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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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Abstract

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

Design: Retrospective cross-sectional study.

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

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

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

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

Introduction

Running has increased in popularity across the globe due to health and social benefits achieved in a relatively short period by an easily accessible sport that is low in cost.[1] Despite identification of risk factors and predictors of running related injuries (RRI), the incidence of RRI remains high; a systematic review by van Ghent and colleagues (2007) reported incidence of RRI ranging from 19.4-79.3%.[2] The most commonly reported factor associated with RRI is previous injury.[3-5] In addition, high training volume,[6] greater training distance,[2] and less running experience[7] are other common risk factors for RRI.

Less is known about the relationship between RRI and non-modifiable risk factors such as age and sex. For example, men and women are thought to have differing RRI risk profiles, but agreement on what exactly these sex-specific risk factors are is still lacking.[5] RRIs are also thought to increase with age[8], yet experience (which increases with increasing age) protects a runner from injury.[9] Therefore, an older runner with many years running experience may have a more adapted musculoskeletal system, but older runners new to running may not have the same tolerance for loading and may be at an even greater risk of RRI.

Modifiable risk factors for RRI are related to training and physical characteristics. Running at a higher intensity [10 11] and running less than 2 hours per weeks or less than 2 sessions per week[12] are suggested risk factors. In addition, running more than 60 mins per session was found to be protective for RRI.[11] Physical characteristics such as lower limb alignment[13] have also been explored. Often studies do not account for the multifactorial nature of running, which is reliant on the harmonisation of many variables, not just isolated influences.[7] Identifying the factors associated with injury that are most consistent for specific groups of runners, with a range of different experiences, training patterns and backgrounds in sport and activity may be instrumental in reducing RRI. This is particularly relevant for less experienced runners,[7] thus RRI in runners with different levels of experience to running needs to be explored further.

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

Methods

A survey was compiled based on questions included in previously published RRI surveys[10 8] and the Oslo Sports Trauma Research Centre (OSTRC) questionnaire for overuse injuries.[17] Ethical approval was obtained from the University of the West of Scotland (School of Science and Sport) Ethics Committee. A pilot survey was conducted in 12 adults (males and females with a range of running experience) and survey questions refined accordingly. The survey platform used was "QuestionPro" and the final survey consisted of 34 questions covering self-reported anthropometric data, general exercise, running experience and goals, running activity and environment, current RRIs and RRIs in the last 12 months. Questions on running activity were specific to the 4 weeks prior to completion of the survey, and the OSTRC questions were specific to the week of completing the survey. Approval from parkrun UK was granted and the survey disseminated through UK parkrun via their online weekly parkrun newsletter. Responses were collected during the month of June 2017.

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

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

A logistic regression model was used to identify odds ratios (OR) of significant risk factors for injury. Due to the large numbers of variables, factor analysis was first performed on the continuous and ordinal variables: running surface frequency (soft/muddy trail, multi-surface, hard/rocky trail, grass, road, athletics track, treadmill), weekly running frequency, weekly general exercise frequency, frequency replacing trainers, average weekly running time and distance, length of running experience, running goal, BMI and age to reduce the degrees of freedom prior to logistic regression analysis. The variable that contributed most to a factor was included in the next stage of analysis, along with the nominal variables (sex, leg dominance, inclusion of different distances in weekly programme, use of orthotics, training programme, participation in other sports, previous RRI in the past 12 months). For the logistic regression analysis, a method described by Bursac et al (2008) was used to select variables for the model.[18] In brief, univariate logistic regression analysis of the selected variables was performed and those with a criteria p <0.25 were included in the iterative model. During the iterative process, variables were removed from the model if they were not significant (p <0.1) and if they were not a confounder (creating a change greater than 20% in any other variable estimate). On completion of the iterative phase, excluded variables were re-entered into the model and re-included if significant (p<0.1). The OR and 95% confidence Interval (95%CI) of the variables in the final model were reported.

Results

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

Injured and non-injured group comparisons showed that body mass index (BMI) was significantly higher in the injured group (p=0.025, injured 24.64 kg/m^2, non-injured 24.15 kg/m^2). A significantly greater proportion of injured runners used orthotics (p<0.001; 23.2% injured, 14.6% non-injured), had a training goal of 5k or less (p=0.005; injured 9.5%, non-injured 5.0%), and used a self-devised training plan (p=0.014; injured 9.8%, non-injured 5.2%). A significant difference was found for sex (p=0.032), frequency of general exercise per week (p=0.029), running experience (p=0.029), previous injury (p=0.021), the inclusion of runs with different lengths (p=0.008), and the frequency of running on the road (p=0.039), rocky/hard trails (p=0.042) and soft/muddy trails (p=0.025), but no specific contributor was identified for any of these variables.

