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Published in:
Scandinavian Journal of Medicine & Science in Sports

DOI:
[10.1111/sms.12346](https://doi.org/10.1111/sms.12346)

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Document Version
Publisher's PDF, also known as Version of record

Publication date:
2015

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):
Kluitenberg, B., van Middelkoop, M., Smits, D. W., Verhagen, E., Hartgens, F., Diercks, R., & van der Worp, H. (2015). The NLstart2run study: Incidence and risk factors of running-related injuries in novice runners. *Scandinavian Journal of Medicine & Science in Sports*, 25(5), E515-E523.
<https://doi.org/10.1111/sms.12346>

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The NLstart2run study: Incidence and risk factors of running-related injuries in novice runners

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Accepted for publication 21 September 2014

Running is a popular form of physical activity, despite of the high incidence of running-related injuries (RRIs). Because of methodological issues, the etiology of RRIs remains unclear. Therefore, the purposes of the study were to assess the incidence of RRIs and to identify risk factors for RRIs in a large group of novice runners. In total, 1696 runners of a 6-week supervised “Start to Run” program were included in the NLstart2run study. All participants were aged between 18 and 65, completed a baseline questionnaire that covered potential risk factors, and completed at least one running diary. RRIs were registered during the program with a weekly running log.

An RRI was defined as a musculo-skeletal complaint of the lower extremity or back attributed to running and hampering running ability for three consecutive training sessions. During the running program, 10.9% of the runners sustained an RRI. The multivariable Cox regression analysis showed that a higher age, higher BMI, previous musculo-skeletal complaints not attributed to sports and no previous running experience were related to RRI. These findings indicate that many novice runners participating in a short-term running program suffer from RRIs. Therefore, the identified risk factors should be considered for screening and prevention purposes.

Running is a popular form of vigorous-intensive physical activity. About 13% of the Dutch population participates in running as a type of recreational exercise on a regular basis (van Bottenburg et al., 2006). Important reasons for participation in recreational running are most likely the positive health effects resulting from running (Taunton et al., 2003; Verhagen, 2012).

The high incidence of running-related injuries (RRIs), which is reported up to 79%, is contradictory to the positive health effects (Lysholm & Wiklander, 1987; Bovens et al., 1989; Lun et al., 2004; Kelsey et al., 2007). Especially, novice runners are at high risk of sustaining an RRI (Buist et al., 2008, 2010a; Tonoli et al., 2010). Besides, the occurrence of an RRI is an important reason for dropout from running (Koplan et al., 1995). Therefore, it is of particular importance to prevent RRIs in a running program for novice runners because this will increase running persistence and thereby contribute to public health.

The identification of factors that increase injury susceptibility is an important step toward prevention of RRIs (Finch, 2006). Risk factors for injury can be divided into intrinsic factors (e.g., gender, age, and BMI)

and extrinsic factors (e.g., running shoes, training program, and running surface). The development of an RRI results from the complex interaction between both intrinsic and extrinsic factors (Meeuwisse, 1994).

There is some evidence that higher BMI, increased age, no previous running experience, previous injuries, and previous sports participation are associated with RRIs in novice runners (Buist et al., 2010a,b; Nielsen et al., 2013). However, these studies reported conflicting results, which might be explained by non-standardized training schedules or due to preselection of potential risk factors, which were entered into the multifactorial analysis. For identification of risk factors for RRIs, multiple factors should be analyzed simultaneously in a multifactorial model. This form of analysis, however, is sensitive for bias when more than one variable is entered into the model per 10 occurred injuries (Peduzzi et al., 1996). Because of small sample sizes, previous prospective cohort studies on RRIs in novice runners could only investigate a limited number of potential risk factors (Ghani Zadeh Hesar et al., 2009; Buist et al., 2010b; Bredeweg et al., 2012a). To overcome the preselection of potential risk factors and create a multifactorial model, a

large sample size is needed. Therefore, the purposes of the current study were to assess the incidence of RRIs and to identify risk factors for the development of RRIs in a large group of runners participating in a running program for novice runners.

