

1 **A retrospective survey of injuries occurring in dogs and handlers participating in**  
2 **canicross**

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14 **Conflict of interest**

15 The authors declare that there is no conflict of interest.

16 **Funding:**

17 No financial support or proprietary aid, in any form, was received.

18

19 **Summary**

20 Objectives: Canicross is a popular canine and human cross-country sport. The purpose of  
21 this study was to identify the most common injuries, their severity, risk factors, and the  
22 recovery.

23 Methods: An internet-based retrospective survey design was used to examine the  
24 characteristics of injuries, demographic and competition information, and associations with  
25 injury rate.

26 Results: 160 surveys were received and indicated that at the time of the survey 21.9% of  
27 dogs (35/160) in this survey had experienced at least one injury. Lacerations, abrasions  
28 and punctures was the most common injury type (22/49), most frequently occurring in the  
29 footpads of the forelimb (13/16). The majority of dogs (38/49) recovered from their injuries.  
30 69/147 of the human handlers experienced injuries while competing, being ankle injuries  
31 (25/69), and bruises, cuts, and grazes (20/69), the most common. Risk factors for injuries  
32 were being a purebred Labrador, dogs running with another dog, and additionally  
33 competing in agility.

34 Conclusions: Labradors, dogs running with another dog and dogs also participating in  
35 agility competitions were at higher risk for injury. Injuries of the footpads of the forelimb  
36 were the most common injuries in dogs. Most dogs had a complete recovery from their  
37 injuries.

38 Clinical Significance: This is the first study that gives us insight into injuries occurring in  
39 dogs and handlers competing in canicross. This will help making recommendations for this  
40 sport as well as enable veterinarians to understand the risks and injuries.

41

## 42 Introduction

43

44 Canicross is a sport in which human handlers run cross-country with dogs. It was originally  
45 popular as an off-season training for sled dogs but has now become a popular stand-alone  
46 sport. Dogs are typically attached to the human runner, the handler, by a shock absorbing lead  
47 such as a bungee cord or an elastic line, which is connected to a pulling harness on the dog  
48 and a waist belt on the human. The distance of canicross races ranges anywhere from 1 km  
49 to 45 km or more.<sup>1</sup>

50 The first official canicross race in the UK was run in 2000 and in 2002 the first canicross World  
51 Championships were held in Ravenna, Italy. The sport is continuing to grow in popularity in  
52 Europe as well as Canada. In 2008 canicross made its debut at Crufts with over one hundred  
53 runners participating and many races are run every year all across Europe.<sup>2</sup> With the sport

54 comes the importance for training and conditioning to optimize endurance and the utilization  
55 of physiotherapy and other fitness maintenance treatments to enhance athletic performance  
56 and decrease the risk of injuries.<sup>3-9</sup>

57 As with any sport, there is a potential for injury during training and competition, and illness and  
58 injuries obtained outside of running may affect athletic performance as well. Studies have been  
59 done to investigate demographics and injuries in canine sports such as agility and greyhound  
60 racing. A survey of American agility dog handlers conducted in 2009 found that 33% of the  
61 1,627 dogs had been injured, with 58% of the injuries occurring during agility competition.<sup>10</sup>  
62 Results of another study on 1,669 agility handlers and 3,801 dogs found that of the agility-  
63 related injuries soft tissue strains, sprains, and contusions to the shoulder, back, phalanges,  
64 and neck were the most commonly reported injuries.<sup>11</sup> In greyhound racing, of nearly 500  
65 injuries reported at two Massachusetts-based racing tracks, fractures were the most common  
66 type of injury making up 74.4% of reported injuries,<sup>12</sup> and it has been previously reported that  
67 stress fractures of carpal, metacarpal, tarsal and metatarsal bones are common in these  
68 dogs<sup>13-19</sup>. These studies show that the potential for injury in canine athletics is high and injury  
69 type may vary depending on the sport. Therefore, a canicross specific injury study could be  
70 valuable as to date, there is limited information available on dogs involved in canicross. To  
71 accomplish this, we surveyed handlers about their dog's participation in canicross. The  
72 objectives of this study were to characterize the demographics and injuries incurred by both  
73 human and canine canicross runners and determine if there are any associations or risk factors  
74 involved in these injuries.