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

The factor analysis yielded 5 factors (first variable listed per factor included in the univariate analysis; factor 1: soft/muddy trail frequency, multi-surface frequency, hard/rocky trail frequency, grass frequency, road frequency; factor 2: weekly running frequency, weekly exercise frequency, frequency of replacing running trainers, average weekly running distance; factor 3: average weekly running time, weekly running frequency; factor 4: length running experience, running goal; factor 5: age). Univariate analysis was performed on 12 variables and from those, nine were considered for the iterative process of logistic regression analysis (soft/muddy trail frequency, weekly running frequency, average weekly running time, length of running experience, sex, inclusion of different distances, orthotics use, training programme, and previous RRI past 12 months). Table 2 shows the variables included in the final regression model after the iterative process. The model was significant ($p<0.001$), with $\chi2=45.947$ (df=9).

Discussion

This study reports on the incidence and factors associated with RRI in 1145 runners in the UK (female n=641, male n=504). Despite taking part in 5k runs, only 83 runners stated this distance as their running goal. Of all runners, 46.7% were aiming for 10 miles to ultramarathon distance in the same year, and a quarter (24.1%) did not have a running goal. Just under half (n=570) had a current RRI, although 86% continued to train despite this. Further, the vast majority of injured runners reported pain due to a RRI (91%), 89% felt their RRI was directly affecting their running performance, and 86% had had to reduce their running volume due to RRI. Although direct group comparison between injured and non-injured showed a statistically significant difference for BMI with BMI being lower in the non-injured group, average group BMI was still classed as normal weight (BMI<25) in both groups. As BMI was not a significant factor in subsequent regression analysis, the initial significant group comparison for BMI should be interpreted with some caution. Males were 1.45 times more likely to have reported a RRI than females. Previous studies have suggested that RRI in men is more often associated with training characteristics,[19] whereas in females, physical characteristics are likely to be related to higher risk of injury such as increased navicular drop[15] and internal hip rotation/

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

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

This high percentage of runners continuing to run with injury perhaps reflects not only the nature of overuse injuries typically associated with running, but the dedication to running for health and fitness benefits [1] taking precedence over injury. The current study found that runners with 6 months or less running experience were 1.53 times more likely to be injured compared to those with 2-5 years running experience, 1.98 times more likely to be injured compared to those with 5-10 years running experience, and 1.73 times more likely to be injured than those with over 10 years running experience. As many factors in running are modifiable and the injuries tend to be of gradual onset, runners who are more experienced may know their own injury threshold better and tend to manage this differently in comparison to more novice runners.[7] Experienced runners may have a musculoskeletal system more adapted to running[22] and are more likely to modify their load in response to pain, temporarily change running style, and adapt to the terrain to self-manage an injury whilst still continuing to run .[23] The current study also showed that those new to running (running for less than 12 months) and who had followed a self-devised programme had a greater incidence of injury (65% reported RRI) compared to those who had used a recognised structured programme such as the Couch to 5km (C25K), which gradually increases the duration of running over a 9-week period (49% reported RRI). A graduated introduction to running appears to reduce the likelihood that the load capacity of the tissues needed to adapt to the new forces of running will be exceeded,[15 23] but more research is needed to confirm this.

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

The most injured area in the current study was the knee (22% of all current injuries), in agreement with previous literature [10 12 19] although considerable variation exists in the way in which RRI's are reported in previous studies. Runner self-diagnosis is used in some studies [10 13] but agreement on a specific diagnosis usually requires a battery of clinical tests administered by an experienced sports medicine clinician therefore a patients' interpretation of their own diagnosis is unlikely to be accurately identified. Therefore, self-reporting the area of injury (rather than self-diagnosis) is justifiable. [11 12 19] The current study found slightly more reports of right sided RRI's. Studies often do not report which side the injury is on and only include the lower limb, omitting the trunk and pelvis despite emerging evidence of the importance of gluteus medius playing an integral role in running [24] and increasing prevalence of lateral pelvis pain/ gluteal tendinopathies in runners. [25] Moreover, hip abductor and hip flexor muscle strength is reported to be significantly less on the injured side of runners with lower limb RRIs, regardless of symptom duration.[26]

