ORIGINAL ARTICLE

A prospective study of running injuries: the Vancouver Sun Run "In Training" clinics

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Objectives: Seventeen running training clinics were investigated to determine the number of injuries that occur in a running programme designed to minimise the injury rate for athletes training for a 10 km race. The relative contributions of factors associated with injury were also reported.

Methods: A total of 844 primarily recreational runners were surveyed in three trials on the 4th, 8th, and 12th week of the 13 week programme of the "In Training" running clinics. Participants were classified as injured if they experienced at least a grade 1 injury—that is, pain only after running. Logistic regression modelling and odds ratio calculation were performed for each sex using the following predictor variables: age, body mass index (BMI), previous aerobic activity, running frequency, predominant running surface, arch height, running shoe age, and concurrent cross training.

Results: Age played an important part in injury in women: being over 50 years old was a risk factor for overall injury, and being less than 31 years was protective against new injury. Running only one day a week showed a non-significant trend for injury risk in men and was a significant risk factor in women and overall injury. A BMI of > 26 kg/m^2 was reported as protective for men. Running shoe age also significantly contributed to the injury model. Half of the participants who reported an injury had had a previous injury; 42% of these reported that they were not completely rehabilitated on starting the 13 week training programme. An injury rate of 29.5% was recorded across all training clinics surveyed. The knee was the most commonly injured site.

Conclusions: Although age, BMI, running frequency (days a week), and running shoe age were associated with injury, these results do not take into account an adequate measure of exposure time to injury, running experience, or previous injury and should thus be viewed accordingly. In addition, the reason for the discrepancy in injury rate between these 17 clinics requires further study.

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From 1996 to 2000, the Vancouver Sun Run "In Training" Clinics have helped over 12 000 people train for one of the largest 10 km races in the world. Designed primarily for the beginner, the training regimens within the 47 separate clinics provide a graduated programme that intersperses walking with jogging or running in order to minimise the chance of sustaining an injury in the training period leading up to, and during, the Vancouver Sun Run.

However, we are unsure how effective these clinics are at achieving that end. Although there has been a focus in the literature on understanding the factors that contribute to the risk of injury for a given population of runners, there has been less emphasis on developing running programmes that would be optimal—that is, minimise the injury rate—for deconditioned or novice runners. This study is a preliminary prospective analysis of the injuries that occur in these training programmes. The objective was to determine the injury pattern in a sample of the In Training clinics during their 13 week programme. Certain factors associated with the risk of injury are analysed and odds ratio calculation performed based on logistic regression modelling. The associated risk factors for injury were identified by previous authors and include: age, body mass index (BMI), previous activity, arch height, running shoe age, concurrent cross training, predominant running surface, and running frequency a week.[1–8]

METHODS

Subjects

The 844 subjects were registered in 17 of the In Training clinics administered by The Sport Medicine Council of British Columbia. These were primarily recreational runners interested in either completing the 10 km race distance or improving their existing race time. There were no fitness requirements for enrollment with the In Training clinics. Subjects were recruited, out of a possible 1020 runners, by virtue of being registered in the selected clinics. A total of 176 participants elected not to participate in this study.

"In Training" protocol

The 13 week training protocol was designed by sport medicine doctors practicing at the Allan McGavin Sport Medicine Centre, and includes two sections to accommodate novice and intermediate runners. The novice group is primarily sedentary and deconditioned people interested in establishing a running programme probably to improve health and fitness. The programme for this group incorporates run/walk repeats that eventually lead to a continuous running session in the 12th week.

The intermediate programme is designed for people who have completed the novice walk/run programme and would like to increase their running endurance and intensity in a safe and effective way. Hill training, interval, and fartlek sessions are implemented.

Both training programmes require the participants to run three times a week; two of these sessions are separate from the group run on the day of their respective clinic. It is recommended that participants allow one day of rest (or cross training) between any two running sessions. Training sessions vary in length from 35 to 66 minutes, depending on their progression in the programme.

