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Running with injury: a study of UK novice and recreational runners and factors associated with running related injury

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1 **Running with injury: a study of UK novice and recreational runners and factors associated with**
2 **running related injury**

3

4 **Abstract**

5 **Objectives:** To investigate the incidence and type of running related injuries in novice and
6 recreational UK runners, and identify factors associated with injury.

7 **Design:** Retrospective cross-sectional study.

8 **Methods:** Novice and recreational runners were recruited through UK parkrun to complete a web-
9 based survey. 1145 respondents reported information on demographics, personal characteristics, and
10 running training characteristics (training goal, novice runners' training plans, frequency of running,
11 running experience, running terrain). Current and previous injuries were self-reported and questions
12 from the Oslo Sports Trauma Centre Questionnaire for overuse injury were completed. Chi-squared
13 tests and binomial logistic regression were performed.

14 **Results:** 570 runners had a current injury and 94% were continuing to run despite their injury causing
15 pain, directly affecting their performance and causing a reduction of running volume. In the first year
16 of running, runners using a self-devised training programme were more likely to be injured compared
17 with using a structured programme such as Couch to 5K. Running experience of over 2 years was
18 protective (OR 0.578-0.65). Males were 1.45 times more likely to be injured. Other factors
19 associated with current injury were wearing orthotics (OR 1.88), and lack of previous injuries in the
20 past 12 months (OR 1.44).

21 **Conclusions:** More experienced runners have a lower rate of injury. A novice runner should use a
22 recognised structured training programme. These results suggest that graduated loading is important
23 for novice runners, and that load modification may be important whilst recovering from an injury,
24 however full recovery from previous injury may prevent future injury.

25 **Key Words:** risk factors; running experience; Couch to 5k; injury prevention; overuse; loading.

26 **Introduction**

27 Running has increased in popularity across the globe due to health and social benefits achieved in a
28 relatively short period by an easily accessible sport that is low in cost.¹ Despite identification of risk
29 factors and predictors of running related injuries (RRI), the incidence of RRI remains high; a
30 systematic review by van Ghent and colleagues (2007) reported incidence of RRI ranging from 19.4-
31 79.3%.² The most commonly reported factor associated with RRI is previous injury.³⁻⁵ In addition,
32 high training volume,⁶ greater training distance,² and less running experience⁷ are other common risk
33 factors for RRI.

34 Less is known about the relationship between RRI and non-modifiable risk factors such as age and
35 sex. For example, men and women are thought to have differing RRI risk profiles, but agreement on
36 what exactly these sex-specific risk factors are is still lacking.⁵ RRIs are also thought to increase with
37 age⁸, yet experience (which increases with increasing age) protects a runner from injury.⁹ Therefore,
38 an older runner with many years running experience may have a more adapted musculoskeletal
39 system, but older runners new to running may not have the same tolerance for loading and may be at
40 an even greater risk of RRI.

41 Modifiable risk factors for RRI are related to training and physical characteristics. Running at a higher
42 intensity^{10 11} and running less than 2 hours per weeks or less than 2 sessions per week¹² are suggested
43 risk factors. In addition, running more than 60 mins per session was found to be protective for RRI.¹¹
44 Physical characteristics such as lower limb alignment¹³ have also been explored. Often studies do not
45 account for the multifactorial nature of running, which is reliant on the harmonisation of many
46 variables, not just isolated influences.⁷ Identifying the factors associated with injury that are most
47 consistent for specific groups of runners, with a range of different experiences, training patterns and
48 backgrounds in sport and activity may be instrumental in reducing RRI. This is particularly relevant
49 for less experienced runners,⁷ thus RRI in runners with different levels of experience to running needs
50 to be explored further.

51

52 Injury surveillance studies in runners often includes runners training for a set distance event, with
53 distances ranging from 5km to marathon.² Many studies specifically focus on recreational runners,¹⁰
54 ^{13 12} where recreational runners are defined as someone with over 3 months running experience,¹⁴
55 whereas those with less than 3 months running experience are termed novice runners.^{15 11 14} RRI
56 studies have also included running populations from several countries, e.g. Nielsen et al (2012) in
57 their review included running populations from USA, Canada, New Zealand, The Netherlands,
58 Scandinavia, Switzerland and Germany, but no research has been undertaken in a general population
59 of novice and recreational runners in a UK population.⁷ The largest recreational running event in the
60 UK is parkrun, which is a free organized timed 5km run held weekly at hundreds of locations
61 throughout the UK. Runners of any experience can take part, and in particular runners new to the
62 sport are encouraged. Since it began in 2004 in the UK it has grown, and due to its success, parkrun
63 has now spread in popularity throughout the world. The increase in participation of recreational and
64 novice runners in such a setting poses an ideal opportunity to explore RRI prevalence and risk factors
65 in runners who take part in a regular 5km distance. Therefore, this study aims to investigate the
66 prevalence and type of RRI in a general population of novice runners and recreational runners in the
67 UK, and to determine whether there is an association with non-modifiable and modifiable factors
68 associated with injuries.