In the current study, the use of orthotics was associated with a 1.88 times increased rate of injury, but although the use of orthotics has also been suggested to be associated with injury in previous running studies,[5 6] cause or effect is unknown. Therefore these results do not indicate orthotics were the cause of injury, but it suggests that typically issues with foot mechanics and RRI's may be inclined to be addressed with orthotics. Buist et al (2010) suggested greater foot pronation in women was a risk factor,[15] but in a prospective cohort study, pronation was not associated with increased risk of injury in runners.[27] So although 23% of injured runners used orthotics, the management of RRI may require a multifactorial approach, perhaps such as suggested by Synder et al (2009) who demonstrated a change in rear foot mechanics and reduction of loading of more distal structures of the lower limbs with specific strengthening of the hip muscles[28] However proximal strengthening, it's effect on loading the musculoskeletal system, and relationship with RRI's needs further investigation as do alternative strategies such as gait re-training[29] which have been recently suggested as a more appropriate injury prevention intervention, especially in those starting running for the first time.

The present study had several limitations. Firstly, it was a retrospective questionnaire and self-reporting may affect recall accuracy and bias. Unfortunately, it was not possible to continue to follow the participants prospectively for logistical reasons. The OSTRC defintition for overuse injuries measures the current problems a runner is experiencing due to RRI in real-time.[17] Using the definition of RRI by Yamato et al (2015), which defines injury as a restriction/stoppage of running for 7 consecutive days or 3 scheduled training sessions[30], would have possibly recorded different injury rates. The current study also recorded retrospective weekly average running time and distance over the preceding four weeks, however it has been suggested that calculating the number of strides per session using pedometers may be more superior than running distance and time, as it is more accurately determines structure-specific cumulative load.[23] Our injury prevention education to runners in clinical practice should be based on the awareness of how factors associated with RRI's interact, taking into consideration the runners profile rather than relying on specific risk factors.

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

Conclusion

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

Practical Implications

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

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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.

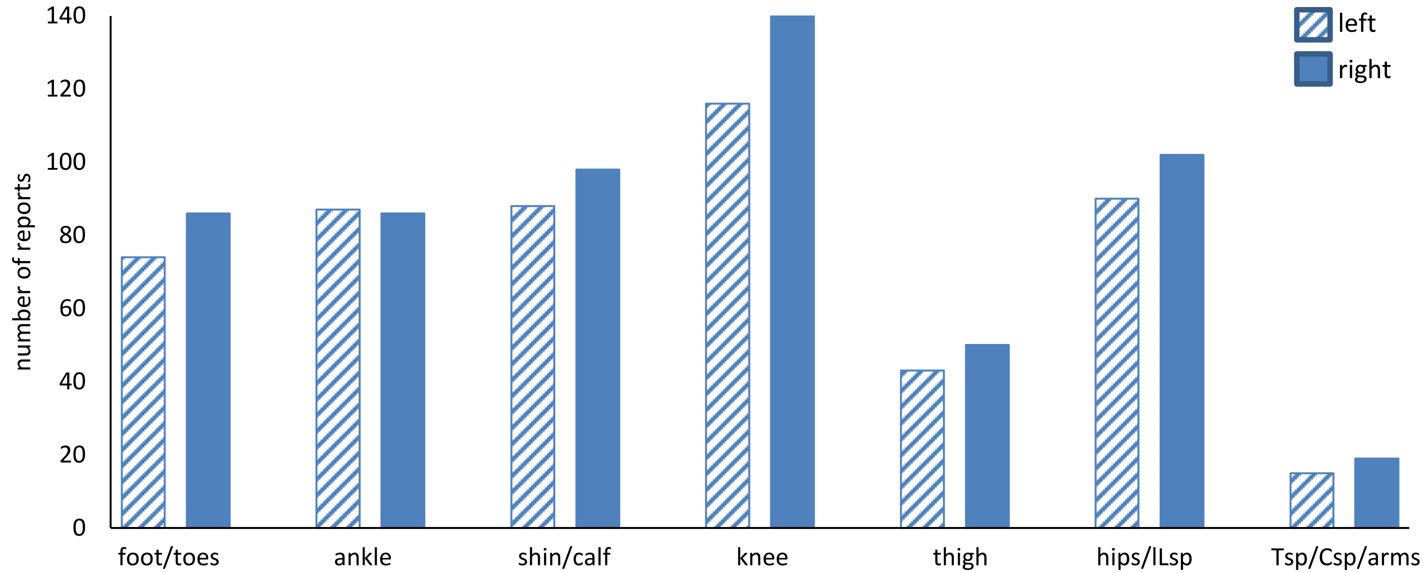
Figure 1B – Number of previous running-related injuries (last 12 months) by body location in all survey respondents (the injuries of both the currently injured and not currently injured groups (n=1145) are combined), left side, right side or unsure (unsure of side of previous injury).

