the injury included location of injury, course of action following injury, frequency of injuries and whether veterinary treatment was sought, and if so, confirmed diagnosis. However, veterinary records were not obtained regarding specific injury. Injuries may have occurred at any time point in the dog's agility pursuits, but were limited to agility related injuries only, rather than those potentially sustained during other training or competition activities. Handler information was also collected and included age, gender and state of residence.

Injury data were entered in into an excel spreadsheet and rechecked against original data in its entirety for accuracy.

Statistical analysis was performed in JMP (v.14.0, SAS Institute, Cary, North Carolina, United States). Data were first assessed regarding the association of all variables of interest with the outcome injury versus no injury in an initial univariable screening (Fisher's exact test for categorical variables, logistic regression for continuous outcomes). All variables with a univariable *p*-value of less than 0.20 for the association with injury were then entered into a multivariable logistical regression model.

Manual backward stepwise removal was performed until all variables remaining in the model had a *p*-value of less than 0.05. Adjusted odds ratios (aOR) were produced from the final multivariable model.

Results

Descriptive Results of Surveyed Handlers

Of the surveyed handlers ($n = 500$), 87.2% were women ($n = 436$) and 11.2% were men ($n = 56$) with the remaining 1.6% ($n = 8$) having not provided gender identification. The ages of the respondents ranged between 18 and over 70 years of age. The largest age group of respondents was between 50 and 59 years ($n = 184$; 36.8%), followed by 60 to 69 years ($n = 105$; 21.0%), 40 to 49 years ($n = 103$; 20.6%), 30 to 39 years ($n = 42$; 8.4%), 18 to 24 years ($n = 19$; 3.8%), more than 70 years ($n = 16$; 3.2%) and 25 to 29 years ($n = 11$; 2.2%). Twenty participants opted to not provide their age (4.0%). Owners had the following affiliations to agility associations and as such competed in a variety of divisions (more than one option could be chosen): American Kennel Club ($n = 366$, 73.2%), United Stated Dog Agility Association ($n = 272$, 54.4%), Canine Performance Events ($n = 194$, 38.8%), United Kennel Club ($n = 94$, 19.8%), North American Dog Agility Council ($n = 65$, 13.0%), Dogs on Course in North America ($n = 10$, 2.0%), Teacup Dogs Agility Association ($n = 4$, 0.8%), or other ($n = 63$, 12.6%).

Descriptive Results of Dogs Included in Survey

►**Tables 1** and **2** report details of the study population and parameters or interest, including body weight, age, sex, age of spay/neuter, breed, training and competition frequencies and level of competition. Of the 500 dogs, 290 (57.9%) were exclusively doing agility, whereas 109 (21.8%) of the dogs also participated in rally obedience, 84 (16.8%) in competitive obedience, 31 ($n = 6.2\%$) in herding and 24 (4.8%) in other sports.

Our study showed that almost one in three dogs ($n = 142$; 28.4%) had sustained at least one injury during their career thus far at the time the survey was completed, with 19% ($n = 27$) of these dogs having more than one injury. Of the total number of injuries reported ($n = 174$), 33.3% ($n = 58$) were in the hindlimb, 25.9% ($n = 45$) in the back/neck, 23.6% ($n = 41$) were forelimb injuries, and 5.2% ($n = 9$) were other injuries. Digital injuries were found to be less common ($n = 21$ 12.1%). When these data were further examined based on anatomic location of the neck or back injuries, back injuries were reported as the most common injury ($n = 31$; 17.8%), followed by shoulder as the most commonly reported forelimb injury ($n = 29$; 16.7%); with iliopsoas ($n = 23$; 13.2%) and stifle ($n = 14$, 8.0%) injuries being reported as most common for the hindlimb.

Modelling of Risk Factors

Univariable logistic regression of continuous variables identified the following variables that were further considered for multivariable modelling: body weight, age at time of survey, years competing, trials/year and events/day (►**Table 1**). Univariable logistic regression of categorical variables likewise identified several variables that were considered for the multivariable model: sex, age at spay/neuter, breed, level of competition, joint supplement use and tail docking (►**Table 2**).