69

70 **Methods**

71 A survey was compiled based on questions included in previously published RRI surveys^{10 8} and the
72 Oslo Sports Trauma Research Centre (OSTRC) questionnaire for overuse injuries.¹⁷ Ethical approval
73 was obtained from the University of the West of Scotland (School of Science and Sport) Ethics
74 Committee. A pilot survey was conducted in 12 adults (males and females with a range of running
75 experience) and survey questions refined accordingly. The survey platform used was “QuestionPro”
76 and the final survey consisted of 34 questions covering self-reported anthropometric data, general
77 exercise, running experience and goals, running activity and environment, current RRIs and RRIs in
78 the last 12 months. Questions on running activity were specific to the 4 weeks prior to completion of

79 the survey, and the OSTRC questions were specific to the week of completing the survey. Approval
80 from parkrun UK was granted and the survey disseminated through UK parkrun via their online
81 weekly parkrun newsletter. Responses were collected during the month of June 2017.

82 Runners based in the UK and who were aged 18 or over were included. The survey was accessed by
83 1543 runners and completed by 1208 (completion rate 78.3%). Responders were categorised as either
84 injured or non-injured based on their response to the first question of the OSTRC: "Have you had any
85 problems participating in normal running training and competition due to any running-related injury
86 during the past week?". As the study looked at factors associated with running activity on RRI, those
87 who had not engaged in any running in the 4 weeks prior to the completing the survey were removed.
88 This included 63 respondents across both the injured and non-injured groups. The final number of
89 responses included in the analysis was 1145.

90 All data analysis was performed using SPSS v.22. Data were summarised using descriptive statistics.
91 Independent t-tests were used to compare continuous variables between the injured and non-injured
92 groups. For categorical variables, a χ^2 contingency table was used and where significant differences
93 for categorical variables were found, standardised residuals were inspected and those smaller than -
94 1.96 or greater than 1.96 were identified as significant contributors.

95 A logistic regression model was used to identify odds ratios (OR) of significant risk factors for injury.
96 Due to the large numbers of variables, factor analysis was first performed on the continuous and
97 ordinal variables: running surface frequency (soft/muddy trail, multi-surface, hard/rocky trail, grass,
98 road, athletics track, treadmill), weekly running frequency, weekly general exercise frequency,
99 frequency replacing trainers, average weekly running time and distance, length of running experience,
100 running goal, BMI and age to reduce the degrees of freedom prior to logistic regression analysis. The
101 variable that contributed most to a factor was included in the next stage of analysis, along with the
102 nominal variables (sex, leg dominance, inclusion of different distances in weekly programme, use of
103 orthotics, training programme, participation in other sports, previous RRI in the past 12 months). For
104 the logistic regression analysis, a method described by Bursac et al (2008) was used to select variables
105 for the model.¹⁸ In brief, univariate logistic regression analysis of the selected variables was

106 performed and those with a criteria $p < 0.25$ were included in the iterative model. During the iterative
107 process, variables were removed from the model if they were not significant ($p < 0.1$) and if they were
108 not a confounder (creating a change greater than 20% in any other variable estimate). On completion
109 of the iterative phase, excluded variables were re-entered into the model and re-included if significant
110 ($p < 0.1$). The OR and 95% confidence Interval (95%CI) of the variables in the final model were
111 reported.

112

113 **Results**

114 Of the 1145 respondents (mean age 47.38, SD 11.47), 49.8% had a current RRI. Across all
115 respondents, 71.7% were based on England, 23.2% in Scotland, 2.7% in Wales, and 2.4% in Northern
116 Ireland. Table 1 shows the responses from the modified OSTRC questions of the injured group. The
117 body locations of the injured group are shown in Fig1(a), and location of injuries in the previous 12
118 months are shown in Fig 1(b).

119 Injured and non-injured group comparisons showed that body mass index (BMI) was significantly
120 higher in the injured group ($p=0.025$, injured 24.64 kg/m², non-injured 24.15 kg/m²). A significantly
121 greater proportion of injured runners used orthotics ($p < 0.001$; 23.2% injured, 14.6% non-injured), had
122 a training goal of 5k or less ($p=0.005$; injured 9.5%, non-injured 5.0%), and used a self-devised
123 training plan ($p=0.014$; injured 9.8%, non-injured 5.2%). A significant difference was found for sex
124 ($p=0.032$), frequency of general exercise per week ($p=0.029$), running experience ($p=0.029$), previous
125 injury ($p=0.021$), the inclusion of runs with different lengths ($p=0.008$), and the frequency of running
126 on the road ($p=0.039$), rocky/hard trails ($p=0.042$) and soft/muddy trails ($p=0.025$), but no specific
127 contributor was identified for any of these variables.