75

## 76 **Materials and Methods**

77

78 A retrospective survey design was used to examine demographic information about dogs and  
79 their handlers involved in canicross as well as frequency of competitions and training, and  
80 injuries sustained. (Appendix 1, viewable online at [www.vcot-online.com](http://www.vcot-online.com)  
81 <http://goo.gl/forms/Nf4aL9T70Q> ).

82 The participants were handlers of dogs involved in the sport of canicross. Several canicross  
83 organizations were contacted and handlers participated voluntarily. The survey was approved  
84 by the Royal Veterinary College Research Ethical Review Board before being released. The  
85 responses to the survey were collected between July 21, 2015 and September 11, 2015.

86 Demographic questions (age, sex, breed of dog), competition information (location, years  
87 competing, race distance, competitions/year, number of dogs running with handler,  
88 participation in other sports, being retired and why) and questions on competition preparation  
89 (frequency of training/week, fitness maintenance, exercises prior and after the race) were  
90 included in the survey. Participants were asked about the injuries suffered (number, type and  
91 location and recovery status) and effect on their competition activity. The severity of the injuries  
92 was classified as mild, if dogs recovered in 1 month or less, and severe if it took more than 1  
93 month. This was based on a previous paper that examined agility-related injury in  
94 dogs.<sup>11</sup> Information regarding whether these injuries were evaluated and treated by a  
95 veterinarian, or if they were obvious for the handlers and managed by them, was not included  
96 in this survey. Similarly, requirement for any veterinary input into the determination of suitability  
97 to return to competition was not included in the survey.

98 Handlers were also asked demographic questions about themselves (age, sex, and years  
99 competing), as well as information about injuries sustained.

100 Descriptive statistics were calculated for several variables. Pearson  $\chi^2$  tests of independence  
101 and contingency tables were used to examine associations between injury and various factors.  
102 For those variables with expected values of 5 or less, Fisher's exact test of independence was  
103 used to correct for small sample size. T-tests were used to test for differences between  
104 frequency of injury types, location of injury and proportions of injured dogs and humans.  
105 Statistical software<sup>a</sup> and a spreadsheet software<sup>b</sup> were used for the analysis. P values < 0.05  
106 were accepted as significant.

107

## 108 **Results**

109 A total of 160 surveys were received, some including information on multiple dogs. Answers

110 were separated for each dog. Characteristics of dogs and handlers are summarized (**Table 1**).  
111 Dogs had a mean  $\pm$  SD age of  $4.2\pm 2.3$  years (range, 0.7-11.5 years). The most commonly  
112 represented sex was male neutered dogs (68/160 [42.5%]) and the majority of dogs primarily  
113 competed in canicross events in the UK (147/159 [92.5%]). Dogs most commonly ran as a  
114 sole dog with their handler (108/160 [67.5%]).

115 Mixed breed dogs were the most commonly represented breed (61/166 [36.7%]), followed by  
116 the Siberian Husky (13 [7.8%]) and Border Collie (13 [7.8%]), the German Shepherd (8 [4.8%]),  
117 and the Labrador Retriever (7 [4.2%]). Of the mixed breed dogs, the most common crosses  
118 were Collie (14/46 [30.4%]) and Labrador Retriever crosses (10/46 [21.7%]).

119 42.5% of dogs (68/160) participated in one or more canine sports in addition to canicross with  
120 a total of 19 sports listed. The most common being agility (40/68), bikejor (20/68), and  
121 scootering (10/68). In bikejor and scootering the dog is also attached to and pulls the human  
122 handler, who is on a bike or a scooter in bikejor and scootering, respectively. Additionally,  
123 33.8% (54 out of 160) of dogs received one or more treatments as fitness maintenance. The  
124 most common of these were massage therapy (32/54), hydrotherapy (15/54), and chiropractic  
125 (11/54).

126 The majority of dogs had been running canicross for less than a year (44/159 [27.7%]). Of the  
127 dogs that trained for canicross at least once a week, the average number of training days per  
128 week was  $3.2\pm 1.3$  (range, 1-7 days). The mean number of races entered per year was  $7.0\pm 6.1$   
129 (range: 0-30 races/year), with the most common being 3 races/year (23/159 [14.5%]). The  
130 mean $\pm$ SD distance run was  $8.5 \pm 7.4$  km (range, 3-64.4 km), with the most common distance  
131 run being 5 km (69/150 [46.0%]), followed by 10 km (34/150 [22.7%]). Of the 160 responses,  
132 112 dogs (70.0%) did warm up exercises before an event and 79 (49.4%) of dogs did cool  
133 down exercises after an event.