Procedures

The same questionnaire was administered on three separate trials over the In Training clinics' 13 week duration. No baseline measures were taken. The first trial was conducted in the 4th week, the second trial in the 8th week, and the final trial in the 12th week. The personal and activity profiles (see below) were administered during all trials to accommodate any runners that were absent during the 4th and 8th weeks respectively. Before the first questionnaire was given to a clinic population, a brief presentation outlining the objectives of the survey was conducted by either a researcher or one of the clinic coordinators. The two page survey was then administered at the beginning of the session, and collected immediately. Survey packages, mailed to selected clinic coordinators, included survey forms, pencils, and a cover letter outlining any changes or recommendations for the survey administrators.

Questionnaire

The two page questionnaire consists of 19 questions divided into four separate sections: personal profile, activity profile, injury history, and injury profile. The personal profile asked for the participant's full name, age, sex, height, weight, and training level (walker, run/walk, or intermediate). This section also included questions on arch height and brand and age of running shoes. A diagram of a foot imprint with selected arch heights was included to assist the participants in their self classification of neutral, high, or low arches. This tool, along with the question on previous aerobic activity, has yet to be validated by doctors. Nevertheless, it was felt that including these variables would improve the scope of the risk factors analysed.

The activity profile investigated previous activity level (designated by aerobic activity three times a week for the previous six months), running frequency in days a week, predominant running surface, whether the participant recorded their sessions, and whether he/she had incorporated cross training into their In Training regimen.

In the injury history section, the participant was asked to indicate whether they had experienced an injury in the past as a result of running, and, if so, to provide details such as injury location and diagnosis.

The injury profile section determined whether the participant was currently experiencing an injury, and if so, to provide injury location and diagnosis. A question was included to ascertain the presence and severity of an injury based on the following guidelines: 1, pain only after exercise; 2, pain during exercise, but not restricting distance or speed; 3, pain during exercise and restricting distance and speed; 4, pain preventing all running. A runner was classified as being injured if they experienced at least a grade 1 injury (pain only after exercise). Both the injury history and injury profile sections asked if a qualified doctor or physiotherapist had diagnosed their previous or current injury. Diagnoses from participants that did not consult a professional were not included.

Risk factors were recorded for a given injury based on the corresponding survey return. If a runner experienced an injury throughout the entire 13 week period and aspects of their activity or personal profile changed, the initial profile data were used.

Statistical analysis

Descriptive statistics were used for baseline calculations. Odds ratios were approximated, including their 95% confidence interval. This multivariate logistic regression model assessed the relative contribution of the predicted risk factors (age, BMI, previous activity, arch height, running shoe age, concurrent cross training, predominant running surface, and running frequency a week) to the overall number of injuries. A similar model was attempted to establish the contribution of the risk factor to severe running injuries (grades 3 and 4), and new injuries (injuries in subjects with no history of injury). Significance was declared if one or more of the risk factors exceeded a p value of 0.05 for the Wald statistic. Baseline characteristics across sex, and associations with orthotic use were analysed using a χ^2 contingency table, with α set at 0.05.

Table 1 Baseline characteristics of study population

	Men (n=205)	Women (n=635)
Age (years)		
<30**	25 (12.3)	116 (18.6)
31–49**	105 (51.5)	397 (63.6)
50–55**	39 (19.1)	72 (11.5)
>56**	35 (17.2)	39 (6.3)
Missing	1	11
BMI (kg/m^2)		
<19**	2 (1.0)	27 (4.3)
20–26**	113 (55.1)	443 (69.8)
>26**	84 (41.0)	106 (16.7)
Missing	6	59
Programme		
Novice (run/walk)**	121 (59.0)	412 (64.9)
Intermediate**	60 (29.3)	127 (20.0)
Walker**	24 (11.7)	93 (14.6)
Missing	0	3
Arch height		
Normal	121 (59.0)	367 (57.8)
Low	33 (16.1)	102 (16.1)
High	46 (22.4)	145 (22.8)
Missing	5	21
Orthotic use	35 (17.1)	113 (17.8)
No orthotic	168 (82.0)	521 (82.0)
Missing	2	1
Previously active**	69 (33.7)	279 (43.9)
Not previously active**	135 (65.9)	355 (55.9)
Missing	1	1
Concurrent cross training	109 (53.2)	324 (51.0)
No cross training	96 (46.8)	311 (49.0)
Missing	0	0
Regular run diary recording**	72 (35.1)	330 (52.0)
No recording**	133 (64.9)	305 (48.0)
Missing	0	0

Values are numbers with percentages in parentheses.
**Significance p<0.05.
BMI, Body mass index.