128 There was no statistical significance found between injured and non-injured runners for age, leg
129 dominance, participation in other sports, weekly running frequency/distance/time, frequency of
130 replacing running shoes, and running surfaces track/grass/mult-terrain.

131 The factor analysis yielded 5 factors (first variable listed per factor included in the univariate analysis;
132 factor 1: soft/muddy trail frequency, multi-surface frequency, hard/rocky trail frequency, grass
133 frequency, road frequency; factor 2: weekly running frequency, weekly exercise frequency, frequency
134 of replacing running trainers, average weekly running distance; factor 3: average weekly running
135 time, weekly running frequency; factor 4: length running experience, running goal; factor 5: age).
136 Univariate analysis was performed on 12 variables and from those, nine were considered for the
137 iterative process of logistic regression analysis (soft/muddy trail frequency, weekly running
138 frequency, average weekly running time, length of running experience, sex, inclusion of different
139 distances, orthotics use, training programme, and previous RRI past 12 months). Table 2 shows the
140 variables included in the final regression model after the iterative process. The model was significant
141 ($p<0.001$), with $\chi^2=45.947$ ($df=9$).

142

143 **Discussion**

144 This study reports on the incidence and factors associated with RRI in 1145 runners in the UK (female
145 $n=641$, male $n=504$). Despite taking part in 5k runs, only 83 runners stated this distance as their
146 running goal. Of all runners, 46.7% were aiming for 10 miles to ultramarathon distance in the same
147 year, and a quarter (24.1%) did not have a running goal. Just under half ($n=570$) had a current RRI,
148 although 86% continued to train despite this. Further, the vast majority of injured runners reported
149 pain due to a RRI (91%), 89% felt their RRI was directly affecting their running performance, and
150 86% had had to reduce their running volume due to RRI. Although direct group comparison between
151 injured and non-injured showed a statistically significant difference for BMI with BMI being lower in
152 the non-injured group, average group BMI was still classed as normal weight ($BMI<25$) in both
153 groups. As BMI was not a significant factor in subsequent regression analysis, the initial significant
154 group comparison for BMI should be interpreted with some caution. Males were 1.45 times more
155 likely to have reported a RRI than females. Previous studies have suggested that RRI in men is more
156 often associated with training characteristics,¹⁹ whereas in females, physical characteristics are likely
157 to be related to higher risk of injury such as increased navicular drop¹⁵ and internal hip rotation/

158 dynamic knee valgus.^{15 20} As it was not feasible to assess these physical characteristics in the current
159 study, further studies assessing the relationship between training and physical characteristic in males
160 and females should be explored. This would clarify whether the approach to RRI prevention in males
161 and females should be different.

162 Six percent of runners in this study were unable to run due to their RRI, which is lower than that
163 found in previous studies.^{10 12 13} This may be due to the methods of injury categorisation, as those
164 studies only included injuries causing complete cessation of running for at least 1 day, resulting in
165 injury incidence values of 17% - 32.2%. Bahr (2009) suggests that injuries should be measured based
166 on functional level and pain²¹ as reflected by the OSTRC questionnaire¹⁷, as typically injuries
167 sustained by runners are usually overuse injuries of gradual onset, and not the sudden traumatic
168 injuries common in contact sports that completely stop participation in sport.²¹ If these injuries are not
169 included during injury surveillance, injury rates may not be accurately presented and will be lower
170 than those injuries recorded that do not stop running but do affect performance. RRI incidence of
171 29.5% was reported previously when injury definition was based on pain that either prevented running
172 or was present during or after a running session,⁸ and 22% of runners about to take part in a 5km and
173 10km recreational race were found to be performing with a RRI.¹⁹ The current study demonstrates that
174 nearly half of recreational runners have a RRI, and most continue training despite their injury.
175 Therefore injury does not necessarily lead to complete cessation of running.

