Injury Risk Factors Associated with Training and Competition in Flyball Dogs

Blake, Scott; Melfi, Vicky; Tabor, Gillian; Wills, Alison

Published in:
Topics in Companion Animal Medicine

Publication date:
2023

Injury Risk Factors Associated with Training and Competition in Flyball Dogs

Scott P Blake[1*], Vicky A Melfi[1], Gillian F Tabor[1] and Alison P Wills[1]

[1]Hartpury University, Hartpury, Gloucester, GL19 3BE

*****Correspondence: scott.blake@hartpury.ac.uk; Tel.: +447787-568581

Abstract

Flyball is a fast-paced, high-energy canine sport which has received negative press regarding the potential for injury, and possible welfare implications for canine competitors. Whilst frequency of injury within the sport has been investigated, evidence gaps remain regarding cause. The aim of this study was therefore to identify risk factors for injury within the sport, with a view to improving competitor safety. An online questionnaire was used to obtain data on dogs that had competed in flyball in the last five years but remained injury free, and a second questionnaire obtained data on dogs that had also competed within the last five years but sustained an injury. Data relating to conformation and performance was collected for 581 dogs, with the same data plus information relating to injury collected from an additional 75 injured dogs. Data were then compared using univariable, multivariable and multinomial logistic regression.

Dogs completing a flyball course in less than four seconds had the highest level of injury risk (p=0.029), which reduced as time taken increased. There was an association between risk of injury and increasing age, with dogs over 10 years old most likely to be injured during their career in the sport (p=0.004). Furthermore, dogs using an angle of flyball box of between 45° and 55° had a greater risk of injury, while using an angle between 66° and 75° reduced the risk of injury by 67.2% (OR: 0.328). Use of carpal bandaging was significantly associated with carpal injuries (p=0.042). These findings identify new risk factors for injury within flyball which can be used to improve welfare and safety for competitors.

Keywords: canine injury; flyball; canine sports medicine; questionnaire; injury risk

Introduction

Flyball is a canine sport where opposing teams of four dogs race relay fashion along parallel lanes over four hurdles set at regular intervals, requiring a unique combination of speed, flexibility, and proprioception.

At the far end of each lane, the dog turns on a spring-loaded flyball box, catching a tennis ball whilst completing a 180° turn, before returning to the start line in the fastest time possible. Previous research has found career injury levels in flyball of between 39% and 34%, which is similar to those seen in agility (Pechette Markley *et al*., 2021; Inkilä *et al*., 2022), with faster and younger dogs most at risk (Pinto *et al*., 2021). Forelimb injuries are the most common in flyball, especially to the tendinous structures of the shoulder as well as back and spine (Montalbano *et al*., 2109; Pinto *et al*., 2021), but it is currently unclear whether the majority of injuries are caused by a single overload event or longer-term overuse. Shoulder injury was also the most common injury in a recent agility survey, followed by iliopsoas injury (Pechette Markly, 2021). Unlike agility, the height of the hurdles in flyball are set to the height of the shortest dog in a team, meaning taller dogs will not be challenged to the same extent as smaller dogs if the height of the hurdle sits below their centre of mass (Miro *et al*., 2020). One element of flyball where no research exists relates to the angulation of the spring-loaded surface of a flyball box, which competitors land on during their 180° turn. The sport's governing bodies do not specify which angle must be used and in recent years teams have experimented with increasing the angle from the traditional 45°, to as high as 89° (See figure 1). Changing the angle will affect the musculoskeletal demands placed on competitors, but, at present, there is no understanding of how this may impact risk of injury. Previous work has also suggested a relationship between increased rates of injury and the use of carpal bandaging (Montalbano *et al.*, 2019) which appears to be commonplace in the sport and is practical for reducing friction type burns on the paw pads, however, there is no evidence of athletic benefit, nor does it limit extension of the carpus during agility activities (Applegrein *et al*., 2018). The present study aimed to investigate injury risk factors in the sport of flyball, specifically evaluating use of carpal bandaging, angle of incline of the flyball box which competitors land on during their 180° turn, and competitor age and speed in relation to injury risk. We hypothesised that box angles closer to 90°, the use of carpal bandaging, higher speed and increasing age would be associated with increased injury risk.