Materials and methods

Study design and participants

The present study is part of the NLstart2run study, a prospective cohort study on the health effects resulting from a 6-week “Start to Run” program (Kluitenberg et al., 2013). All participants ($N = 7660$) who signed up for the “Start to Run” program in 2013 were informed about the NLstart2run study. The “Start to Run” program is a 6-week running course that is organized biannually (in March and September) by the Dutch Athletics Federation. All participants who entered the study in March or September 2013 were followed prospectively during the 6-week running program.

All participants of the “Start to Run” program, aged between 18 and 65 were eligible for inclusion. Participants were included in the study after signing a digital informed consent and completing the baseline questionnaire. The study design, procedures, and informed consent procedure were approved by the Medical Ethics Committee (no. 2012/350) of the University Medical Center Groningen, the Netherlands. The study is registered in the Netherlands Trial Registry (NTR3676).

Running program

The running program aimed to prepare participants in 6 weeks for a 20-min run without breaks. The running program advised two training sessions per week with an optional third session. A licensed athletics trainer supervised one training session, the other sessions had to be completed individually following a standardized training schedule. Each training session began with a warm-up and finished with a cool-down, which both took approximately 15 min.

Baseline measurements

A baseline questionnaire was administered online 1 week before the start of the running program. This questionnaire covered demographics and other potential risk factors for RRI. These factors included age, sex, calculated body mass index (BMI) [weight (kg)/height² (m)], waist-hip ratio [waist circumference (cm)/hip circumference (cm)]. Textual instructions accompanied with two instructive pictures were shown to ensure the participants correctly measured waist and hip circumference. Previous running experience was assessed with a single question that asked whether participants were ever engaged in running on a regular basis. Also, a single question concerning former lower extremity complaints that the participant attributed to running was used to assess self-reported previous running injuries. Other sports activities that were practiced on a regular basis in the past 12 months were assessed and, based on the type of sport, classified into sports with axial loading (e.g., volleyball, basketball, or running) and sports without axial loading (e.g., swimming or cycling; Buist et al., 2010b). Information about previous musculo-skeletal complaints during sports and exercise that were not attributed to running was also obtained (yes/no answer). In a second question the self-assessed origin of these musculo-skeletal complaints was asked, to separate sports injuries from other musculo-skeletal complaints (i.e., complaints attributed to sports or not). Finally, participants had to provide information about type of running shoes (new vs used) and age of running shoes at start of the program.

Web-based training log during the 6-week running program

During the 6-week running program, at the end of each week, a training log was sent to the participants. This log asked for training characteristics in the preceding week. Weekly running frequency was obtained and running exposure (in minutes) was collected for each training session. In each training session was asked for the presence of pain to the lower extremity or lower back during or after running. If pain was present, anatomical locations were registered with a body chart. Pain was classified as running-related pain, when the subject attributed the pain to running. A final question was asked if the entire training session could be completed, despite of the pain. When participants did not enter their digital training log after 5 days, an e-mail reminder was sent automatically. Participants were contacted by phone when the log was not completed 1 week after sending the reminder.

RRI registration

In the current study, an RRI was defined as a musculo-skeletal complaint of the lower extremity or back that the participant attributed to running and hampered running ability for three consecutive training sessions (Buist et al., 2010b; Bredeweg et al., 2012b). Hampering of running could either be a reduction in running speed, distance, or duration, or an inability to run, both as a result of running-related pain. RRI registration was based on the self-reported information in the running log. An RRI was registered when running ability was hampered for three consecutive training sessions as a result of pain at the same body part and the subject attributed that pain to running. In the running log, participants were asked not to report muscle soreness and blisters in the pain registration.