176 This high percentage of runners continuing to run with injury perhaps reflects not only the nature of
177 overuse injuries typically associated with running, but the dedication to running for health and fitness
178 benefits¹ taking precedence over injury. The current study found that runners with 6 months or less
179 running experience were 1.53 times more likely to be injured compared to those with 2-5 years
180 running experience, 1.98 times more likely to be injured compared to those with 5-10 years running
181 experience, and 1.73 times more likely to be injured than those with over 10 years running experience.
182 As many factors in running are modifiable and the injuries tend to be of gradual onset, runners who
183 are more experienced may know their own injury threshold better and tend to manage this differently
184 in comparison to more novice runners.⁷ Experienced runners may have a musculoskeletal system

185 more adapted to running²² and are more likely to modify their load in response to pain, temporarily
186 change running style, and adapt to the terrain to self-manage an injury whilst still continuing to run.²³
187 The current study also showed that those new to running (running for less than 12 months) and who
188 had followed a self-devised programme had a greater incidence of injury (65% reported RRI)
189 compared to those who had used a recognised structured programme such as the Couch to 5km
190 (C25K), which gradually increases the duration of running over a 9-week period (49% reported RRI).
191 A graduated introduction to running appears to reduce the likelihood that the load capacity of the
192 tissues needed to adapt to the new forces of running will be exceeded,^{15 23} but more research is needed
193 to confirm this.

194 Previous studies have reported previous injury as one of the most common factors associated to
195 current RRI,³⁻⁵ suggesting that continuing to run with pain is self-limiting and inevitably leads to
196 further injury if not addressed. Yet contrary to this, the current study found that runners who had not
197 been injured over the past 12 months were 1.43 times more likely to be injured. Therefore, it may be
198 conceivable that an RRI is inevitable, similarly described by Kluitenberg et al (2016) as “without
199 training no injury will occur”.¹¹ This makes identification of factors related to RRI even more
200 important such that runners can be protected from injury and supported, especially for those new to
201 running who may have come from different sporting backgrounds, or have had a sedentary lifestyle.

202 The most injured area in the current study was the knee (22% of all current injuries), in agreement
203 with previous literature^{10 12 19} although considerable variation exists in the way in which RRI's are
204 reported in previous studies. Runner self-diagnosis is used in some studies^{10 13} but agreement on a
205 specific diagnosis usually requires a battery of clinical tests administered by an experienced sports
206 medicine clinician therefore a patients' interpretation of their own diagnosis is unlikely to be
207 accurately identified. Therefore, self-reporting the area of injury (rather than self-diagnosis) is
208 justifiable.^{11 12 19} The current study found slightly more reports of right sided RRI's. Studies often do
209 not report which side the injury is on and only include the lower limb, omitting the trunk and pelvis
210 despite emerging evidence of the importance of gluteus medius playing an integral role in running²⁴
211 and increasing prevalence of lateral pelvis pain/ gluteal tendinopathies in runners.²⁵ Moreover, hip

212 abductor and hip flexor muscle strength is reported to be significantly less on the injured side of
213 runners with lower limb RRIs, regardless of symptom duration.²⁶

214 In the current study, the use of orthotics was associated with a 1.88 times increased rate of injury, but
215 although the use of orthotics has also been suggested to be associated with injury in previous running
216 studies,^{5 6} cause or effect is unknown. Therefore these results do not indicate orthotics were the cause
217 of injury, but it suggests that typically issues with foot mechanics and RRI's may be inclined to be
218 addressed with orthotics. Buist et al (2010) suggested greater foot pronation in women was a risk
219 factor,¹⁵ but in a prospective cohort study, pronation was not associated with increased risk of injury
220 in runners.²⁷ So although 23% of injured runners used orthotics, the management of RRI may require
221 a multifactorial approach, perhaps such as suggested by Synder et al (2009) who demonstrated a
222 change in rear foot mechanics and reduction of loading of more distal structures of the lower limbs
223 with specific strengthening of the hip muscles²⁸ However proximal strengthening, it's effect on
224 loading the musculoskeletal system, and relationship with RRI's needs further investigation as do
225 alternative strategies such as gait re-training²⁹ which have been recently suggested as a more
226 appropriate injury prevention intervention, especially in those starting running for the first time.

227 The present study had several limitations. Firstly, it was a retrospective questionnaire and self-
228 reporting may affect recall accuracy and bias. Unfortunately, it was not possible to continue to follow
229 the participants prospectively for logistical reasons. The OSTRC definition for overuse injuries
230 measures the current problems a runner is experiencing due to RRI in real-time.¹⁷ Using the
231 definition of RRI by Yamato et al (2015), which defines injury as a restriction/stoppage of running for
232 7 consecutive days or 3 scheduled training sessions³⁰, would have possibly recorded different injury
233 rates. The current study also recorded retrospective weekly average running time and distance over
234 the preceding four weeks, however it has been suggested that calculating the number of strides per
235 session using pedometers may be more superior than running distance and time, as it is more
236 accurately determines structure-specific cumulative load.²³ Our injury prevention education to
237 runners in clinical practice should be based on the awareness of how factors associated with RRI's
238 interact, taking into consideration the runners profile rather than relying on specific risk factors.