Materials and Methods

Survey Design

Two descriptive, cross-sectional, anonymous online questionnaires were created to enable interactions with a geographically diverse respondent group whilst obtaining a large sample (Evans and Mather, 2006). The first contained 20, mainly closed-end multiple choice questions and gathered data from owners with dogs that had participated in flyball in the last five years but had remained uninjured. The second contained 47, mainly closed-end, multiple choice questions which gathered data on dogs who had participated in flyball in the last five years but had received an injury within that timeframe. Agreement was obtained from the British Flyball Association (BFA) to allow both questionnaires to be distributed to its members. Potential respondents were asked to confirm that they were over 18 years of age, registered with the BFA, and had actively participated in flyball in the last 5 years. Additionally, participants were given information pertaining to their data protection rights, risks and benefits, and withdrawal procedures before being asked to consent to the study. Responses were restricted to a single response per internet protocol address, although participants were able to exit and resume at will. Questions were influenced by the existing literature and broken down into three categories (biological, performance and injury) as can be seen in table 1.

Statistical Analysis

After a preliminary analysis, answers to the questions relating to owner experience, age dogs started training and dog age, were grouped into categories to facilitate analysis. Following univariate binary logistic regression analysis, a multivariate binary logistic regression model, where the dichotomous variable was injury (yes/no) was built through a backward stepwise process, with variables retained if Wald test p-values were <0.05 (Pallant, 2010). The fit of each model was assessed using the Hosmer-Lemeshaw goodness of fit test (George and Mallery, 2010). Furthermore, two multivariate multinomial logistic regression models were built using only injuries in a single anatomical location (n=101). The most frequent anatomical location of injury was the shoulder, consequently shoulder injury served as the baseline category. In the first model, we included all variables that could predispose to injuries in specific sites: box angle; current age; speed; age at first injury; breed; weight; height; bandaging and owner experience. In the second multinomial model, only the variables significant on the multivariate binary logistic regression as risk factors for injuries were included: speed; current age and box angle. The regression coefficients were calculated for these factors and then used to calculate the logit values of the categories relative to the baseline category. The association between use of bandaging and carpal injury was tested by cross tabulating carpal injury/non-carpal injury versus bandage use (yes/no). Responses where owners had stated use of bandaging was due to a previous injury were removed. A Fisher's exact test was used due to the 2x2 nature of the crosstabulation. All statistical analysis was performed in SPSS v. 28 (IBM Corporation, Armonk New York, USA)

Results

Once incomplete surveys were removed, data for 581 uninjured dogs versus 75 injured dogs were collected from approximately 3,000 BFA members. Some dogs had an injury in more than one anatomical location, and some had repeated injuries, resulting in/meaning a total of 268 injuries were reported. The demographic data can be seen in tables 2, 3 and 4.

Risk factors associated with training and competition in dogs competing in flyball

Results from our model were statistically significant, $\chi^2(16) = 42.952$, $p < 0.001$ (table 5). Of the four predictor variables tested, box angle (p=0.045); dog age (p=0.004); and speed (time to complete the course) (p=0.029), were statistically significant predictors of injury risk (Table 6).

Box Angle

Dogs using a 45-55 degree angle box were found to have a greater risk of injury. Increasing the angle to between 56-65 degrees reduced the risk of injury by 10.9% (OR: 0.891). The greatest reduction in risk was encountered within the 66-75 degrees range, with a 67.2% lower chance of injury (OR: 0.328) compared to 45-55 degrees. 76-85 degrees and 86-95 degrees also had a decreased risk, presenting 38.8% (OR: 0.612) and 37% (OR: 0.630) less risk of injury than a 45-55 degrees box.

Dog Age

Dogs aged over 10 years old had the highest risk of injury, whilst, in comparison, those aged between 6 and 9 years old had 18.6% lower risk of injury (OR: 0.814). Between ages 2-5 (OR: 0.249) the risk of injury was 75.1% lower than 10+ years old dogs, with no injuries reported in dogs under 2 years old.

Time to Complete Course

In our model dogs completing the flyball course <4 seconds had the highest risk of injury, whilst the lowest risk was observed for dogs taking longer than 6 seconds. Dogs completing the course between 4.1 and 6.0 seconds had a higher risk of injury in comparison with dogs taking longer than 6 seconds (OR: 1.078).

