Incidence and risk factors of running-related injuries during preparation for a 4-mile recreational running event

I Buist, S W Bredeweg, B Bessem, et al.

doi: 10.1136/bjsm.2007.044677

Updated information and services can be found at:
http://bjsm.bmj.com/content/44/8/598.full.html

These include:

References
This article cites 25 articles, 9 of which can be accessed free at:
http://bjsm.bmj.com/content/44/8/598.full.html#ref-list-1

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Notes

To order reprints of this article go to:
http://bjsm.bmj.com/cgi/reprintform

To subscribe to British Journal of Sports Medicine go to:
http://bjsm.bmj.com/subscriptions
Incidence and risk factors of running-related injuries during preparation for a 4-mile recreational running event

I Buist, S W Bredeweg, B Bessem, W van Mechelen, K A P M Lemmink, R L Diercks

ABSTRACT

Objective In this study, the incidence and the sex-specific predictors of running-related injury (RRI) among a group of recreational runners training for a 4-mile running event were determined and identified, respectively.

Design Prospective cohort study.

Methods Several potential risk factors were prospectively measured in 629 novice and recreational runners. They were observed during an 8-week training period for any running-related musculoskeletal injuries of the lower limbs and back. A running-related injury was defined as any musculoskeletal pain of the lower limb or back. A running-related injury was defined as any musculoskeletal pain of the lower limb or back. Multivariate Cox regression analyses were conducted to determine the incidence of RRI and to identify sex-specific risk profiles. Furthermore, the findings suggest that novice runners may benefit the most out of preventive interventions for RRI.

The popularity of running as a recreational activity is high and is still increasing. Nowadays, almost every city in Western society has its own marathon and recreational running events. The reason for novice runners to participate in a running programme is most likely to improve health and fitness and for intermediate runners to improve personal performance.

Apart from its beneficial health effects, running also puts runners at a risk of developing a running-related injury (RRI). In the literature, injury rate of RRI is expressed in number of RRIs (or injured runners) per 100 runners at risk, and when exposure is measured, the incidence of RRI in number of RRIs (or injured runners) per 1000 h of running is also included. Reported injury rates of RRIs per 100 runners at risk is high, and varies from 50% to 79%, and injury incidence from 7 to 59 RRIs per 1000 h of running. The wide disparity of incidence rates found in several studies on RRI is caused by variations in definition of injury, differences in population at risk (novice, recreational and elite runners with different training loads) and differences in the duration of follow-up periods (time at risk). Most of the RRIs (50%–75%) are injuries due to overuse located at the knee or below.

The aetiology of the RRIs is multifactorial, with both intrinsic (personal) and extrinsic (environmental) factors contributing. Intrinsic factors include age, sex, body mass index (BMI), physical fitness, previous injury and anatomical alignment. Extrinsic factors can be running distance and frequency per week, predominant running surface, running shoe age and running shoe type. In the literature, only four factors ((1) reported running experience, (2) previous injury, (3) running to compete and (4) excessive weekly running distance) have been associated consistently with RRI.

A more recent systematic review on determinants of lower extremity running injuries in long-distance runners shows that higher training distance per week in male runners and a history of previous injuries in male and female runners were risk factors for sustaining an RRI. Conflicting or no evidence is found for other factors like age, BMI, static biomechanical alignment, running surface, running frequency, warm up and stretching. Furthermore, male and female runners have different risk profiles for RRI. In addition, risk factors can interact and therefore should be considered simultaneously to adjust for confounding. Eventually, a combination of intrinsic and extrinsic risk factors predisposes runners to develop an RRI.

Until now, most of the studies on incidence and risk factors of RRI are conducted on long-distance runners. Inclusion of novice runners in prospective cohort studies on the risk factors for RRI will reduce the healthy runner selection bias. Only a limited number of studies exist that control for the time at risk, that is, exposure time, and little is known about different risk profiles for RRI between male and female recreational runners. Therefore, the purpose of this study is to determine the incidence of RRI and to identify sex-specific predictors of RRI among a group of novice and recreational runners training during an 8-week period for a 4-mile running event.