When the final multivariable model was built, only four variables remained significant in the model: age, breed, age at neuter/spay, and competition level (►**Table 3**). Adjusted odds ratios showed that with every year increase in age, odds of injury increase by 11% (aOR: 1.11 [1.01–1.21]). Among the most commonly represented breeds, Border Collies were at higher risk of injury (aOR: 2.73 [1.64–4.54]) compared with Sheltie, Aussie, and other breeds. Age at neuter/spay was associated with injury risk for animals that were neutered between 4 months and 1 year (aOR: 2.45 [1.31–4.60]) compared with all other categories. Lastly, both master and intermediate level had higher odds for injury than novice competitors (aOR: 3.91 [1.30–11.78] and 3.57 [1.08–11.76] respectively).

Table 1 Demographics and descriptive statistics of continuous dog characteristics (mean and standard deviations [SD] or range shown)

	Injured mean (SD)	Uninjured mean (SD)	Injured median (range)	Uninjured median (range)	Univariable *p*-value
Body weight (kg)	17.9 (9.5)	16.3 (8.63)	16.6 (3.6–61.3)	15.9 (1.8–44.5)	0.06*
Age (years)	6.8 (2.5)	5.7 (2.7)	7 (2–11)	5 (1–11)	0.001*
Competitions					
Years competing to date	4.6 (2.6)	3.7 (2.6)	5 (1–11)	3 (0–11)	0.001*
Trials/year	21.7 (10.6)	19.6 (10)	20 (4–50)	20 (0–50)	0.04*
Days/trial	2.1 (0.5)	2 (0)	2 (0–3)	2 (2)	0.83
Events/day	3.5 (1.1)	3.4 (1.3)	4 (1–8)	3 (0–7)	0.18*

*marks variables included in the initial multivariable model

Table 2 Demographics and descriptive statistics of categorical dog characteristics (number and % in category)

	Uninjured dogs	Injured dogs	Univariable *p*-value
Sex			0.14*
Spayed female	136 (37.9%)	70 (49.3%)	
Neutered male	130 (36.3%)	50 (35.2%)	
Intact male	58 (16.2%)	13 (9.2%)	
Intact female	33 (9.2%)	9 (6.3%)	
Body condition score			0.25
Low (1–3)	15 (4.2%)	6 (4.2%)	
Ideal (4–6)	298 (83.2%)	109 (76.8%)	
High (7–9)	19 (5.3%)	9 (6.3%)	
Not recorded	26 (7.3%)	18 (12.7%)	
Age of spay/neuter			0.005*
$<$ 4 months	15 (4.2%)	5 (3.5%)	
4 months–1 year	108 (30.2%)	67 (47.2%)	
$>$ 1 year	134 (37.4%)	46 (32.4%)	
Intact	90 (25.1%)	23 (16.2%)	
Not recorded	11 (3.1%)	1 (0.7%)	
Breed			0.01*
Border Collie	63 (17.6%)	45 (31.7%)	
Sheltie	45 (12.6%)	16 (11.3%)	
Aussie	39 (10.9%)	16 (11.3%)	
Mixed breed/other	211 (58.9%)	65 (45.7%)	
Level of competition			0.001*
Novice	46 (12.8%)	4 (2.8%)	
Intermediate	54 (15.1%)	17 (12.0%)	
Masters	257 (71.8%)	121 (85.2%)	
Not recorded	1 (0.3%)	0 (0%)	
Joint supplement use			0.01*
Yes	194 (54.2%)	99 (69.7%)	
Fish oil specifically	44 (12.3%)	11 (7.7%)	
None	119 (33.2%)	32 (22.6%)	
Not recorded	1 (0.3%)	0 (0%)	
Tail docked			0.02*
Bob	12 (3.6%)	1 (0.7%)	
Docked	85 (23.6%)	22 (15.5%)	
Full	261 (72.8%)	119 (83.8%)	
Front dew claws			0.42
Present	209 (58.4%)	89 (62.7%)	
Absent	149 (41.6%)	53 (37.3%)	
Diet			0.93
Commercial dry	197 (55.0%)	81 (57.0%)	
Home cooked/raw	52 (15.5%)	18 (12.6%)	
Comm. dry/Home-made	77 (21.5%)	29 (20.4%)	
Comm. raw/cooked	32 (8.0%)	14 (9.8%)	