RESULTS

Table 1 gives baseline characteristics of the participants. A large discrepancy was noted among the training clinics with respect to sex, with 635 (75.2%) female and 205 (24.3%) male participants. The run/walk programme included most of the runners of both sexes. Significantly more women (p = 0.021) were registered in the novice programme (64.9% *v* 59.0%), and the intermediate programme appeared to have a significant (p = 0.021) majority of male participants (29.3 *v* 20.0%). There was no significant difference in the number of injuries between runners in the novice (run/walk) and intermediate programmes.

Significantly more women reported having a BMI less than 19 (4.3 *v* 1.0%; p = 0.002) and a BMI of 20–26 (69.8 *v* 55.1%; p = 0.003). Conversely, significantly more men were registered with a BMI greater than 26 (41.0 *v* 16.7%; p<0.001). In addition, more women than men (43.9 *v* 33.7%; p = 0.010) declared they were active before beginning the 13 week programme, and women were significantly (p<0.001) more likely to keep a running diary (52.0 *v* 35.1%). No significant differences were not found in the different designations of arch height (normal, low, and high) or concurrent cross training between sexes.

A large number of the participants wore shoes less than three months old (42.3%). The only shoe age category that showed an injury rate above the mean was one to three months (31.6%), and participants with shoes more than two years old recorded an injury rate of 27.9% or 1.6% below the mean.

Figure 1 outlines the relative percentages of predominant running surfaces. Most runners (69.1%) chose to run primarily on roads, 18.6% preferred trails/off-road, and 12.3% ran on other surfaces such as grass, track, or treadmill.

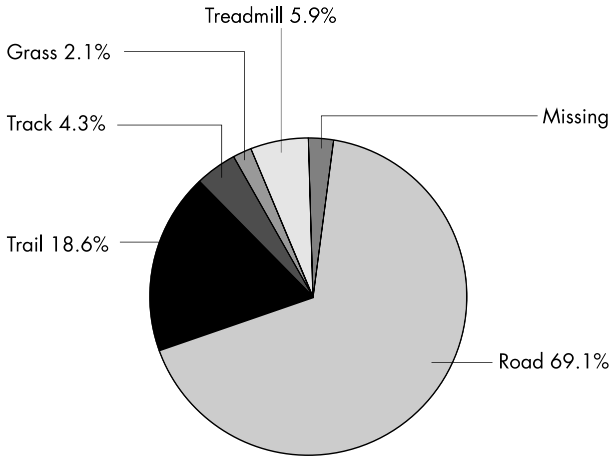

Figure 1 Breakdown of running surfaces.

Table 2 Running frequency

	No	%
1 day/week	49	5.8
2 days/week	244	29.0
3 days/week	501	59.6
4 days/week	36	4.3
5 days/week	9	1.1

Data were not provided in five cases.

Close to 60% of the participants surveyed complied with the recommended running frequency of three times a week (table 2). Almost 30% (29.0%) of the runners reported running twice a week, and 5.8% and 1.1% documented running one day and five days a week respectively.

Overall, 29.5% (249 recorded injuries for 844 runners) of the runners surveyed in this 13 week training programme experienced an injury (grade 1 severity or greater). Figure 2 illustrates the variation in the injury rate across the clinics surveyed. Certain clinics registered injury rates as high as 48%, whereas others reported rates below 20%. As this finding was unexpected, it would be inappropriate to pursue a statistical analysis on these data until more information is gathered.