METHODS

Study period and settings

A prospective cohort design was used for the study. A flowchart of the study is shown in fig 1. Potential participants for the study were 1459 recreational runners who signed up for the “4-mile
training programme’, an 8-week programme to prepare for the Groningen 4-mile. The Groningen 4-mile is a major recreational annual running event in the northern part of The Netherlands. Over 15 000 mainly novice and recreational runners participate in it each year in the first week of October.

**Study procedure and subjects**

All participants (n = 1459) who signed up for the 4-mile training programme were invited by mail to participate in the study. Information about the study, a baseline questionnaire, an informed consent form, and a running diary were sent along with the invitation. The only exclusion criterion was being younger than 18 years. The standardised baseline questionnaire covered demographic variables and questions on potential risk factors for RRI. The potential risk factors for RRI that were assessed by the baseline questionnaire were age, sex, BMI, current and past musculoskeletal injuries of the lower limb, running experience and current running routines (years of experience and frequency and duration in hours per week), participation in other sports (hours per week and type of sports: axial loading or non-axial loading) and motivation for entering the programme (health/fitness or competitive/personal performance). Running experience was assessed by the baseline questionnaire. The participants had to categorise themselves as novice runners, runners with previous experience who have taken up running again or runners who were already engaged in regular running.

During the programme, participants registered information on exposure to running and RRI in a personal running diary. The running diary consisted of eight sections (one for each training week). The total minutes of running and the occurrence of running-related pain during or after running were registered per day. The running-related pain was scored as pain after running, pain during running without a restriction in running, pain that caused a restriction in running mileage, running pace or running duration, or running not possible as a result of running-related pain. At the end of the programme, the participants returned their running diary by mail.

The study design, procedures and informed consent procedure were approved by the Medical Ethics Committee of University Medical Center Groningen (UMCG). All participants provided written informed consent.

**Training programme**

The training programme was developed by a coach of the Royal Dutch Athletics Association. Five training clinics were part of the training programme and were organised by local running clubs at the end of the third to seventh weeks. The 8-week training programme required participants to run three times per week in the first to seventh weeks and twice in the last week of the programme. The programme finished with the 4-mile running event at the end of the eighth week. Within the training programme for the Groningen 4-mile, deviations were made for novice and recreational runners. The training programme for novice runners started with ten 1-minute repetitions of running alternated by 1 minute of walking. The training programme for experienced runners started with 30 minutes of continuous running. The exposure time of running in the training programmes for novice and recreational runners varied, respectively, between 10–40 and 20–60 minutes per training.

**Injury definition**

A running-related injury was defined as any musculoskeletal pain of the lower limb or back causing a restriction in running (mileage, pace or duration) for at least 1 day.

**Analyses**

Demographic variables and potential risk factors for RRI were analysed for differences between male and female participants at baseline using two-tailed t tests for normally distributed continuous variables. £2 statistics were used for discrete variables. Differences were considered statistically significant at p < 0.05. Incidence of RRI was calculated for all participants and for men and women separately as the number of new injuries reported per 1000 h of running exposure. Exposure time (in hours of running exposure) was calculated from the time a participant started the running programme until he reported an RRI (injured runners) or until the end of the programme (non-injured runners).

Potential risk factors for RRI were first univariately analysed to see the independent relation with RRI. Variables independently associated (p ≤ 0.25) with RRI among either men or women were entered in sex-specific multivariate Cox regression prediction models. Hazard ratios (HR) and the corresponding 95% confidence intervals (CI) were calculated for the factors associated with RRI. All analyses were performed using SPSS V.14.0.

**RESULTS**

A total of 1459 recreational runners signed up for the 4-mile running clinics. Among them, 899 were willing to participate in the study and completed the baseline questionnaire. Of the 899 who consented to participate, 24 were younger than 18 years and were therefore excluded. Data of 629 of 875 participants were analysed, 207 men (35%) and 422 women (67%). Two hundred forty-six participants neither started running nor returned their running diary over the full 8-week period. Consequently, they were excluded from data analyses.