Analyses

Participants were excluded from the analyses when no information was entered into the running log. Baseline characteristics for all potential risk factors were presented as means and standard deviations for continuous variables and in numbers and percentages for categorical variables. Running exposures were reported as medians with interquartile ranges (IQR). Both weekly and total incidence densities of RRIs were calculated as the number of RRIs per 1000 h of running exposure and the number of RRIs per 1000 training sessions (i.e., athletic exposures). Hours of running exposure were measured from the start of the program until an RRI occurred or until the end of the program. Number of training sessions was measured as the sum of all training sessions until an RRI or until the end of the running program.

When baseline characteristics were missing, multiple imputations were used to include these cases into the complete case analysis and avoid bias because of missing values. Data were imputed using the MICE method implemented in SPSS (IBM SPSS statistics version 22, SPSS Inc., Chicago, Illinois, USA) to create 10 multiple imputed datasets. Analyses were done on all datasets and results were averaged and adjusted for standard errors according to Rubin's rule (Rubin, 2004).

All potential risk factors were first univariately entered into a Cox regression analysis to examine the independent link of these variables to RRI. Subsequently, all these potential risk factors were entered into a multivariable Cox regression model following the Enter method. Minutes of running until RRI or until the end of the program were considered the time scale for the Cox regression model. The event of interest was the occurrence of an RRI during the running program. For the categorical factors, the group with the lowest injury risk was chosen as reference. Hazard ratios (HR) with corresponding 95% confidence intervals (CI) were reported. Possible risk factors with $P \leq 0.05$ were considered statistical significant. The Cox regression analyses were conducted with R

statistics (version 3.1.1; R Core Team, 2014) using the R packages mice (van Buuren & Groothuis-Oudshoorn, 2011) and survival (Therneau, 2014).

Results

Participants

A total of 7660 runners registered for the 2013 “Start to Run” program, which was organized by the Dutch Athletics Federation. From these registrants, 1936 expressed an interest to participate in the NLstart2run study. Among these participants, 30 fell outside the age range and 134 did not complete the baseline questionnaire, resulting in a study sample of 1772 runners. Seventy-six of the included participants (4.3%) were excluded from analyses because no data were entered in the running log. The remaining 1696 participants were included in the analyses. An overview of the participants flow can be found in Fig. 1.

Baseline characteristics

For a number of participants, baseline information was missing for weight (0.1%), height (0.4%), and waist and

hip circumference (12.4%). Consequently, these data were imputed. The baseline characteristics of the participants who were included in the analyses are shown in Table 1. The majority of participants were female (78.5%). Most participants (60.3%) did not have prior running experience and had never suffered from a previous RRI (82.7%). At baseline, 43.8% of the participants were engaged in other sports activities and 570 participants (33.6%) had a history of musculo-skeletal complaints of which 278 (48.8%) were attributed to sports (i.e., sports injury).

Running exposure

Weekly running exposure ranged from a median of 25 min (IQR 27) in week 1 to 49 min (IQR 69) in week 5 (Table 2). The median running exposure during the entire running program was 227 min (IQR 162).

RRIs during the program

During the running program, 185 participants (10.9%) developed an RRI. The estimated incidence densities are