134 The majority of the handlers in the survey were female, with a mean  $\pm$  SD age of  $38.3 \pm 9.8$   
135 years (range, 16 to 64 years). Handlers' years of experience running in canicross events  
136 ranged from less than 1 year to 20 years. The greatest number of participants had been

137 running with their dog for less than 2 years (57/134 [42.5%]), followed by participants running  
138 for 2 to 4 years (49/134 [36.6%]), and participants running 5 years or more (28 /134 [20.9%]).

139

140 Out of 160 dogs, 8.1% (13) had been reported with an orthopaedic, neurological, or systemic  
141 disease. The most common of these was hip dysplasia (4/13), and epilepsy (3/13 ). Of these  
142 diseases, 3 participants said that the disease interfered with their dog's competition activity.

143 Of the 160 dogs, 21.9% (35) had sustained one or more injuries since they started running  
144 canicross. The anatomic location of injuries is summarized in **table 2**. Of these dogs, 24 had  
145 incurred one injury, 8 had incurred 2 injuries, and 3 had incurred 3 injuries since they began

146 running canicross. Out of the 49 reported injuries, the most common type of injury was  
147 lacerations, abrasions, and punctures (22/49), followed by muscle and tendon injuries (8/49).

148 The most common area for lacerations, abrasions, and punctures was to the footpads (16/22),  
149 specifically the footpads of the forelimb (13/16). Dogs had recovered back to full running

150 performance from 38 out of 49 of the injuries. Of the reported recovery times for injuries that  
151 had completely recovered, 23 out of 33 took less than a month to recover, while the remainder

152 10 took greater than one month to recover. Severity and occurrence of injuries is summarized  
153 **(Figures 1 and 2)**.

154 It was found that purebred Labradors were more likely to be injured than other breeds (2-tail  
155 p-value= 0.042). All of these injuries were lacerations, abrasions and punctures (3) or nail

156 tears (2), and all occurred while training for canicross. While Labradors accounted for 1.6%  
157 (n=2/125) of uninjured participants, they made up 14.3% (n=5/35) of the injured population.

158 No significant association was found between injury occurrence and the other most common  
159 breeds, or between injury occurrence in mixed breeds when compared to purebred dogs

160 (p=0.463). When evaluating dogs that also competed in agility and bikejor, there was no  
161 significant difference in injury occurrence between dogs that participated in bikejor and those

162 that did not (p-value = 0.150). However, canicross dogs that also participated in agility were  
163 more likely to have sustained 2 or more injuries than those that did not (p-value = 0.006). No

164 significant association with injury occurrence was found with variables such as sex of dog,  
165 neutering status, fitness maintenance, warm up and cool down exercises, distance run,  
166 number of competitions/year, and number of training days ( $p>0.05$ ). Results of  $\chi^2$  analysis  
167 indicated that there was a significant difference in injury occurrence between dogs that ran  
168 alone with their handler and dogs that sometimes or always ran with another dog during  
169 canicross, with dogs that ran as a sole dog being less likely to be injured ( $p=0.028$ ). There was  
170 no significant difference in injury occurrence of humans who ran with one dog and humans  
171 who sometimes or always ran with two dogs during canicross ( $p=0.526$ ).

172

173 Of the human canicross runners, 46.9% (69 out of 147) had suffered one or more injuries while  
174 running with their dog. The most commonly reported injuries were ankle injuries (25/69),  
175 bruises, cuts, and grazes (20/69), knee injuries (13/69), and hip injuries (7/69). Human runners  
176 were significantly more likely to be injured than canines ( $p<0.0001$ ). Results of  $\chi^2$  analysis did  
177 not indicate a significant correlation between injury status in humans and injury status in the  
178 dog with which they run ( $p=0.550$ ).

179 Humans that have been running in canicross events for 5 years or less were less likely to be  
180 injured than those running in canicross for more than 5 years ( $p=0.030$ ). Dogs running in  
181 canicross events for greater than 2 years were more likely to have incurred 2 or more injuries  
182 than dogs running in events for 2 years or less (2-tail  $p$ -value = 0.001).