239 Future studies should conduct large epidemiological studies on RRI in runners with varying
240 experience, and to use technology such as pedometers to help identify optimal loading for prevention
241 of RRI for novice, recreational and more experienced runners. This is particularly relevant as there
242 still exists a lack of consensus across the plethora of potential factors associated with RRI in runners
243 of different abilities.

244

245 **Conclusion**

246 Runners new to running and following their own training programme are at higher risk of injury,
247 whereas those with more than 2 years' experience are less likely to be injured. In this population,
248 males were more likely to be injured, and wearing orthotics is associated with injury but proximal
249 biomechanics should be considered in future studies. Thorough clinical reasoning when considering a
250 runners' injury should be based on the knowledge that RRI's are complex and that factors associated
251 with RRI interact to create an injury risk profile which can be addressed. However, as demonstrated
252 by the large number of injured recreational runners in this study that continued to run despite their
253 pain and performance reduction, education and injury prevention research must have a wider impact
254 in the global community in order to reduce incidence of RRI.

255

256 **Practical Implications**

- 257 • Runners with less than 6 months experience are more likely to be injured, but as experience
258 increases to over 2 years the incidence of injury reduces.
- 259 • If new to running, following a recognised structured programme such as C25K for novice
260 runners will reduce incidence of injury.
- 261 • Males are more likely to have an injury, and more injured runners wear orthotics to correct
262 foot mechanics, but perhaps biomechanical factors related to the hip and pelvis should be
263 considered for prehabilitation and rehabilitation.

264

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267 invaluable help disseminating the survey.

268

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Table 1 – Descriptive data of injured runners based on the Oslo Sports Trauma Research Center (OSTRC) questionnaire on overuse injuries. RRI = Running-Related Injury.

Variable	n (%)
Problems participating in running/competition due to RRI	
no injury, full participation	575 (50.2)
injury with full participation	231 (20.2)
injury and reduced participation	260 (22.7)
injury and cannot participate	79 (6.0)
Reduction in running volume	
no reduction	84 (14.8)
to a minor extent	176 (31.0)
to a moderate extent	148 (26.1)
to a major extent	102 (18.0)
cannot participate at all	58 (10.2)
Reduction in running performance	
no reduction	61 (10.8)
to a minor extent	199 (35.3)
to a moderate extent	148 (26.2)
to a major extent	95 (16.8)
cannot participate at all	61 (10.8)
Pain from RRI	
none	51 (9.5)
minor	331 (57.1)
moderate	155 (27.6)
major	30 (5.9)

Figure 1A – Number of running-related injuries by body location in the injured group (n=570 runners), left side and right side injuries.

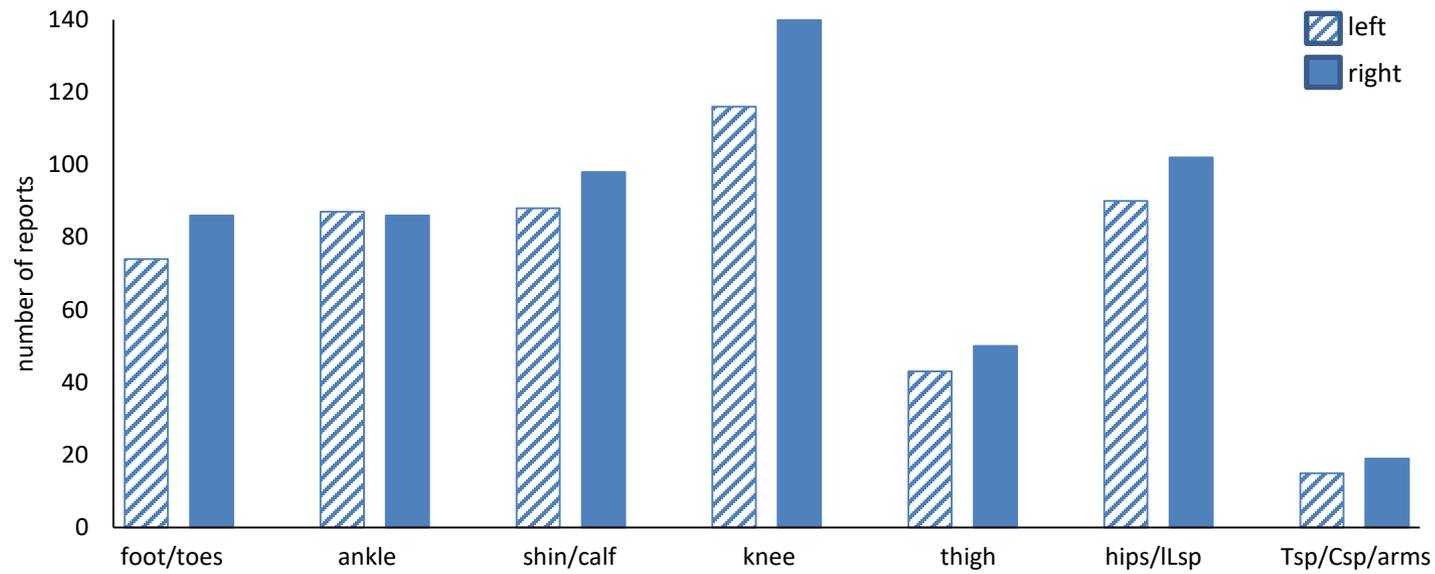
Figure 1B – Number of previous running-related injuries (last 12 months) by body location in all survey respondents (the injuries of both the currently injured and not currently injured groups (n=1145) are combined), left side, right side or unsure (unsure of side of previous injury).