*marks variables included in the initial multivariable model

Table 3 Final multivariable logistic regression model describing the association of risk factors with injury in 500 dogs included in the survey. Adjusted ORs account for all other effects in the model

	Adjusted OR (95% CI)	Multivariable *p*-value
Age (< 1, 1–10, > 10)	1.11 (1.01–1.21)	0.02
Breed		0.001
Border Collie	2.73 (1.64–4.54)	
Sheltie	1.02 (0.52–2.04)	
Aussie	1.30 (0.66–2.56)	
Mixed breed/other	Referent	
Age at neuter/spay		0.001
< 4 months	1.90 (0.58–6.21)	
4 months–1 year	2.45 (1.31–4.60)	
> 1 year	0.65 (0.21–2.00)	
Intact	Referent	
Competition level		0.003
Master	3.91 (1.30–11.78)	
Intermediate	3.57 (1.08–11.76	
Novice/beginner	Referent	

Abbreviations: CI, confidence interval; OR, odds ratio.

Discussion

After Levy and colleagues first defined injury trends in 2009, our investigation sought to investigate lifestyle and management factors, time in sport, as well as training and cross-training activities which were not included in the original surveys published.[2,5–7] Like Levy and colleagues, and, more recently, Montalbano and colleagues, Border Collies were again shown to be the most prevalent breed to participate in competitive sport.[2,8] Levy and colleagues published that 16.8% of their study population was comprised of Border Collies, as compared with the 22.0% found in this study; while Montalbano and colleagues revealed that 27.7% of flyball participants were Border Collies. Prior literature has attributed the popularity of this breed in agility sports to their athleticism and willingness to perform.[6] A recent investigation on gait mechanics and speed of ambulation in Weimaraner dogs documents that with increasing speed, there are associated changes that could lead to fatigue related musculoskeletal injuries.[8] This may play a role in Border Collie injury given the relatively decreased amount of time spent in stance phase when compared with the Labrador Retriever.[9] However, a study by Lafuente and Whyle looking at injuries in canicross dogs and handlers identified that Labradors had an 10.25 increased odds of injury over other breeds in the study. This was attributed to a potential change in kinetics and kinematics of dogs that suffer from certain orthopaedic diseases, of which Labradors commonly suffer.[10] Further studies on breed specific gait changes and mechanics would be required to elucidate whether similar findings are conserved across various rates of speed for different breeds of dogs while performing agility events. In contrast, it might simply be the proficiency in which this breed performs in a timed event, meaning that the increased acceleration and mass create more stress on ligaments and tendons leading to increased frequency of injury.[11,12] Regardless, it may be hypothesized that many breed-related factors including, but not limited to, body weight and condition, drive, conformation, behaviour, and relative aging play roles.

Increasing age was another factor that was statistically associated with injury in the multivariate model, suggesting an approximate 10% increase in odds of injury as these athletes get older. Both longer exposure to sport activity and decline in musculoskeletal integrity (repetitive motion and/or age-related change) could contribute to increased injury risk and warrant further investigation. These age-related findings are similar to findings by Montalbano and colleagues in fly ball participants; however, they found that this effect plateaus once a dog reaches 6 years of age.[13,14] A leading cause of soft tissue injury is thought to stem from a loss of flexibility in the musculotendinous unit due to decreased collagen solubility and increased crosslinking, but muscle integrity and diminished mitochondrial integrity with aging may also be related to impaired energetics leading to fatigue, which cannot be discounted.[15,16] In human literature, Garrett also describes that major muscular injuries are often preceded by minor muscular strains. These minor abnormalities lead to altered mechanics and may predispose for a more severe disruption in muscular tissue.[17]