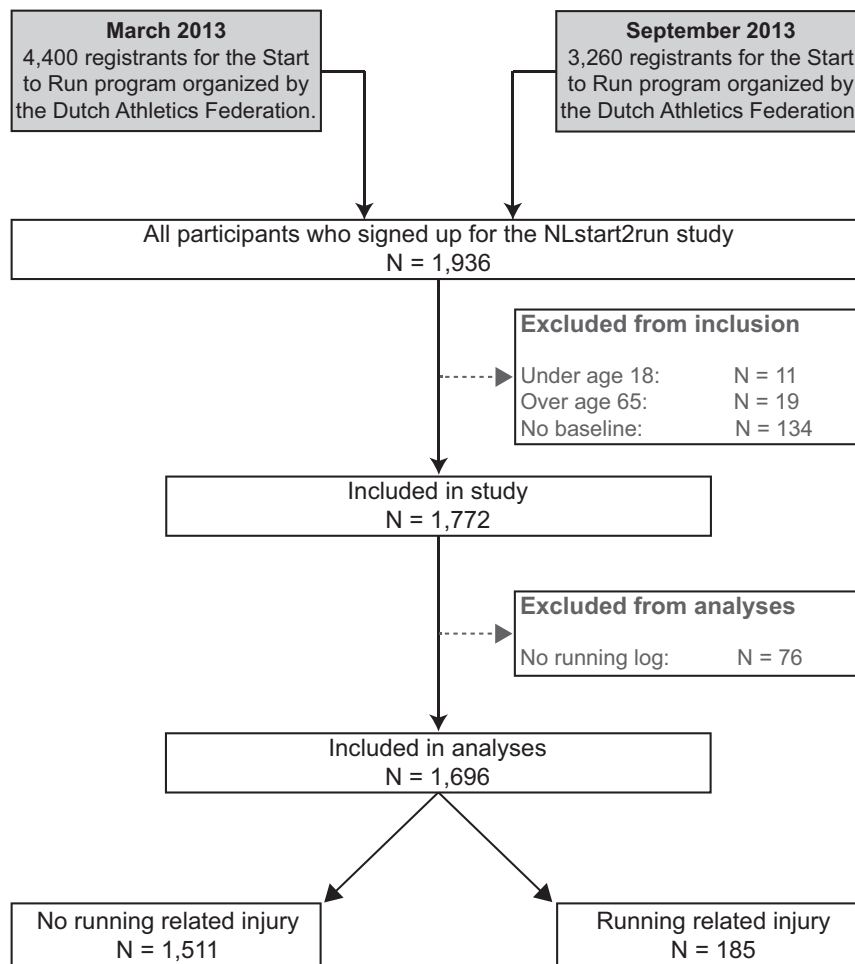


Fig.1. Flowchart of the participants included and excluded from the NLstart2run study.

Table 1. Baseline characteristics of the total population and both for the injured and non-injured participants

Variable	All (<i>N</i> = 1696)	Non-injured (<i>N</i> = 1511)	Injured (<i>N</i> = 185)
Gender			
Male	364 (21.5)	318 (21.0)	46 (24.9)
Female	1332 (78.5)	1193 (79.0)	139 (75.1)
Age (year)	43.3 (10.0)	43.1 (9.9)	45.1 (10.2)
BMI (kg/m ²)	25.5 (4.0)	25.4 (4.0)	26.2 (4.5)
Waist-hip ratio	0.91 (0.09)	0.91 (0.09)	0.91 (0.11)
Running experience			
No	1023 (60.3)	891 (59.0)	132 (71.4)
Yes, more than a year ago	460 (27.1)	421 (27.8)	39 (21.1)
Yes, less than a year ago	213 (12.6)	199 (13.2)	14 (7.6)
Previous RRI			
No	1402 (82.7)	1243 (82.3)	159 (85.9)
Yes	294 (17.3)	268 (17.7)	26 (14.1)
Previous sports activity			
No	953 (56.2)	849 (56.1)	104 (56.2)
Yes, with axial load	348 (20.5)	314 (20.8)	34 (18.4)
Yes, without axial load	395 (23.3)	348 (23.0)	47 (25.4)
Previous musculo-skeletal complaints			
No	1126 (66.4)	1020 (67.5)	106 (57.3)
Yes, not attributed to sports	292 (17.2)	245 (16.2)	47 (25.4)
Yes, attributed to sports	278 (16.4)	246 (16.3)	32 (17.3)
Running shoes			
New	957 (56.4)	843 (40.6)	59 (31.9)
Used	672 (39.6)	613 (55.8)	114 (61.6)
Other	67 (4.0)	55 (3.6)	12 (6.5)
Age of running shoes			
< 3 months	814 (48.0)	718 (47.5)	96 (51.9)
3–12 months	364 (21.5)	324 (21.4)	40 (21.6)
> 12 months	518 (30.5)	469 (31.0)	49 (26.5)

Categorical data was presented as *N* (%) and continuous data as means (SD).
 BMI, body mass index; RRI, running-related injury.