183

## 184 **Discussion**

185

186 Results of this study indicated that injuries affected approximately 22% of canicross dogs, with  
187 38% of these injuries occurring during canicross training or competition. This is a smaller  
188 proportion of dogs than were injured in studies done on agility dogs.<sup>10,11,23</sup> A possible  
189 explanation for this result could be that agility dogs have more variation in demands on the  
190 body with the many different obstacles they encounter during agility competition and more

191 extreme forces exerted on them while jumping in agility compared to running Canicross.<sup>10,20</sup> In  
192 addition, dogs injured during canicross seemed to incur more minor injuries with a shorter  
193 recovery time when compared to the studies investigating dogs injured during agility and  
194 greyhound racing.<sup>10-12,18</sup> However, this survey study revealed serious injuries that forced the  
195 retirement from competition indicating that there is the potential for more serious injury to  
196 occur.

197 It was observed that length of time running in canicross had some effect on injury occurrence,  
198 as dogs running in canicross events for greater than 2 years were more likely to have incurred  
199 2 or more injuries. This is in contrast to results observed in agility dogs, where it has been  
200 observed that dogs competing in agility for more than 4 years are at a decreased risk of injury,  
201 probably due to an increased expertise and skill acquisition, putting themselves at a lower risk  
202 of injury<sup>11</sup>. However, in agility there is a variety of obstacles that would require skill training, in  
203 contrast to a more uniform and repetitive activity such that present in canicross. Although skill  
204 improvement could decrease the risk of injury in skill demanding sports, it would be reasonable  
205 to think that the longer a dog has been participating in a sport, the higher is the likelihood they  
206 have suffered one or more injuries in their career. The incidence of injuries in racing  
207 greyhounds has been reported to increase during the second year in a survey, but other  
208 factors, such as racing track characteristics and racing speed, could also have influenced the  
209 risk of injury<sup>21</sup>. Humans running in canicross for greater than 5 years were also more likely to  
210 be injured. Injuries in runners have been reported in 17-79% of people, with some variability  
211 between men and women, and different factors increasing the risk of injury, such as previous  
212 injuries or the use of orthotics<sup>22</sup>. Although both dogs and human runners may develop overuse  
213 injuries and stress fractures secondary to their increased activity<sup>14,17,23-25</sup>, the intensity of the  
214 activity, rather than the duration, may play a more important role in the development of  
215 injuries<sup>22,23,26</sup>. However, in the study presented here we did not find a significant relationship  
216 between length of races, number of competitions entered per year or training days per week  
217 and injuries. Labradors running canicross were more likely to be injured than other dogs, with  
218 an odd ratio of 10.25. The proportion of injured Labrador retrievers (14.3%) was much higher



219 than the proportion of this breed in the study (4.21%). Labrador Retrievers are commonly  
220 affected by certain orthopaedic conditions including cranial cruciate ligament disease, hip  
221 dysplasia, and elbow dysplasia.<sup>27-30</sup> Some orthopaedic conditions have been reported to alter  
222 the kinetics and kinematics of affected animals<sup>31-34</sup> and it is uncertain if these could play a role  
223 in the injuries found in this survey study. Dogs that ran with another dog during some or all  
224 canicross events were more likely to get injured when compared to those that ran only with a  
225 handler. There is no evidence of this happening in other sports where dogs run in groups, such  
226 as sled, so it is hypothesized that the presence of two dogs running together may also cause  
227 some behavior that is more likely to get a dog injured, such as deviation from a steady running  
228 path and interference with gait or twisting of leads due to the presence of two dogs, which  
229 could potentiate injury. Canicross dogs that also participate in agility were more likely to incur  
230 2 or more injuries. This suggests that risk factors for injury in canicross dogs may include  
231 breed, number of dogs running together in canicross events, and additional participation in  
232 agility. While there was no significant association found between injury occurrence and fitness  
233 maintenance, or warm up and cool downs during event, there may be differences in the value  
234 of different techniques as results of the survey indicated employment of so many diverse  
235 fitness maintenance and warm up and cool down techniques.