(see attached file)

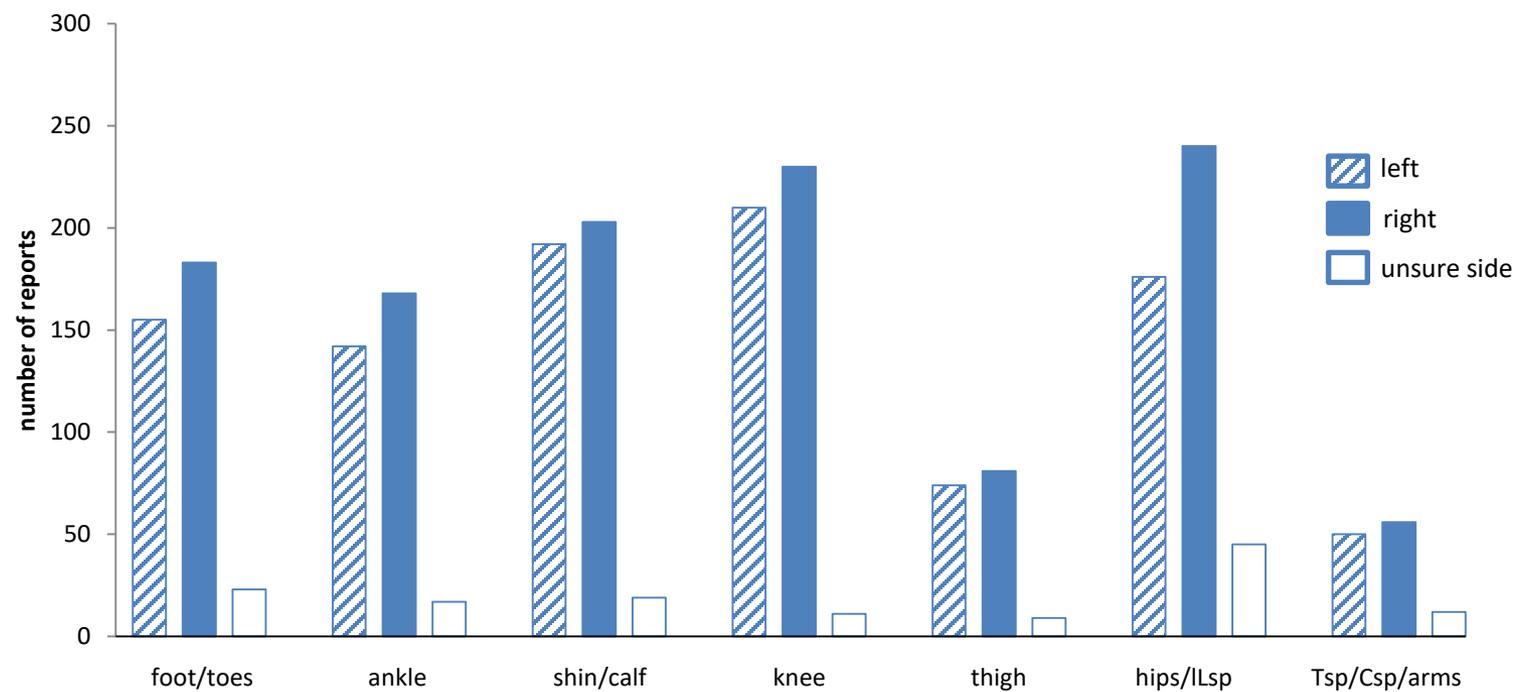
Table 2 – Variables in the final logistic regression model. Significant p-values are highlighted in bold. An Odds Ratio (OR) greater than 1 indicates a risk factor for injury, whereas an OR less than 1 is protective. The upper and lower values of the 95% Confidence Intervals (CI) are given.