Table 2. Weekly running exposure in minutes [median with interquartile range (IQR)] and RRI incidence

	Exposure (IQR)	RRIs (<i>N</i>)	Incidence (<i>N</i> /1000 h)
Week 1	25.0 (27)	16	15.9
Week 2	32.0 (21)	56	53.4
Week 3	36.0 (30)	48	44.0
Week 4	41.0 (36)	39	33.1
Week 5	49.0 (69)	22	17.3
Week 6	38.0 (60)	4	3.6
Total	227.0 (162)	185	27.5

RRI, running-related injury.

shown in Table 2 for each separate week of the running program. As shown in Table 2, most RRIs were sustained during weeks 2 and 3 and the estimated incidence density was highest in week 2. The overall incidence density of RRIs during the running program was 27.5 RRIs per 1000 h of running or 9.9 RRIs per 1000 athletic exposures. Most RRIs occurred at the knee (38.4%), followed by the calf (20.0%), Achilles tendon (13.0%), and shin (13.0%; Fig. 2).

Risk factors for RRI

Results of the univariate and multivariable analyses are presented in Table 3. In the univariate analyses, age, BMI, no previous running experience, previous musculo-skeletal complaints not attributed to sports, and running shoes used were related to RRI. A higher age (HR 1.02; 95% CI 1.00–1.04), higher BMI (HR 1.04 95% CI 1.00–1.07), previous musculo-skeletal complaints not attributed to sports (HR 1.78; 95% CI 1.26–2.53), and no previous running experience (HR 2.38; 95% CI 1.24–4.57) were also associated with the occurrence of RRI in the multivariable analysis.

Discussion

The purpose of the current study was to examine the incidence of RRIs and risk factors for RRIs in runners following a 6-week “Start to Run” running program. During the running program, 185 runners (10.9%) sustained an RRI. Risk factors for RRIs were a higher age, a higher BMI, previous musculo-skeletal complaints not attributed to sports, and no previous running experience. In the current study, no significant association with RRI was found for gender, waist-hip ratio, previous RRI,

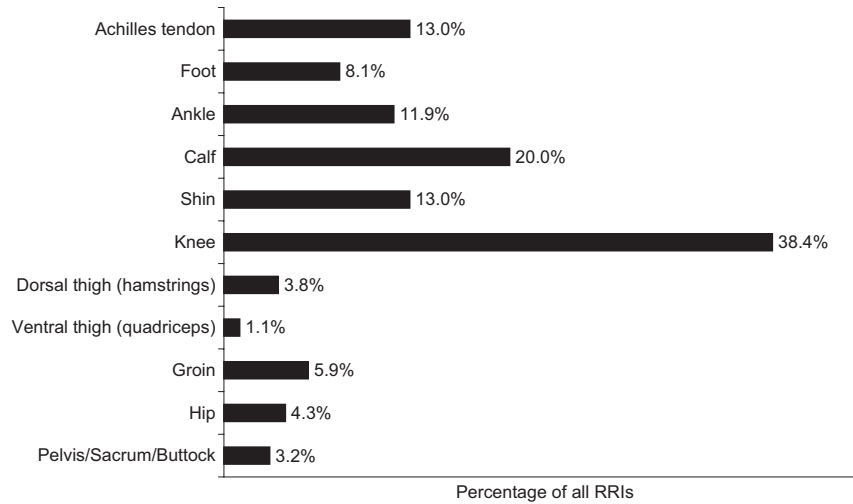


Fig. 2. Anatomical distribution of RRIs.