Risk factors associated with injuries in specific anatomical locations

The first multinomial logistic regression model (including all possible predictors of injury location) did not find a significant overall association with the anatomical location and the injury parameters ($X^2(671)=237.951$, p=1.000).

Association between bandage use and injuries

Regarding carpal bandaging, 22.5% of all dogs included in this survey were reported to use carpal bandaging, with 92.2% of owners stating it was to prevent injuries. There was a higher proportion of injured dogs using bandages, and conversely, there was a higher proportion of uninjured dogs not using bandages. There was a statistically significant association between use of bandage and all injury, p = 0.034 (Fig 1) A further test was also performed to assess the association between use of bandaging (yes/no) and carpal injuries. There was a statistically significant association between occurrence of carpal injuries and the use of bandaging (p=0.042), with a higher proportion of dogs with carpal injury using bandages (55.6%) versus those that did not (44.4%) (Figure 2). All other injuries were non-significant.

Discussion

Our results show a relationship between time to complete the flyball course and risk of injury, with dogs completing the course in the quickest times having the highest level of risk, which reduced as time increased. Comparable survey data (Pinto *et al*., 2021) separated flyball dogs into ≤4 seconds and > 4 seconds and found a similar result, with 32.1% of dogs running ≤ 4 second receiving at least one career injury, compared to 19.7% of > 4 second dogs. Speed has been shown to significantly increase the risk of injury in racing greyhounds (Sicard and Manley, 1999), however further research is needed to understand the possible relationship between speed and injury within flyball, as it may be influenced by box angulation as well as other factors. To limit certain confounders, we carried out additional, independent tests of association, but no statistically significant results relating to height, weight, breed, or box angulation were found.

Box angle was identified as a significant injury risk factor (p=0.045) and dogs using a 45–55 degree box angle had a greater risk of injury history, whilst using a 66-75 degree box reduced the risk of injury by 67.2%. Range of motion and joint angulation in all limbs will be affected by box angle, just as altering jump heights has been shown to affect kinematics in agility (Birch *et al*., 2015). The level of asymmetry that dogs experience in their joint range of motion would also change, with angles closer to 90° expected to create less asymmetry than those closer to 45°, as dogs would be turning on a more horizontal surface. Data from dogs completing A-frame obstacles suggests maximum extension of the carpus is reached at angles less than 30° (Applegrein *et al*., 2018). Similarly, peak forces, both upon impact with the box and landing from the turn would be expected to vary with box angulation (Blake and de Godoy, 2021). Dogs may also approach different angles at different speeds which would also affect force (Miró *et al*., 2020). In the UK, to limit the risk of injury it is common practise for dogs to train and compete using the same angulation of equipment, but at present, not enough research specific to the flyball box exists that might allow us to draw conclusions from this element of our study. Further research is required to understand how a flyball competitor negotiates the box turn, and how varying the angle of the box affects biomechanics and speed.

Dogs aged over 10 years old were shown to have the highest risk of injury (p=0.004) with risk of injury increasing in with age. We did not explore this data further however as we realised a *post-hoc* flaw in our study, where frequencies were based on the dog's age when the survey was conducted, and not the dog's age when it was injured. Reporting is therefore based on the age or frequency of injured dogs within the survey and not when injuries are most likely to happen.

Perhaps the most striking result from this research is that the use of carpal bandaging has a statistically significant association with carpal injuries, although reasons for the association are unclear. It is possible that bandaging could contribute to overall limb stiffness, depending on how tightly it is applied but there is no evidence that wrapping can limit extension of the carpal joints (Tomlinson and Manfredi, 2014). There is evidence to suggest that increases in tissue temperature due to wrapping may weaken underlying structures and increase injury risk in equines (Brock and Spooner, 2021). There is potential benefit in wrapping across the carpal pad to limit friction injuries, especially when running and turning on synthetic surfaces, and, similarly, wrapping the dew claw against the forelimb is likely to limit avulsion type injuries. Further research is needed before any recommendations regarding bandaging use can be made. In the meantime, flyball governing bodies should consider guidelines covering the use of bandaging where it does not exist already, to ensure wrapping is not applied in such a way that would induce ischemia (Westermann *et al*., 2014), and wrapping is replaced in between competition heats to ensure comfort and to avoid possible oedema (Solheim, 2020).