236 Lacerations, abrasions, and punctures of the footpads of the forelimb were the most common  
237 injury type and site of dogs involved in the survey population. While the forelimb may be more  
238 likely to be injured simply because it hits the ground of a potentially hazardous surface before  
239 the hindlimb, other mechanisms may also be at work. Further studies are needed to investigate  
240 this. Lacerations, abrasions, and punctures can be problematic as they can lead to infection  
241 and more serious injuries, which could affect future athletic performance, and therefore  
242 prevention is important.<sup>17</sup> Protective paw wear such as boots, particularly for the front paws,  
243 may be useful to try to prevent this type of injury. In a study undertaken on working dogs at a  
244 rescue site found that footpad injuries was the most common injury in these working dogs  
245 (18/20), but paw injuries were not incurred while dogs were wearing paw protection.  
246 Recommendations for the development of safe and effective paw protection that does not

247 hamper agility during this type of work were made in that study. Many of these handlers  
248 reported that their dogs wore boots during training.<sup>34</sup> Similarly to these findings, paw protection  
249 may possibly be helpful during canicross courses and training in preventing footpad injuries,  
250 although further studies would be needed. Protective canine boots are being used on police  
251 dogs in Germany and other canine sports such as sled dog racing with a multitude of different  
252 brands and designs available for dogs.<sup>35</sup>

253 Humans participating in canicross were found to be more likely to be injured than their dogs  
254 with 47% of canicross human runners in the survey having experienced an injury associated  
255 with running with their dog compared to the 22% of canicross dogs that were injured. The most  
256 common injuries found in human canicross runners in this survey were injuries to the ankles,  
257 knees, and hip as well as bruises, cuts, and grazes. This made lacerations and abrasions a  
258 common injury finding in both human and canine canicross runners. This is similar to other  
259 studies performed in human runners where incidence of injury varies between 19.4% to 79.3%,  
260 and the lower extremity is a common site for injuries<sup>22,24</sup>. A study looking into injuries among  
261 handlers and dogs competing in agility, also found a higher occurrence of injury in the handlers  
262 (14.1%) in comparison with the dogs (8.81%), with similar injuries to our study<sup>25</sup>. There is the  
263 possibility that human reported injuries may be greater and more specific partially due to ability  
264 of humans to communicate the specific pain, which is a limitation when reporting canine injury,  
265 however, as there was such a large proportion of humans injured from running with their dogs  
266 with 25 different human injury types reported in this study, future studies looking at human  
267 injury and risk factors in canicross are warranted.

268

269 Limitations of the present study should be evaluated when interpreting the results. The  
270 accuracy of these findings depends on handler-reported data and recall compared to  
271 veterinary confirmed injuries. Another limitation is self-selection bias as survey respondents  
272 volunteered to participate in the survey. It is possible that handlers with a greater interest or  
273 personal experience with dogs injured in canicross were more likely to complete the survey.  
274 However, studies have found that self-selected survey respondents who care about the issue

275 being studied are more likely to provide complete and higher quality data than randomly-  
276 selected respondents.<sup>36,37</sup> There was no confirmation that the injuries encountered by the  
277 dogs had been evaluated or treated by veterinarians. Although the more obvious injuries, such  
278 as lacerations and abrasions, or nail tears, could have been easily identified by the handlers,  
279 other more subtle injuries could have been missed or wrongly localized by the handlers and  
280 therefore not have been properly diagnosed by a veterinarian, and reported in this survey. The  
281 majority of injuries found were self-evident, so it is hoped this limitation wouldn't change the  
282 results of this study greatly. Similarly, there was no requirement for any veterinary input into  
283 the determination of suitability of a dog to return to competition, so it is unknown if this decision  
284 was made on the basis of a veterinarian evaluation or not. It has been reported that subjective  
285 lameness evaluation differs among evaluators, even experienced ones, and it is poorly  
286 correlated to objective evaluation of gait.<sup>38,39</sup> However, in addition to lameness evaluation,  
287 veterinarians usually perform an orthopaedic examination, which could have influenced further  
288 the decision. If the decision to return the dog to competition was made by the handler, other  
289 factors, such as competitive or economical reasons could have biased the choice. It is unclear  
290 how all these factors would have influenced the decision to return a dog to competition, and  
291 the results of this study.

292 Return to competition is one of the ultimate goals in recovery from athletic injury, which is not  
293 a consideration with non-competition pets. Return to competition after injury was high in  
294 canicross dogs in this survey population with 84% of injured dogs having recovered back to  
295 full running performance. However, the athletic performance of most of the injured dogs was  
296 affected while they had the injury. The results of this study also suggest that risk factors for  
297 injury in canicross dogs may include breed, number of dogs running together in canicross  
298 events, and additional participation in agility.