(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



140
120
100
80
60
40
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number of reports
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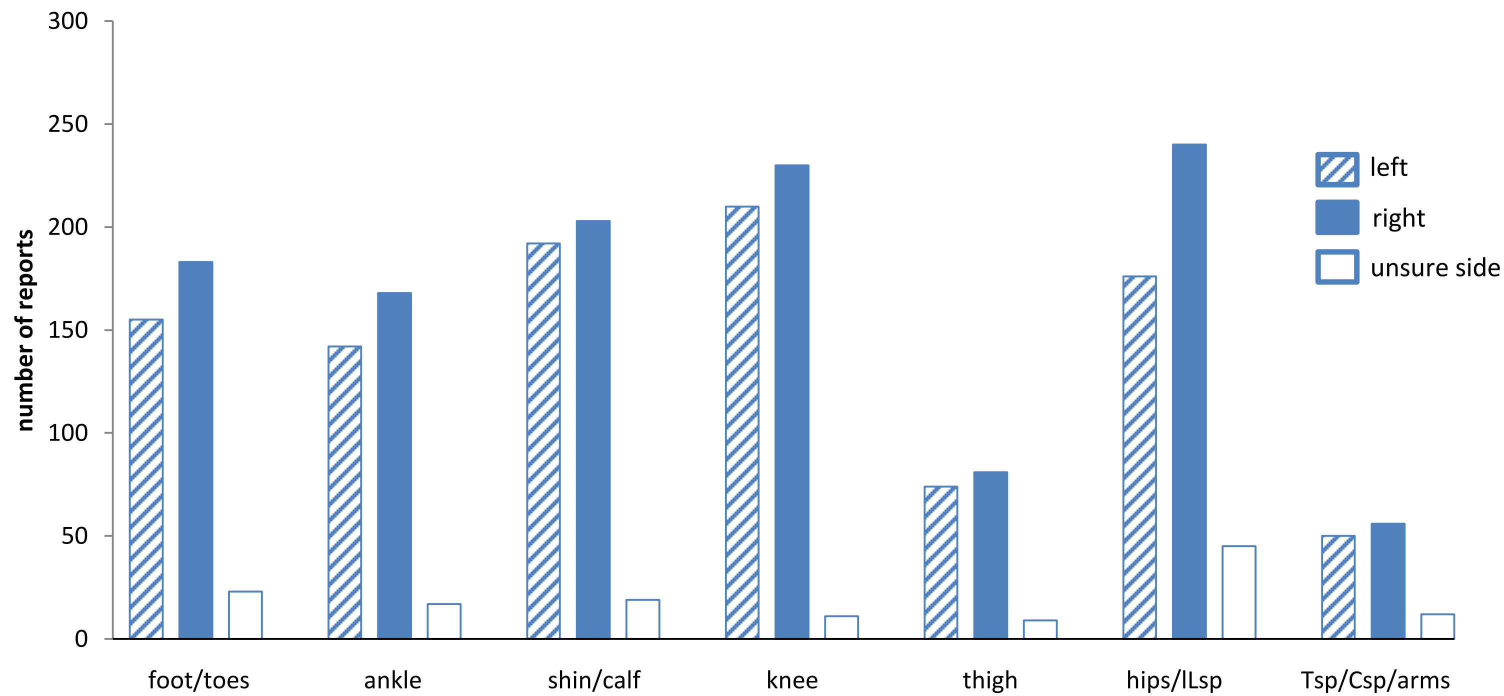
right
foot/toes
ankle
shin/calf
knee
thigh
hips/lLsp
Tsp/Csp/arms

B



300
250
200
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number of reports
left
right
unsure side
foot/toes
ankle
shin/calf
knee
thigh
hips/lLsp
Tsp/Csp/arms

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-inured 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-inured 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				0.419
never	146 (14.2)	72 (14.4)	74 (14.1)	
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				0.335
never	196 (19.9)	105 (21.8)	91 (18.0)	
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				0.508
never	679 (66.6)	317 (65.2)	342 (68.0)	
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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