**Baseline characteristics**

Baseline characteristics of 629 recreational runners are shown in table 1. Most of the participants used the training programme to restart running (44%) or were already participating in running (25%). The main reason for participating in the training programme was to improve fitness and health (70%). Male participants (35%) were 4.2 years older (p < 0.05) than female participants (67%) and showed a significantly higher BMI (25.9 vs 24.4, p < 0.05). Furthermore, male participants

---

**Figure 1** Flowchart of the Groningen 4-Mile Study.

---

| 899 Completed baseline questionnaire |
| 24 were excluded: under age 18 |
| 875 Included in the study |
| 246 excluded from analyses: |
| Did not start running |
| Did not return the running diary |
| 629 Included in analyses |
and female participants was 7.5 (95% CI 17.6). The difference between the incidence of RRIs per 1000 h of exposure in male runners was 30.1 (95% CI 25.4 to 34.7). The difference in the total exposure time. The incidence of RRIs per 1000 h of running exposure, exposure time until the first RRI was used.

A total of 163 new RRIs were recorded by 629 runners at risk. Incidence of RRI 65). Most of the RRIs appeared at the knee and below in female participants (35 of 98), and the knee in men (25 of 65). Most of the RRIs appeared at the knee and below in female (67%) and in male participants (80%). The only significant difference between male and female participants was the percentage of RRIs localised at the knee, that is, 23% in female versus 39% in male participants.

Risk factors for RRI
All variables assessed at baseline were analysed to see the relation with the occurrence of an RRI. An overview of all potential risk factors and hazard ratios is shown in table 3.

### Univariate Cox regression analyses
The univariate Cox regression analyses showed that male participants were not at higher risk than female participants (HR 1.3; 95% CI 1.0 to 1.8). The variable age was significantly related with sustaining an RRI in male participants—that is, younger male runners were at higher risk of sustaining an RRI (p<0.001). Furthermore, running experience was protective for sustaining an RRI. BMI, motivation for entering the programme, previous sports activity and previous injury of the lower extremity were not significantly associated with RRI (p>.05).

Higher BMI in female participants was related to the risk of sustaining an RRI (p<0.05). Univariate Cox regression analysis also shows that in female participants (non-axial), previous sports activity (HR 1.8; 95% CI 1.1 to 3.2) and no previous running experience (HR 2.3; 95% CI 1.3 to 4.0) were significantly associated with the hazard of sustaining an RRI. All other variables assessed at baseline were independently not significantly associated with RRI (see table 3).

### Multivariate Cox regression analyses
Table 4 shows the significant factors of the multivariate Cox regression models for male and female participants separately. Sex (male), corrected for age, BMI, previous sports activities and running experience were significantly related to RRI (HR 1.4; 95% CI 1.1 to 2.0). Older age was associated with lower risk of RRI in male participants. Lack of running experience was the most important risk factor for RRI in men (HR 2.6; 95% CI 1.2 to 5.5) and in women (HR 2.1; 95% CI 1.2 to 3.7). Furthermore, female runners who reportedly engaged in non-axial sports activities at baseline were at a higher risk (HR 1.9; 95% CI 1.1 to 3.2) of...
sustaining an RRI. Higher BMI was also a risk factor for RRI in female participants (HR 1.1; 95% CI 1.0 to 1.1).

**Discussion**

The aim of this prospective cohort study was to determine the incidence of RRI, expressed as the number of RRIs per 1000 h of running and per 100 runners at risk, and to determine the sex-specific risk factors associated with RRI in runners who are training for a 4-mile (6.7 km) recreational running event in an 8-week period. Information gathered by means of this study is used to determine who are at risk for developing an RRI.