Table 3 Distribution of injuries by anatomical site

Location	Men	Women
Knee	21 (36)	62 (32)
Shin	10 (17)	28 (15)
Foot	8 (14)	25 (13)
Achilles/calf	5 (8)	20 (10)
Ankle	6 (10)	20 (10)
Hip/pelvis	4 (7)	19 (10)
Low back	4 (7)	10 (5)
Hamstring	0 (0)	6 (3)
Thigh	0 (0)	2 (1)

Values are numbers with percentages in parentheses. Certain subjects indicated multiple injury locations.

Owing to the nature of this study design, we were unable to determine if a subject experienced multiple injuries over the 13 week period. For example, runners citing an injury in week 4 and recovering in week 8 only to be injured again in week 12, and runners citing an injury over all three trials, would be classified as experiencing one injury.

The knee was the most commonly injured anatomical site for both sexes, with 36% and 32% of men and women respectively reporting injuries to this area (table 3). Tibial stress syndrome was reported as the most commonly diagnosed injury. Injuries to the shin, foot, ankle, hip/pelvis, low back, hamstring, and thigh were reported in that order of frequency, equivalent across the sexes.

The 29.5% figure includes both new injuries and injuries that were felt by the subject to be a result of a complication from a previous injury. Half of those reporting an injury had previously sustained an injury to the same anatomical area, and a large percentage of these (42%) declared themselves not 100% rehabilitated on starting the In Training programme. Most injuries (35.5%) were grade 2 (pain during a run, but not restricting distance or speed grade).

The multivariate regression model was found to be significant for both men (χ^2 (3 df) = 15.876, p = 0.001) and women (χ^2 (3 df) = 15.318, p = 0.002) comparing overall number of injuries as the dependent variable (table 4). The difference between the respective sex models, however, lies in the factors found to be significantly associated with the injury rate. Being over the age of 50, wearing running shoes four to six months

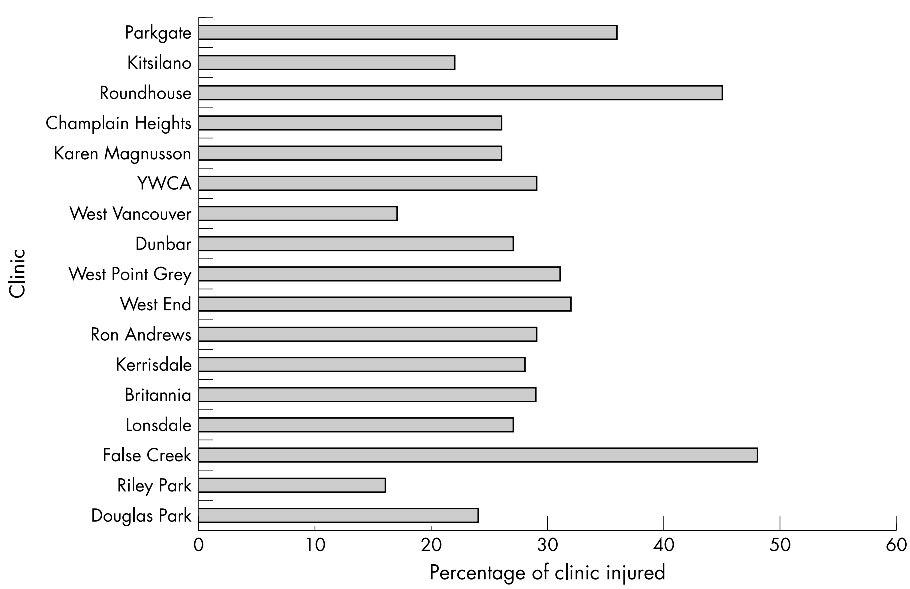

Figure 2 Injury rate distribution with selected In Training clinics.