In agility, increasing age often comes with advanced competitive levels. Advanced competition levels come with more contact time with obstacles such as the A-frame and dog walk, which have previously been shown to have an increased association with injury.[2] Variations in A frame height have been shown to minimally impact carpal extension, resulting in repetition of actions where end carpal extension is met. With time, the soft tissues affording support for the joint could succumb to injury.[18] Dogs who have sustained a prior injury also have an increased risk of injury with an OR of 1.5.[6] Long-term management of chronic, repetitive injuries, and/or non-resolving injuries continues to have an effect on overall performance and soundness as the competitor advances as an athlete. Jump height adjustments with advancing levels may also play a role in increased injury risk, as the vertical force is highest when dogs land at a more acute angle after completing a higher obstacle as compared with a shorter obstacle taken at a higher speed. Peak vertical force was found to be up to 4.5 times body weight when measured in the forelimbs following a hurdle type obstacle. In addition, the forelimbs are loaded asymmetrically upon landing. This may further exacerbate pre-existing orthopaedic conditions and contribute to degeneration over time,[19] and may be speculated to cause a higher rate of shoulder injuries in this population of agility dogs. Higher loads and faster loading may also fatigue muscles more quickly. In human medicine, fatigued muscles are at a much higher risk of strain injury.[17]

Neuter status was associated with injury risk. Spayed female dogs made up 48.6% ($n = 69$) of the injuries reported, whereas castrated male dogs were 35.2% ($n = 50$) of the

population, and intact males were 9.86% ($n = 14$) and intact females were 6.34% ($n = 9$). In 2004, a study by Spain and colleagues indicated that dogs neutered at less than 5.5 months of age had an increased incidence of hip dysplasia.[20] This was thought to be attributed to abnormal joint conformation resulting from increased bone length following the neuter procedure. This finding, however, could have been falsely elevated based upon the age at which these dogs were evaluated (false positive).[20] A difference in tibial plateau angle was also identified in large breed dogs neutered before 6 months of age, where they were 13.6 times more likely to have a tibial plateau angle greater than or equal to 35 degrees.[21] Similarly, in Golden Retrievers early gonadectomy has been correlated with a fourfold risk of orthopaedic injury, suggesting a link between gonadectomy and injury which concurs with our study.[22] These joint abnormalities are thought to be in part mediated by alteration of gonadal hormone influence on developing musculoskeletal tissues, by which bone growth rates with some disease processes have already been shown to exhibit a sex predilection.[23]

The limitations of this study include a potential recall bias due to the survey format calling upon historic data of prevalence and not incidence during specific events. Furthermore, injury recall was not verified by veterinary records. Willingness to participate and reporting by respondents regarding a single dog when they may have owned more than one dog participating may have led to a selection bias when reporting. For example, handlers may have selectively chosen a dog that had experienced an injury during an agility-based activity. However, despite this, there were still fewer injured dogs reported than non-injured canine participants, reflecting similar findings in prior survey studies.[2,5–7] Another limitation of this study is that temporal associations were not evaluated. Therefore, causation cannot necessarily be established with these, but rather the injury and the variable in question are merely an association.

In conclusion, associations for age, breed, neuter status and competition level remained significant in the multivariate model as being associated with injury in agility dogs. This study supported findings in similar survey studies of canine performance athletes and, for the first time, examined the effects of early health decisions and their impact on injury risk, including age of neuter, tail docking and joint supplementation on risk of injury. Based on this information, veterinarians can begin to understand and discuss lifestyle and demographic factors with agility dog owning clients. In future studies, temporal relationships between age at time of injury and type of injury could provide more information to aid in both early and lifelong management of our agility athletes. Lastly, we hope these findings springboard targeted prospective research to better investigate these correlations.

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Conflict of Interest
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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