**Incidence and characteristics of RRI**

The incidence of RRI of 25.9% in our cohort of 629 recreational runners at risk is comparable with the incidences found in other studies. The “Vancouver Sun Run” study showed an injury incidence of 29.5% in a group of runners following a 13-week training programme preparing for a 10 km running event. A second study, also on recreational runners, showed an incidence of 58%, with novice participants training for a 15 km run during a period of 28 weeks. Since our study had a shorter follow-up and therefore less time at risk, the smaller number of RRIs per 100 runners at risk may be obvious. If we defined RRI according to the definition of Taunton et al—pain as a result of running—the number of RRIs per 100 runners at risk would be as high as 60.4%.

Only a few studies on RRIs have assessed exposure time in a way that the incidence per 1000 h of exposure to running could be calculated. The overall incidence of 30 per 1000 h of running exposure was higher than the incidence of 12 per 1000 h found by Bovens et al. Although the definitions of RRI were identical, duration of follow-up and ultimate goal of training were different—training for a marathon versus a 4-mile race. Lun et al found an incidence rate of 59 per 1000 h of exposure during a follow-up of 6 months. The most important difference with this study is that participants were already running more than 20 km/week at baseline. Also, 46 participants were lost to follow-up, whereas only 87 runners were included in the analyses. Our study showed that more than 70% of the RRI were localised at the knee and below. This result is in line with other studies on RRI. Novice runners were the most disadvantaged by an RRI, that is, they did not start running after sustaining an RRI. This might not be such a strange finding. Novice runners have no experience, and a 4-mile run can be a big hurdle for a novice runner. In this manner, by sustaining an injury, it is likely that the runner thinks that the remaining training time is too short for him or her to be able to complete the 4-mile run. A more experienced (recreational) runner may be able to listen properly to the language of his or her body, better than a novice runner. An experienced runner might also be able to feel or know whether he or she is able to complete the race, even without the full 8 weeks of training. Furthermore, an experienced runner is used to running on a regular basis and may be addicted to running, and therefore more likely to keep running.

**Potential risk factors for RRI**

**Sex**

The multivariate Cox regression model showed that male participants were at a higher risk than female participants. On the other hand, when sex was analysed univariately, there was no significant relation with RRI. Macera stated that in population-based studies, the injury rate was the same for male

![Figure 2](https://example.com/figure2.png)

**Figure 2** Mean exposure time per week for (A) novice runners, (B) runners with previous experience who have taken up running again, and (C) runners who were already engaged in regular running.
and male recreational and elite runners. This finding is in
contrast with the results from a recent systematic review article
on risk factors for RRI in long-distance runners, in which the
only statistically significant association for overall lower
extremity running injuries showed a positive relation with the
female sex.10

Age and BMI

In the current study, younger age in male participants was
positively associated with the risk of sustaining an RRI. This
finding is supported by other studies that conclude that
increasing age was significantly related with lower incidences
of RRI.7 25 A reason for this phenomenon could be "the healthy
runner effect", whereby only those runners who stay injury-free
continue to run.7 On the other hand, only 25% of the
participants in our study population were already engaged in
regular running. Other studies conclude that increasing age is a
statistically significant risk factor for sustaining an RRI.1 6
Higher BMI is associated with sustaining an RRI in female
participants. Heavier persons may have a higher risk of RRI
because of the added physical stress of extra weight.21 Different
associations between BMI and RRI are found in the literature:
Martini found that lower BMI (<19.5) and higher BMI (>27)
were risk factors for development of RRI.

Previous sports activities

Only women who where participating in sports activities
without axial loading at baseline (eg, cycling and swimming)
were 1.8 times at higher risk (95% CI 1.1 to 3.2) than women
participating in sports activities with axial load at baseline, that
is, sports involving running and jumping. Other studies found
no clear links between participation in other sports activities
and development of RRI.5 8 The difference between our results
and results from other studies could be caused by the fact that
we categorised "previous sports activities" into axial loading and
non-axial loading.

Running experience

Lack of running experience was the most important risk factor
for male and female participants in this study (HR 2.6 in men
and 2.1 in women). In another study on RRI, participants who
were running less than 3 years were 2.2 times at a higher risk
compared to the more experienced ones. Review articles of van
Mechelen2 and Hoeberigs24 also state that running inexperience
is a major risk factor for sustaining an RRI. Although they arrive
at the same conclusion, caution is advised when making a
comparison with our study, since in those studies, running
experience was assessed as the number of years engaged in
running, and the study populations were different compared to
our study, that is, participants had more running experience.