Table 3. Results of the univariate and multivariable Cox regression analyses for overall RRIs

Variable	Univariate analysis			Multivariable analysis		
	HR	95% CI	P-value	HR	95% CI	P-value
Gender						
Male	1.12	0.80–1.56	0.522	1.00	0.66–1.53	0.994
Age (year)	1.02	1.01–1.03	0.010	1.02	1.00–1.04	0.014
BMI (kg/m ²)	1.04	1.01–1.08	0.009	1.04	1.00–1.07	0.034
Waist-hip ratio	2.44	0.49–12.26	0.278	1.20	0.13–11.10	0.876
Running experience (ref = yes, less than a year ago)						
No	2.13	1.23–3.69	0.007	2.38	1.24–4.57	0.009
Yes, more than a year ago	1.35	0.73–2.49	0.335	1.41	0.75–2.63	0.282
Previous RRI						
Yes	0.74	0.49–1.13	0.160	1.29	0.75–2.22	0.362
Sports activity (ref = yes, with axial load)						
No	1.14	0.77–1.68	0.514	1.18	0.80–1.74	0.417
Yes, without axial load	1.20	0.77–1.86	0.429	1.19	0.77–1.86	0.438
Previous musculo-skeletal complaints (ref = no)						
Yes, not attributed to sports	1.87	1.33–2.64	< 0.001	1.78	1.26–2.53	0.001
Yes, attributed to sports	1.24	0.83–1.84	0.294	1.19	0.80–1.77	0.400
Type of running shoes (ref = used)						
New	1.39	1.01–1.90	0.042	1.22	0.79–1.89	0.371
Other	2.22	1.19–4.13	0.012	1.84	0.96–3.52	0.064
Age of running shoes (ref = < 3 months)						
3–12 months	0.90	0.62–1.31	0.585	1.24	0.80–1.90	0.337
> 12 months	0.80	0.57–1.13	0.212	1.03	0.64–1.67	0.901

BMI, body mass index; CI, confidence interval; HR, hazard ratio; RRI, running-related injury.

previous sports injury, other sports activities, and running shoes used during the program.

Incidence

Incidence rates in previous research among novice runners varied between 16.0% and 53.5% (Buist et al., 2008; Van Ginckel et al., 2009; Bredeweg et al., 2012b; Nielsen et al., 2013). Compared with these rates, the observed incidence rate of 10.9% in the current study is low. Large differences in RRI incidence are often attributed to variance in RRI definition (Buist et al., 2010b). A

more strict RRI definition will result in a lower incidence rate. Nevertheless, RRI definitions in these previous studies were more or less the same to our definition in terms that these studies also registered an RRI when pain to the lower extremity or back caused a restriction of running for at least 1 week (Buist et al., 2008, 2010b; Van Ginckel et al., 2009; Bredeweg et al., 2012b; Nielsen et al., 2013). There were, however, differences in injury registration. In the current study, RRIs were registered by the researchers, based on the information entered in the running logs. This method was similar to the method used by Buist et al. (2008, 2010b) and

Bredeweg et al. (2012a). In contrast, other studies asked the participants to report an RRI to the researcher when an injury met the RRI definition (Van Ginckel et al., 2009; Nielsen et al., 2013).

In addition to the injury definition, the follow-up period might also influence the incidence of RRIs. In this study the follow-up of 6 weeks was relatively short compared with follow-up periods of 8 to 13 weeks in other studies (Buist et al., 2008, 2010b; Van Ginckel et al., 2009). Naturally, more RRIs will be reported during a longer follow-up period. To compare RRI incidences between studies with different follow-up periods, RRI incidence can be expressed as an incidence density (e.g., the number of RRIs per 1000 h of running or per 1000 athletic exposures). Unfortunately, most studies do not report RRI incidence densities, presumably because running exposure until RRI or until the end of follow-up was not monitored. Previous studies that included incidence densities for novice runners reported values between 30 and 33 RRIs per 1000 h of running (Buist et al., 2010a,b; Bredeweg et al., 2012b). The incidence density of 27.5 observed in our study is slightly lower compared with previous studies among novice runners. However, RRI incidence in novice runners is substantially higher compared with incidence densities of 2.5 to 5.8 RRIs per 1000 h of running in more experienced runners (Lysholm & Wiklander, 1987). Although other studies among novice runners did not report incidence densities per 1000 athletic exposures, in the present study, the RRI incidence density expressed per 1000 training sessions was 9.9. This value is comparable with RRI incidence densities reported in cross-country runners (Rauh et al., 2000, 2006, 2007).