Table 4 Significant factors associated with the injury rate

Risk factor	Relative risk (95% confidence interval) Overall injury Men	Overall injury Women	New injury Men	New injury Women
Age (years)				
Less than 31	–	–	–	0.575 (0.342 to 0.967)
31 to 37	–	–	–	–
38 to 43	–	–	–	–
44 to 50	–	–	–	–
Greater than 50	–	1.919 (1.107 to 3.328)	–	–
BMI (kg/m^2)				
Less than 21	–	–	–	–
21 to 24	–	–	–	–
24 to 26	–	–	–	–
Greater than 26	0.407 (0.211 to 0.785)	–	–	–
Running frequency				
1 day/week	–	3.648 (1.082 to 12.297)	–	–
2 days/week	–	–	–	–
3 days/week	–	–	–	–
4 days/week	–	–	–	–
5 days/week	–	–	–	–
Arch height				
Normal	–	–	–	–
Low	–	–	–	–
High	–	–	–	–
Running surface				
Road	–	–	–	–
Trail	–	–	–	–
Grass	–	–	–	–
Treadmill	–	–	–	–
Running shoe age				
1–3 months	–	–	–	0.611 (0.378 to 0.987)
4–6 months	0.355 (0.151 to 0.834)	1.735 (1.009 to 2.984)	–	–
7–12 months	–	–	–	–
1–2 years	–	–	–	–
Previous activity	–	–	–	–
Cross training	–	–	–	–

BMI, Body mass index.

old, and only running one day a week were reported as risk indicators for injury in women.

For the men, having a BMI of 26 or greater and running in shoes four to six months old were associated with a lower number of injuries.

The model investigating the odds ratio of experiencing a new injury incorporating the same proposed associating variables was significant only for women (χ^2 (2 df) = 8.114). Being less than 31 years old and wearing new running shoes (one to three months old) were associated with less injuries for female respondents. The model examining these same associated variables in the contribution of only severe injuries was not significant in either sex.

DISCUSSION

Injury analysis

The 29.5% injury rate reported in this study is in line with other documented injury rates of 25–65%.[1 9] The injury incidence in this study was expected be lower than that found in the general literature on running because of the specific design of the In Training clinics' programme to minimise running injuries. However, it is difficult to put the injury incidence of this investigation into perspective as very few, if any, of the studies in the literature followed runners for such a short time. Furthermore, differences in injury definition used by different authors may further confound appropriate comparison across studies.

The injury rate disparity (fig 2) between the clinics studied was surprising, given that the In Training clinics are marketed at, and primarily comprise, a similar group—that is, normally sedentary people that are novice to running. All clinics follow the same running programme for the same duration and at the same time of the year. However, the participants attend only one training session a week with the clinic, therefore the clinic coordinators/run leaders only have influence over this one session. The other training sessions during the week are performed according to the individual participant, which indicates that at least two out of the three recommended training sessions are outside the control of the In Training clinic programme. Our results warrant further investigation into the level of compliance of clinic coordinators and/or run leaders with the overall programme agenda, the efficacy of the training programme itself, and other factors that could influence the epidemiology of running injuries between the various clinics.

There are a few limitations to this study that the reader should consider. Unfortunately, clinic attendance levels were not consistent, resulting in some participants not filling out all three survey trials. The data from these participants were still included in our analysis of injury incidence, with the understanding that it was our objective to ascertain the scope of injuries within the In Training clinics, not calculate an injury rate. For this reason, data from all survey trials were incorporated such that an injury during any of the three trials—that is, week 4, 8, or 12—would constitute one injury for that runner.

Our finding that the knee was the most common site of injury is well supported.[4 6] In a review of 5992 cases seen at the Division of Sports Medicine of the University of British Columbia between 1978 and 1991, the knee was found to be the most often injured site among runners, and patellofemoral pain syndrome the most commonly occurring injury.[10 11] Ballas *et al*[12] also reported that patellofemoral pain syndrome was the most common injury in a breakdown of 860 overuse running injuries presented at the Franciscan Sports Medicine Center.

Tibial stress syndrome was the most documented diagnosed injury in this investigation. Unfortunately, this provides little indication of the most common injury during the 13 week programme, as diagnoses were obtained from only 43.7% of the injured population.