Variable		Odds Ratio (OR)	95% CI.for OR		p-value
			Lower	Upper	
Sex (male)		1.446	1.133	1.844	0.003
Inclusion of different distances (no)		1.277	0.991	1.644	0.059
orthotics (yes)		1.884	1.382	2.569	0.000
Previous RRI last 12 months (no)		1.437	1.075	1.920	0.014
Length Running experience (compared to 6 months or less experience)	6-12 months	1.005	0.618	1.635	0.983
	1-2 years	0.709	0.446	1.125	0.144
	2-5 years	0.651	0.430	0.987	0.043
	5-10 years	0.505	0.313	0.814	0.005
	>10 years	0.578	0.377	0.886	0.012

A



B



Appendix 1 –Characteristics of the study population. Significant differences between injured and non-injured groups ($p < 0.05$) are indicated in bold in the p-value column. Values in bold in the injured and non-injured columns indicate values with χ^2 standardised residuals < -1.96 or > 1.96 .

Variable	all	injured	non-injured	p-value
Age (years), mean (SD)	47.38 (11.47)	47.54 (11.09)	47.23 (11.84)	0.647
Sex, n (%)				0.032
female	641 (56.1)	302 (53.0)	339 (59.3)	
male	501 (43.9)	268 (47.0)	233 (40.7)	
BMI (height / weight ²), mean (SD)	24.40 (3.68)	24.64 (3.81)	24.15 (3.54)	0.025
Leg dominance, n (%)				0.289
left	111 (9.7)	50 (8.8)	61 (10.7)	
right	1029 (90.3)	518 (91.2)	511 (89.3)	
Frequency of > 30 mins exercise per week, n (%)				0.029
<1	14 (1.2)	10 (1.8)	4 (0.7)	
1	36 (3.1)	22 (3.9)	14 (2.4)	
2	130 (11.4)	70 (12.3)	60 (10.5)	
3	306 (26.7)	146 (25.6)	160 (27.9)	
4	273 (23.9)	148 (26.0)	125 (21.8)	
5	177 (15.5)	89 (15.6)	88 (15.3)	
6	104 (9.1)	39 (6.8)	65 (11.3)	
daily	104 (9.1)	46 (8.1)	58 (10.1)	
Participates in other sports besides running, n (%)				0.978
yes	988 (86.4)	492 (86.5)	496 (86.4)	
no	155 (13.6)	77 (13.5)	78 (13.6)	
Orthotics, n (%)				<0.001
no	929 (81.1)	438 (76.8)	491 (85.4)	
yes	216 (18.9)	132 (23.2)	84 (14.6)	
Running experience, n (%)				0.029
<6 months	150 (13.1)	87 (15.3)	63 (11.0)	
6-12 months	129 (11.3)	75 (13.2)	54 (9.4)	
1-2 years	156 (13.6)	78 (13.7)	78 (13.6)	
2-5 years	304 (26.6)	147 (25.8)	157 (27.3)	
5-10 years	148 (12.9)	62 (10.9)	86 (15.0)	
more than 10 years	258 (22.5)	121 (21.2)	137 (23.8)	
Running goals, n (%)				0.005
5k or less	83 (7.2)	54 (9.5)	29 (5.0)	
10k	193 (16.9)	100 (17.5)	93 (16.2)	
10 miles	53 (4.6)	30 (5.3)	23 (4.0)	
half marathon	305 (26.6)	156 (27.4)	149 (25.9)	
marathon	132 (11.5)	50 (8.8)	82 (14.3)	
ultra marathon	46 (4.0)	17 (3.0)	29 (5.0)	
none	276 (24.1)	133 (23.3)	143 (24.9)	
other	57 (5.0)	30 (5.3)	27 (4.7)	
Previous RRI in last 12 months				0.021
no	245 (21.4)	138 (24.2)	107 (18.6)	
yes	900 (78.6)	432 (75.8)	468 (81.4)	

Appendix 2 – Running-specific characteristics. Significant differences between injured and non-injured groups ($P < 0.05$) are indicated in bold in the p-value column. Values in bold in the injured and non-injured column indicate values with absolute χ^2 standardised residuals of < -1.96 or > 1.96 .