299

300 Footnotes

301 a. SPSS

302 b. Microsoft Excel

303

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305 A copy of the survey form used is available at: <http://goo.gl/forms/Nf4aL9T70Q>.

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415 TABLES

<b>40. Characteristic</b>	<b>No. (%) of Responses</b>
Sex of Canine	
Male neutered	68 (42.5%)
Male entire	27 (16.9%)
Female spayed	58 (36.3%)
Female entire	7 (4.4%)
Number of dogs running with handler during competition	
1	



2	108 (67.5%)
1 or 2	36 (22.5%)
	16 (10.0%)
Number of years dog has been running Canicross	
<1	
1	44 (27.7%)
2	35 (22.0%)
3	30 (18.9%)
4	18 (11.3%)
5	12 (7.5%)
6	8 (5.0%)
7	6 (3.8%)
8	0 (0.0%)
9	2 (1.3%)
10	2 (1.3%)
>10	1 (0.6%)
	1 (0.6%)
Frequency of canine Canicross practice (no. of times/wk)	
<1	
1	3 (1.9%)
	10 (6.3%)
2	41 (25.8%)
	59 (37.1%)
3	18 (11.3%)
	19 (11.9%)
4	6 (3.8%)
	3 (1.9%)
5	
6	
7	
Sex of Handler	
Male	29 (21.8%)
Female	104 (78.2%)
Region	

UK	147 (92.5%)	416
North America	9 (5.7%)	417
other European country	3 (1.9%)	418
		419
Percentages are based on the total numbers of responses for each category: sex of canine (n=160), number of dogs running with handler during competition (160), number of years dog has been running Canicross (159), frequency of canine Canicross practice (159), sex of handler (133), Region (159).		
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Table 1- Selected characteristics of Canicross dogs and their handlers. 423

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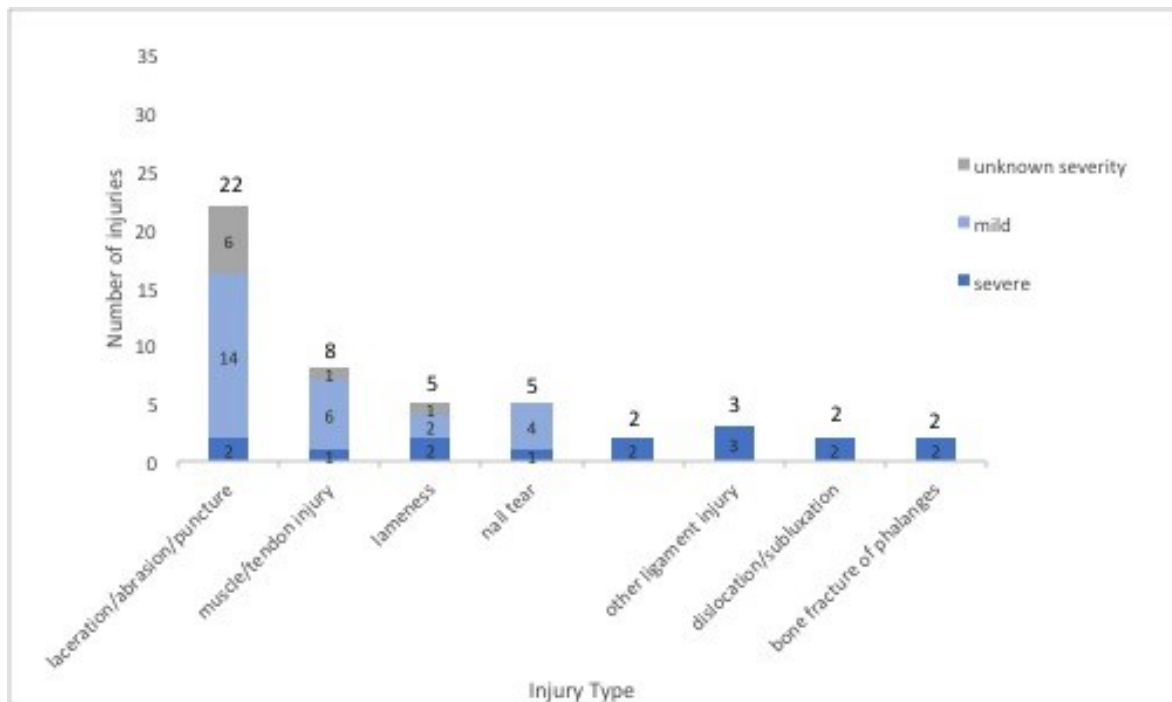
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Anatomic location	No. (%) of Injuries
footpads	16 (32.7%)
of forelimb (13)	438
of hindlimb (3)	439
nails	5 (10.4%)
of forelimb (1)	441
of hind limb (4)	442
shoulder	5 (10.4%)
stifle joint	4 (8.2%)
forearm (antebrachium)	3 (6.1%)
phalanges	2 (4.1%)
of forelimb (1)	448
of hind limb (1)	449
back	2 (4.1%)
lower thigh	2 (4.1%)
carpal joint	1 (2.0%)
tarsal joint	1 (2.0%)
neck	1 (2.0%)
chest	1 (2.0%)
elbow	1 (2.0%)
flank	1 (2.0%)
hip	1 (2.0%)
patella	1 (2.0%)
upper thigh	1 (2.0%)
hind limb (unspecified)	1 (2.0%)