Factors significantly associated with injury

The results from the logistic regression show that women over 50 years old, who wear running shoes four to six months old, and who run only one day a week have a higher odds ratio of experiencing an injury. Conversely, wearing running shoes four to six months old was associated with a reduced likelihood of injury in men, as was having a BMI of greater than 26 kg/m^2. Women less than 31 years old had a significantly lower odds ratio of sustaining a new injury. Unfortunately, as it was expected that the participants would run the same approximate distance on a weekly basis because everyone was following the same running programme, weekly mileage was not included as a variable of interest. Given the discrepancy in the running frequency—that is, more than 30% of the subjects did not comply with the recommended running frequency—this assumption is probably not accurate. Therefore it is difficult to interpret the results of the logistic regression without this important risk factor (weekly running distance) included in the model. In the reviews of Van Mechelen[2] and Brill and Macera,[3] running distance is considered to be one of the strongest contributors to injury. In fact, these authors assert that it is difficult to determine accurately the risk of injury to a population, despite recording numerous other risk factors, unless exposure time is taken into account. It is recommended that future investigations into the risk of injury for this running population include a method of recording exposure time.

Despite the fact that weekly mileage was not included in the injury model, our results with respect to age appear to be in line with military studies in which all subjects, regardless of age, had to undergo the same training volume.[13] These studies show a significant trend for injury with increasing age.[13 14] Conversely, in civilian populations, older age has been reported as potentially protective against injuries by virtue of experience allowing a runner to "listen to the language of their body" and know how to avoid possibly compromising training habits.[9] However, these protective effects are proxy variables that age is felt to incorporate, and not necessarily the direct result of the aging process. It has been reported that age is not a significant risk factor for runners in a comparable population of male and female recreational entrants to road races or members of fitness clubs.[1 5 6] One study did conclude that increasing age was associated with a significant decrease in running injuries, but suggested that the "healthy runner effect", whereby only runners who remain free of injuries continue to run, was probably responsible for this finding.[4]

We found that a higher BMI was a protective factor against injury for the men in this training programme. Marti *et al*[4] found that men with a BMI less than 19.5 kg/m^2 and greater than 27 kg/m^2 were at greater risk of injury, although it should be noted that only 1.8% of their 4358 subjects actually had a BMI over 27. Macera *et al*[1] and Walter *et al*[5] both found that BMI was not related to running injuries in their respective multivariate regression analyses.

It has been speculated that running frequency (days running a week) may affect risk of injury. In examining a subgroup running the same weekly distance in 2, 3 or 4 weekly sessions, Marti *et al*[4] reported no significant differences in the incidence of running related injuries. Consequently, it has been suggested that running frequency does not play a part beyond the effect of increased weekly mileage.[2] The results from this study offer a different context for running frequency and its effect on the injury rate. Women involved in a fixed training programme in which there is a group session on one of three suggested training days, yet who only run in the group session, are at an increased risk of injury. Men also showed a similar trend, with an odds ratio of 4.162 (95% confidence interval 0.920 to 18.837), but this was not significant ($p = 0.064$). The group run session in this study increased in mileage with progression of the programme. Therefore it stands to reason that a person who does not build an adequate training base during the other sessions will be more likely to be injured when they do run in a session that steadily increases in distance. These results suggest that coordinators of similar walk/run programmes should strongly recommend compliance with the training sessions prescribed.

The results from this study with respect to age of running shoes are inconclusive. Wearing shoes four to six months old was associated with fewer injuries overall in men, and wearing new shoes (one to three months old) was associated with fewer new injuries in women. On the other hand, running in shoes four to six months old was associated with overall injury in women. Interpretation of this apparent discrepancy is difficult without taking into account weekly mileage, running experience, and previous injury. Although it is commonly felt that new shoes are protective against injuries by virtue of their cushioning and support qualities, it has also been suggested that injured runners may try to solve their problem by frequently changing shoes.[2] Therefore, newer running shoes (less than six months old) would appear to act as both a protective and risk factor for the onset of running related injuries in this population. Although this is speculation, these results illustrate the need to understand more clearly the direct effect of running shoe age on a large population of novice runners.