Demographic data in our study was similar to existing research, with the Border Collie breed making up a large percentage of competitors. Unlike agility participants, rates of injury were not significant in the breed (Pechette Markley *et al*., 2021) adding weight to the supposition that there are breed specific risks in agility not seen in other sports.

Injured dogs in our study started participating in flyball at a mean age of 1 year 10 months, whilst uninjured started at approximately 1 year 7 months. BFA rules prevent dogs younger than 18 months participating in the sport, so dogs aged under two would have limited time exposure to training and competition, potentially accounting for lower injury rates prior to age two. Further research is necessary to understand the effects of sport specific training in dogs that may not have reached skeletal maturity, versus the benefits, such as greater tendon adaptation, which may help to prevent injury (Thorpe *et al*., 2010). Within BFA competitors, we found rates of injury of approximately 13%, which is lower than the 39% and 34% seen in existing research (Montalbano *et al*.,2019; Pinto *et al*., 2021). One reason for this difference is that survey respondents were not asked to declare claw injuries which accounted for a large proportion of injuries previously reported (Pinto *et al*., 2021). Our reasoning was that although the likelihood of broken claws was high based on existing data, the consequences for most dogs would be low, with minimal impact on their ability to participate, and owners unlikely to seek veterinary assistance. Owners were asked to confirm details of more serious injuries to the paws such as a fracture or friction burn. Another reason for lower frequency of injury in our data is that only injuries incurred over the last five years were declared, which encompasses the COVID-19 pandemic, meaning it is unlikely that sport specific training would have taken place for some time. The 34% and 39% injury rates stated previously (Pinto *et al*., 2021; Montalbano *et al*.,2019) were also sustained over career lifetimes, whilst the same research by Pinto *et al*, (2021) stated that only 23.3% of dogs were injured in the year prior to the study. Similar differences in data can be found in agility surveys, with rates of career injuries reported as high as 42% (Pechette Markley et al., 2021) versus 14% experienced in one year of competition (Inkilä *et al*., 2022). We therefore deem our results to be in line with existing data.

There were limitations to our study, including the five-year timeframe for injury occurrence. An ideal retrospective study would have been to only declare injuries in the last 12 months, that were diagnosed by a veterinarian. This would reduce potential bias issues regarding recall, as well as diagnosis, both of which could lead to incorrect conclusions being drawn (Mukherjee, 2015). The timing of this study, however, meant that it would have been unlikely that any flyball training or competing would have taken place in the 12 months prior to launch. Five years was therefore selected to provide a limit to recall bias (Gosling *et al*, 2004), whilst still obtaining an appropriate sample size. We have also reported an association between injury risk and time taken to complete a flyball run, but as this is based on owner reporting, and may only be indicative of absolute best time, as opposed to the mean for individual dogs. An additional confounder is that some competitions may be held outside on grass surfaces during summer months, introducing a large degree of variance to grip, ground reaction forces (GRF) and speed, whilst winter competitions are held indoors using synthetic matting as a running surface. Further research is required to understand how surface type may influence the potential for injury but was outside the scope of this investigation.

Conclusion

This study has provided new data on possible causes of injury within flyball, as well as expanding upon, and supporting the conclusions of existing research. We have shown that associations exist between age of participant, speed, box angulation and carpal bandaging on both the frequency and type of injury. Further research is needed to ascertain why carpal bandaging is associated with injury before any recommendations can be made for the sport’s governing bodies. Similarly, it is unclear based on current evidence whether certain angulations of flyball box may be safer for dogs to use than others. More research is required to understand exactly how angle of incline of the flyball box affects impact forces, joint angulation and turn technique, before any guidelines can be provided.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare that no conflicts of interest are present

Acknowledgements

The authors would like to thank Dr Roberta Godoy and Dr Jane Williams for assistance with statistical analysis. The authors would also like to thank Jeannette Shelley of the British Flyball Association for her supporting role.

References

Appelgrein, C. *et al.* (2018) 'Reduction of the A-Frame Angle of Incline does not Change the Maximum Carpal Joint Extension Angle in Agility Dogs Entering the A-Frame', 31(2), p. 6.