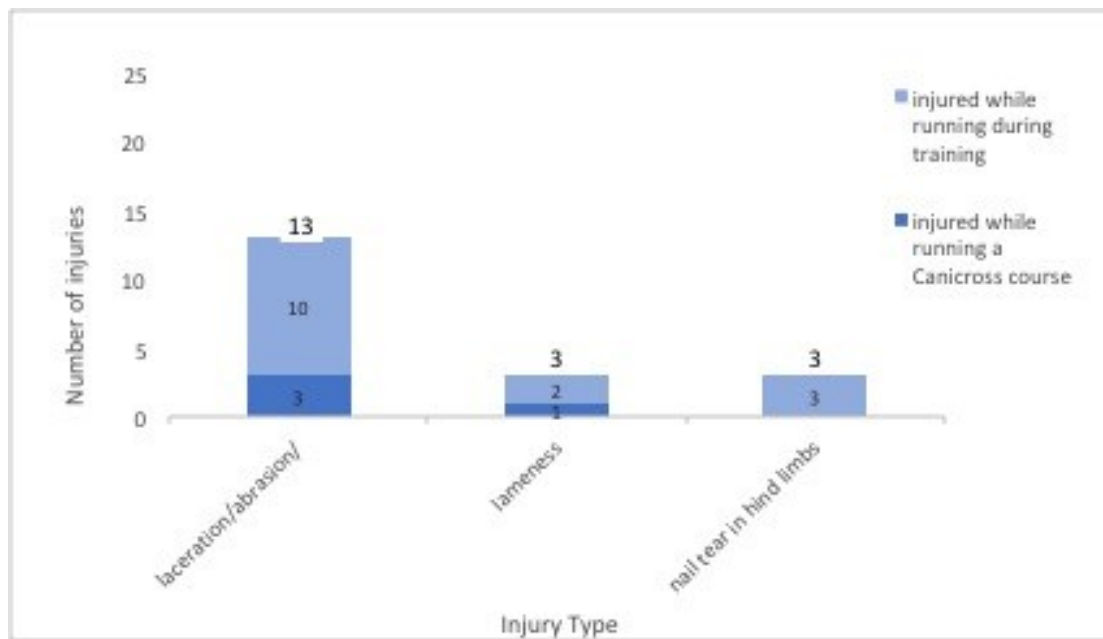
Table 2- Anatomic Location of 49 reported injuries in Canicross dogs



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Figure 1-Type and severity of reported injuries in Canicross dogs. Severe injuries are classified as those taking greater than 1 month to recover and current injuries that have not yet recovered and have been ongoing for greater than 1 month. Mild injuries are classified as those that took 1 month or less for recovery. Injuries in which the recovery time was not specified or injuries that have been ongoing for less than 1 month are classified as unknown severity. Results of  $\chi^2$  analysis with Yates correction for continuity indicated significant difference in severity across injury types ( $p=0.009$ ).

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Figure 2-Type of injuries reported in Canicross dogs where injury was known to have occurred during Canicross training or during Canicross course running.