Previous injury of the lower extremity

No association was found between previous injury of the lower
extremity and RRI. Hootman et al25 stated that "previous lower
extremity injuries that were completely healed should not
increase the risk for a subsequent lower extremity injury". According to Taunton et al,1 of those with a previous injury,
42% indicated not being completely rehabilitated before starting
with the training programme. It is not clear whether a high rate
of re-injury suggests incomplete healing of the original injury, a
personal susceptibility for re-injury, or an uncorrected biome-
chanical problem.21 A recent systematic review on incidence and
determinants of lower extremity running injuries in long-
distance runners showed strong evidence that a history of
previous injuries was a risk factor for RRI.26 Again, most of the
studies that were included consisted of participants engaged in
long-distance running. Also, in most of the studies on risk
factors for RRI, it is not clear whether previous injuries are
about "running-related" injuries of the lower extremity. If that
is the case, a personal propensity for an uncorrected biome-
chanical problem could be the explanation.21

Conclusion

The incidence of RRI found in this study was 30.1 per 1000 h
of running exposure. Of all runners at risk, 25.9% sustained an
RRI during the 8-week period, and of those who sustained injury,
39% did not restart running.

Male and female participants have different risk profiles. The
study showed that for male recreational runners, younger age
and lack of running experience were significant risk factors for
RRI. In female participants, higher BMI, type of previous sports
activities (non-axial loading) and lack of running experience
were all significant risk factors for sustaining an RRI during the
8-week follow-up. Male participants were more prone to sustain
an RRI after correcting for age, BMI, previous sports activity
and running experience. The highest drop-out rate was seen in
novice runners after sustaining an RRI. Care should be taken

---

Table 2  Number and percentage of participants sustaining RRP and RRRs, total running exposure time, and incidence of RRI per 1000 h of running exposure during the 8-week follow-up

<table>
<thead>
<tr>
<th>Anatomical site</th>
<th>Pain-free and injury-free</th>
<th>RRP</th>
<th>RRI</th>
<th>Exposure (h)</th>
<th>Incidence (n/1000 h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower back</td>
<td>3 (39.3%)</td>
<td>11</td>
<td>17</td>
<td>3565.4</td>
<td>27.5 (22.0 to 32.9)</td>
</tr>
<tr>
<td>Hip/groin</td>
<td>8 (40.1%)</td>
<td>12</td>
<td>23</td>
<td>3565.4</td>
<td>35.0 (26.5 to 43.5)</td>
</tr>
<tr>
<td>Upper leg</td>
<td>2 (34.5%)</td>
<td>16</td>
<td>24</td>
<td>5422.6</td>
<td>30.1 (25.4 to 34.7)</td>
</tr>
<tr>
<td>Knee</td>
<td>8 (59.3%)</td>
<td>31</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower leg</td>
<td>8 (39.3%)</td>
<td>24</td>
<td>217</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankle</td>
<td>6 (10.3%)</td>
<td>5</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot</td>
<td>14 (39.3%)</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>8 (22.2%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Figure 3  Anatomical distribution of RRRIs in male and female participants.

---

when interpreting this result as the study period was relatively short. Also, the sex-specific risk models for RRI showed that among both male and female participants, novice runners were the most at risk. These findings suggest that novice runners are the ones who may benefit most from preventive interventions for RRI.

### What is already known on this topic

Incidence of RRI in recreational runners is high.

### What this study adds

Accurate data collection of RRI and exposure resulted in more precise information on incidence of RRI in recreational runners and potential risk factors. This information gives health care providers the opportunity to reach those runners who are most vulnerable for developing an RRI, that is, novice runners.