Birch, E. and Leśniak, K. (2013) 'Effect of fence height on joint angles of agility dogs', *Veterinary Journal*, 198(SUPPL1). Available at: https://doi.org/10.1016/j.tvjl.2013.09.041.

Blake, S. and de Godoy, R.F. (2021) 'Kinematics and kinetics of dogs completing jump and A-frame exercises', *Comparative Exercise Physiology*, 17(4), pp. 351–366. Available at: https://doi.org/10.3920/CEP200067.

Brock, L. and Spooner, H. (2021) '28 A comparison among equine boots and legwraps on leg surface temperature during and after exercise', *Journal of Equine Veterinary Science*, 100, p. 103491. Available at: https://doi.org/10.1016/j.jevs.2021.103491.

Evans, J.R. and Mathur, A. (2005) 'The value of online surveys', *Internet Research*, 15(2), pp. 195–219. Available at: https://doi.org/10.1108/10662240510590360.

George, D. and Mallery, P. (1999) *SPSS® for Windows® step by step: A simple guide and reference*. Needham Heights, MA, US: Allyn & Bacon (SPSS® for Windows® step by step: A simple guide and reference), p. 357.

Gosling, S.D. *et al.* (2004) 'Should We Trust Web-Based Studies?', *American Psychologist*, p. 12.

Inkilä, L. *et al.* (2022) 'Part II of Finnish Agility Dog Survey: Agility-Related Injuries and Risk Factors for Injury in Competition-Level Agility Dogs', *Animals*, 12(3), p. 227. Available at: https://doi.org/10.3390/ani12030227.

Miró, F. *et al.* (2020) 'Comparative kinematic analysis of hurdle clearance technique in dogs: A preliminary report', *Animals*, 10(12), pp. 1–11. Available at: https://doi.org/10.3390/ani10122405.

Montalbano, C. *et al.* (2019) 'Internet Survey of Participant Demographics and Risk Factors for Injury in Flyball Dogs', *Frontiers in Veterinary Science*, 6(November), pp. 1–6. Available at: https://doi.org/10.3389/fvets.2019.00391.

Mukherjee, S. (2015) 'Communication Surveillance Studies: All is not Lost', p. 4.

Pallant, J. (2020) *SPSS survival manual: a step-by-step guide to data analysis using IBM SPSS*. Seventh edition. Oxford: Routledge.

Pechette Markley, A., Shoben, A.B. and Kieves, N.R. (2021) Internet-based survey of the frequency and types of orthopedic conditions and injuries experienced by dogs competing in agility. *Journal of the American Veterinary Medical Association*. [online]. 259 (9), pp.1001–1008.

Pinto, K.R. *et al.* (2021) 'An Internet survey of risk factors for injury in North American dogs competing in flyball', 62, p. 8.

Sicard, G.K., Short, K. and Manley, P.A. (1999) A survey of injuries at five greyhound racing tracks. *Journal of Small Animal Practice*. [online]. 40 (9), pp.428–432. Available at: https://doi.org/10.1111/j.1748-5827.1999.tb03117.x

Solheim, T.N., Tarabová, L. and Faixová, Z. (2017) 'Changes in Temperature of the Equine Skin Surface Under Boots after Exercise', *Folia Veterinaria*, 61(4), pp. 17–21. Available at: https://doi.org/10.1515/fv-2017-0033.

Thorpe, C.T., Clegg, P.D. and Birch, H.L. (2010) 'A review of tendon injury: Why is the equine superficial digital flexor tendon most at risk?', *Equine Veterinary Journal*, 42(2), pp. 174–180. Available at: https://doi.org/10.2746/042516409X480395.

Tomlinson, J.E. and Manfredi, J.M. (2014) 'Evaluation of application of a carpal brace as a treatment for carpal ligament instability in dogs: 14 cases (2008-2011)', *Journal of the American Veterinary Medical Association*, 244(4), pp. 438–443. Available at: https://doi.org/10.2460/javma.244.4.438.

Westermann, S. *et al.* (2014) 'Effect of a bandage or tendon boot on skin temperature of the metacarpus at rest and after exercise in horses'. Available at: https://pubag.nal.usda.gov/catalog/2423507 (Accessed: 24 March 2021).