Besides RRI definition, registration method and follow-up period, the lower incidence in the current study, compared with the RRI incidences in novice runners reported in other studies, may also be the result of the supervised training program, including the slow gradual increase of load.

Most injuries occurred at the knee (38.4%), followed by the calf, shin, and Achilles tendon with, respectively, 20.0%, 13.0%, and 13.0%. This is in line with previous research amongst novice runners in which most injuries were reported in the knee and lower leg (Van Ginckel et al., 2009; Buist et al., 2010a). Therefore, despite the lower RRI incidence in more experienced runners, the anatomical distribution of RRIs is similar compared with novice runners (Taunton et al., 2003; van Gent et al., 2007).

Risk factors

Previous injuries have shown to increase the risk of developing an RRI (Martí, 1988; Macera et al., 1989, 1991; Walter et al., 1989; van Gent et al., 2007). However, it is not always clear whether these previous

injuries were related to running or other sports activities (Buist et al., 2010a). A recent study among novice runners showed that a previous RRI was not associated with the development of a new RRI, whereas a history of sports injuries was positively related to development of an RRI (Nielsen et al., 2013). Therefore, the current study informed on the history of sports injuries as well as for musculo-skeletal complaints during sports that were not attributed to sports (e.g., low back pain, which was not caused by sports, but resulted in pain during sports). Only previous musculo-skeletal complaints that were not attributed to sports increased the risk of developing an RRI and not previous sports injuries.

The increased RRI risk with previous musculo-skeletal complaints during sports that were not attributed to sports might be explained by the high biomechanical load imposed by running (Hreljac, 2004). Normally, the musculo-skeletal system can adapt to high loads when sufficient recovery time is taken into account. When an optimal load is applied to the musculo-skeletal system followed by sufficient recovery time, the strength of the system will increase (Hreljac, 2004). Suffering from musculo-skeletal complaints during sports might give an indication of a reduced loading capacity of the body, especially when the onset of these complaints is not attributed to sports. It can be argued that the biomechanical load resulting from running is too high for these novice runners suffering from musculo-skeletal complaints during sports and exercise, making them more prone to injury.

In this perspective, practicing sports with an axial load might be protective for developing an RRI, since this might have strengthened the musculo-skeletal system and increased the loading capacity (Bredeweg et al., 2010). The results of the current study, however, did not support this hypothesis. In addition to a reduced loading capacity, previous musculo-skeletal complaints might also have led to an altered movement pattern. This results in unequal loading of the body, which might increase injury susceptibility.

A lack of running experience increased the risk of sustaining an RRI. This finding is in line with other studies in which more running experience was related to a reduced RRI risk (Macera et al., 1989; Hespanhol Junior et al., 2013). Since the running program was aimed at novice runners, most participants were not involved in running on a regular basis before the start of the program. Therefore, running experience was not assessed as years of running experience as done in previous studies among recreational runners (Macera et al., 1989; Hespanhol Junior et al., 2013), but classified into no, recent, and former experience (Buist et al., 2010a; Nielsen et al., 2013). Despite of this difference in classification, no running experience appears to be related to RRI in novice runners too. In more experienced runners, less running experience as risk factor for RRI

is most likely related to “the healthy runner effect,” whereby runners not suffering from injuries are more likely to persevere in running and consequently have more running experience (Marti et al., 1988; Buist et al., 2010a). Novice runners, however, generally have little or no running experience, thus no history of severe RRIs. Therefore, the “healthy runner” phenomenon is probably not applicable to this group of runners. It can be speculated that the decreased RRI risk for novice runners with previous running experience can be explained by neuromuscular or musculo-skeletal adaptations that could be the result of previous running activity, whereas absence of these adaptations might increase RRI risk.