### Table 3 Univariate Cox regression models for male and female participants

<table>
<thead>
<tr>
<th></th>
<th>Male (n = 207)</th>
<th>HR (95% CI)</th>
<th>p Value</th>
<th>Female (n = 422)</th>
<th>HR (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td>1.3 (0.96 to 1.80)</td>
<td>0.09</td>
<td>1.0 (0.96 to 1.01)</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Increase of age by 10 years</td>
<td>0.69 (0.53 to 0.90)</td>
<td>0.006*</td>
<td>0.98 (1.02 to 1.14)</td>
<td>0.002*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>1.03 (0.95 to 1.11)</td>
<td>0.47</td>
<td>1.08 (0.95 to 2.28)</td>
<td>0.077</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivation</td>
<td></td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competition</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health-oriented</td>
<td>1.49 (0.84 to 2.66)</td>
<td>0.37</td>
<td>1.08 (0.70 to 1.67)</td>
<td>0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous sports activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previously active (axial load)</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previously active (non-axial load)</td>
<td>0.95 (0.44 to 2.05)</td>
<td>0.90</td>
<td>1.84 (1.06 to 3.19)</td>
<td>0.029*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not previously active</td>
<td>1.14 (0.61 to 2.14)</td>
<td>0.68</td>
<td>1.64 (0.95 to 2.83)</td>
<td>0.077</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No previous running experience</td>
<td>2.20 (1.06 to 4.58)</td>
<td>0.035*</td>
<td>2.32 (1.34 to 4.02)</td>
<td>0.003*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restarting running</td>
<td>1.95 (1.001 to 3.81)</td>
<td>0.050*</td>
<td>1.31 (0.75 to 2.28)</td>
<td>0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Already participating in running</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous weekly running frequency (n = 155)</td>
<td>1.08 (0.59 to 1.97)</td>
<td>0.81</td>
<td>1.92 (0.94 to 3.93)</td>
<td>0.075</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous running hours per week (n = 155)</td>
<td>0.998 (0.99 to 1.01)</td>
<td>0.65</td>
<td>1.004 (0.99 to 1.01)</td>
<td>0.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous injury of lower extremity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No previous injury</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1 year</td>
<td>0.66 (0.34 to 1.31)</td>
<td>0.24</td>
<td>1.29 (0.81 to 2.05)</td>
<td>0.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;1 year</td>
<td>0.98 (0.57 to 1.69)</td>
<td>0.94</td>
<td>0.86 (0.52 to 1.43)</td>
<td>0.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05.

### Table 4 Multivariate Cox regression models for male and female participants

<table>
<thead>
<tr>
<th></th>
<th>Male (n = 207)</th>
<th>HR (95% CI)</th>
<th>p Value</th>
<th>Female (n = 422)</th>
<th>HR (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td>1.42 (1.02 to 1.99)</td>
<td>0.041*</td>
<td>1.0 (0.96 to 1.01)</td>
<td>0.069</td>
<td></td>
</tr>
<tr>
<td>Increase of age by 10 years</td>
<td>0.63 (0.48 to 0.82)</td>
<td>0.001*</td>
<td>0.82 (0.66 to 1.02)</td>
<td>0.069</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>1.02 (0.94 to 1.11)</td>
<td>0.58</td>
<td>1.06 (1.01 to 1.13)</td>
<td>0.028*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous sports activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previously active (axial load)</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previously active (non-axial load)</td>
<td>0.88 (0.41 to 1.93)</td>
<td>0.76</td>
<td>1.85 (1.07 to 3.21)</td>
<td>0.029*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not previously active</td>
<td>1.08 (0.57 to 2.04)</td>
<td>0.81</td>
<td>1.53 (0.88 to 2.66)</td>
<td>0.130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Already participating in running</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restarting running</td>
<td>2.24 (1.13 to 4.45)</td>
<td>0.021*</td>
<td>1.15 (0.65 to 2.02)</td>
<td>0.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No previous running experience</td>
<td>2.61 (1.23 to 5.53)</td>
<td>0.012*</td>
<td>2.14 (1.24 to 3.70)</td>
<td>0.007*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05.

### REFERENCES


Competing interests None.