Variable	all	injured	non-injured	p-value
Running frequency per week, n (%)				0.073
<1	22 (1.9)	16 (2.8)	6 (1.0)	
1	127 (11.1)	70 (12.3)	57 (9.9)	
2	291 (25.5)	149 (26.2)	142 (24.7)	
3	410 (35.9)	203 (35.7)	207 (36.1)	
4	198 (17.3)	89 (15.6)	109 (19.0)	
5	52 (4.5)	26 (4.6)	26 (4.5)	
6	29 (2.5)	13 (2.3)	16 (2.8)	
daily	14 (1.2)	3 (0.5)	11 (1.9)	
Average weekly running distance (km), mean (SD)	25.38 (25.0)	23.92 (24.18)	26.82 (25.72)	0.05
Average weekly running time (min), mean (SD)	166.02 (188.52)	159.08 (197.72)	172.86 (178.9)	0.22
Runs of different distances included weekly, n (%)				0.008
yes	710 (62.1)	331 (58.3)	379 (65.9)	
no	433 (37.9)	237 (41.7)	196 (34.1)	
How often are running trainers replaced, n (%)				0.951
<6 months	156 (13.7)	76 (13.4)	80 (13.9)	
6-12 months	501 (43.9)	247 (43.6)	254 (44.2)	
more than 1 year	440 (38.5)	220 (38.8)	220 (38.3)	
don't know	45 (3.0)	24 (4.2)	21 (3.7)	
Running programme if < 1 year running experience				0.014
couch to 5k	102 (9.2)	50 (9.1)	52 (9.4)	
running group / coach	43 (3.9)	26 (4.7)	17 (3.1)	
self-devised programme	83 (7.5)	54 (9.8)	29 (5.2)	
other programme	19 (1.7)	11 (2.0)	8 (1.4)	
no programme	92 (8.3)	51 (9.3)	41 (7.4)	
Surface: road				0.039
never	19 (1.7)	13 (2.3)	6 (1.1)	
occ	109 (9.6)	59 (10.5)	50 (8.8)	
sometimes	117 (10.4)	63 (11.2)	54 (9.5)	
often	666 (58.9)	307 (54.6)	359 (63.2)	
always	219 (19.4)	120 (21.4)	99 (17.4)	
Surface: athletics track				0.730
never	799 (82.6)	394 (83.5)	405 (81.8)	
occ	111 (11.5)	49 (10.4)	62 (12.5)	
sometimes	30 (3.1)	16 (3.4)	14 (2.8)	
often/always	27 (2.8)	13 (2.8)	14 (2.8)	
Surface: rocky/hard trails				0.042
never	285 (28.5)	161 (32.5)	124 (24.6)	
occ	342 (34.2)	164 (33.1)	178 (35.2)	
sometimes	198 (19.8)	91 (18.4)	107 (21.2)	
often/always	175 (17.5)	79 (16.0)	96 (19.0)	
Surface: soft/muddy trails				0.025
never	202 (20.0)	114 (23.2)	88 (16.9)	
occ	353 (34.9)	172 (35.0)	181 (34.8)	
sometimes	239 (23.6)	100 (20.4)	139 (26.7)	
often/always	216 (21.4)	105 (21.4)	112 (21.5)	

Surface: grass	never	146 (14.2)	72 (14.4)	74 (14.1)	0.419
	occ	407 (39.6)	198 (39.5)	209 (39.7)	
	sometimes	279 (27.2)	127 (25.3)	152 (28.9)	
	often/always	195 (19.0)	104 (20.8)	91 (17.3)	
Surface: multi-terrain	never	196 (19.9)	105 (21.8)	91 (18.0)	0.335
	occ	277 (28.1)	140 (29.1)	137 (27.1)	
	sometimes	239 (24.2)	110 (22.9)	129 (25.5)	
	often	251 (25.4)	117 (24.3)	134 (26.5)	
	always	24 (2.4)	9 (1.9)	15 (3.0)	
Surface: treadmill	never	679 (66.6)	317 (65.2)	342 (68.0)	0.508
	occ	186 (18.8)	90 (18.5)	96 (19.1)	
	sometimes	82 (8.3)	44 (9.1)	38 (7.6)	
	often/always	62 (6.3)	35 (7.2)	27 (5.4)	

Appendix 3 – Factor analysis results. The variables in bold were considered for regression analysis.

Variable	Factor				
	1	2	3	4	5
Soft/muddy trail frequency	0.812				
Multi-surface trail frequency	0.720				
Hard/rocky trail frequency	0.612				
Grass frequency	0.589				
Road frequency	-0.409				
Athletics track frequency					
Treadmill frequency					
Weekly running frequency		0.859	0.304		
Weekly exercise frequency		0.330			
Frequency of replacing trainers		-0.402			
Average weekly running time			0.733		
Average weekly running distance		0.424			
Length running experience				0.788	
Running goal				0.346	
BMI					
Age					0.527

Appendix 4 – Univariate analysis results of nominal variables and those selected from factor analysis. The variables in bold were considered for the iterative process of the logistic regression analysis (p<0.25)

Variable	p-value
Soft/muddy trail frequency	0.033
Weekly running frequency	0.062
Average weekly running time	0.215
Length running experience	0.029
Age	0.646
Sex	0.032
Leg dominance	0.289
Inclusion of different distances	0.008
Using orthotics	<0.001
Training programme	0.013
Participating in other sports	0.978
Previous RRI last 12 months	0.037

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