In the present study, higher age was a risk factor for RRI. This finding is in line with Nielsen et al. who found a higher risk of RRI in novice runners aged 45 years and older (Nielsen et al., 2013). In contrast, several studies found an inverse relationship between age and RRI risk, suggesting an increased RRI risk at lower ages (Marti, 1988; Hootman et al., 2002; Buist et al., 2010a). The “healthy runner effect” might also explain these conflicting results concerning age as risk factor for RRI, indicating that extensive running experience is protective for RRI occurrence, independent of age. On the other hand, starting running at a higher age seems to be a risk factor for RRI that might be attributed to age-related changes of the musculo-skeletal system (Prescott & Yu, 2012).

Waist to hip ratio was not significantly related to the development of RRI. Higher BMI, however, was related to an increased RRI risk. This finding is in contrast to the results of a systematic review in long distance runners (van Gent et al., 2007). In this review, a BMI > 26 kg/m² was protective for the occurrence of RRI (van Gent et al., 2007). A recent study among 930 novice runners, however, showed a trend that RRI risk increased with increasing BMI (Nielsen et al., 2013). In previous research among novice runners, a higher BMI is often associated with RRI (Buist et al., 2010a,b; Nielsen & Cederholm, 2013). Based on the findings of the present study and the results of other studies among novice runners, a higher BMI is probably related to an increased risk of RRI in novice runners.

Limitations

The major strengths of this study are a prospective study design, the large cohort of almost 1700 novice runners, and the prescribed uniform running program. There were, however, several limitations as well. First, the baseline questionnaire that was used to administer potential risk factors was based on self-reported information. This might have led to recall bias or under- or overestimation of predictor variables. It was tried to minimize these problems inherent to survey research by explaining that answers could not be right or wrong,

making sure the questions were formulated clearly, adding informative pictures when applicable, and splitting up difficult questions in multiple sub-questions. Second, registration of RRIs was also based on self-reported musculo-skeletal complaints in the digital running log. Injured runners were not seen by a health-care professional, thus, no diagnosis of the RRI was available. The registration of injuries in the current study was done using a body chart in combination with a short recall period to minimize the bias associated with self-reported injury information. Third, the cohort consisted mainly of female runners (78.5%), which may limit the generalizability of the results. Finally, with 6 weeks, this running program had a relatively short duration. Previous studies in novice runners had longer follow-up periods ranging from 8 weeks to 1.5 year (Bovens et al., 1989; Buist et al., 2010a,b; Nielsen et al., 2013). This short duration may have led to the low number of RRIs and might not have been long enough to sustain severe overuse injuries. Still, for more than 70% of the injured runners in the present study, the registered RRI was a reason to quit running. This indicates the seriousness of these injuries even during a short-term running program and thereby the importance of preventing these RRIs.

Perspectives

The current study showed that the RRI incidence rate during a supervised 6-week “Start to Run” program was low compared with previous studies on novice runners. Incidence densities were, however, comparable or higher compared with more experienced runners. This highlights the necessity of effective prevention strategies. RRI incidence was highest during the first three weeks of a “Start to Run” program.

Risk factors for RRIs were a higher age, a higher BMI, previous musculo-skeletal complaints during sports and exercise not attributed to sports, and a lack of running experience. Not having previous running experience is the strongest risk factor for RRI followed by previous complaints during sports. Unfortunately, these are non-modifiable risk factors. It is, therefore, of particular importance to identify runners who comply with these characteristics on forehand. Subsequently, these runners can be informed about early signs of RRI. Secondly, it is important that these runners are intensively guided during a running program, particularly during the first 3 weeks. Therefore, future research should focus on possible detrimental training patterns for novice runners, especially for the vulnerable runners, which might lead to new preventive measures.

Key words: Running, injury, incidence, etiology, novice runners, prospective cohort study.

Acknowledgements

The NLstart2run study was funded by a grant of ZON-MW (50-50305-98- 12001). The authors wish to thank all runners who participated in this study, the Dutch Athletics Federation

for giving the opportunity to include participants from the Start to Run program, and Astrid de Vries, Corien Plaggenmarsch and Saskia van de Zande for their assistance during the data collection.

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