Other associated risk factors for injury

Both Marti *et al*[4] and Macera *et al*[1] reported that a previous injury is a significant predictor of reinjury in runners. Our results appear to be in line with their conclusion: half of the injured subjects reported a previous injury to the same anatomical location. However, only injured runners were instructed to provide details of their injury history. As a result, we do not have data from subjects who had a previous injury and were not injured. It was for this reason that history of injury was not included as a risk factor in the regression model.

Of those with a previous injury, 42% indicated they were not completely (100%) rehabilitated before starting the In Training clinics. Macera[7] states that it is not clear whether this high rate of reinjury suggests incomplete healing of the original injury, a personal propensity for reinjury, or an uncorrected biomechanical problem. Again, only the injured runners provided details of their state of rehabilitation on entering the 13 week programme, and therefore we do not have adequate information on the number of participants who were not completely rehabilitated and did not experience an injury. This variable was also excluded from the regression model for reasons previously stated.

This analysis of runners training for this 10 km run reported no significant effect of arch height on the injury rate model. In contrast, Krivickas[8] associated a cavus foot with plantar fasciitis and stress fractures, Kvist[15] reported that a cavus arch is related to the incidence of Achilles tendinitis, Wen *et al*[16] associated abnormal arch height with hamstring and shin injuries, and Ogon *et al*[17] measured a higher rate of impact loading to the lower back with a low arched foot. Our lack of significance may be a result of the lack of professional biomechanical assessment performed on the participants in this study, or the considerably shorter time frame for injuries to occur in runners with high or low arches.

Our finding that the predominantly novice runners who registered in the run/walk programme had an equivalent number of injuries to their more experienced counterparts in the intermediate programme warrants further discussion. Macera[7] and Marti *et al*[4] both found that experienced runners were at a decreased risk of injury during a one year follow up. In fact, van Mechelen,[2] in his review of the literature, concluded that lack of running experience is one of the four outlined factors contributing to injury in runners. We maintain that the lower injury rate among more seasoned runners may be due to the self selection by injury prone people for other types of activity, or a result of a musculoskeletal adaptive process. The lack of a significant difference in this study is probably attributable to both groups of runners (novice and intermediate) being inexperienced in absolute terms. Unfortunately, as running experience was not investigated, definitive conclusions on the injury rate between the two running levels within the In Training clinics cannot be drawn.

Although previous aerobic activity was not found to contribute significantly to the injury model in this study, it has been implicated as a risk factor for musculoskeletal injury during physical training by Neely[14] and Jones and Knapik[13]. Most studies that have assessed the effect of physical fitness on the risk of injury have been of military personnel, for whom there is almost universal agreement that a lack of fitness positively contributes to the risk of injury.[13]

We found that incorporating cross training into the In Training regimen did not influence the injury rate. However, it has been suggested that cross training can decrease the risk of injury in two ways[18]: (*a*) by correcting strength imbalances by conditioning key muscles not affected by running; (*b*) a non-weight bearing activity such as swimming or cycling can replace some of the weekly running mileage, eliminating some of the impact forces that contribute to injury.

We also found that running terrain did not influence the number of injuries. James *et al*[19] also found no association of running on hard surfaces with an increased risk of injury after controlling for weekly distance.[10 12] The apparent lack of effect of training surface may stem from the difficulty of adequately quantifying the time and intensity of running spent on each of the running surfaces.

Conclusion

The injury rate documented in this study is worrying because of the specific intention of the programme's designers to train people to run a 10 km race with a minimum of injury. Moreover, the reason for the discrepancy between the injury rates investigated in this study remains elusive, and it is recommended that, in future investigations into this population, time is devoted to solving this inequality. We found through multivariate regression modelling that age was significantly associated with the injury rate for only the women in this study. In particular, being over 50 years old was associated with overall injury, and being less than 31 was associated with fewer new injuries in women. Having a BMI greater than 26 kg/m^2 was protective for men. Although there was a positive trend for running only one day a week and increasing risk of overall injury in both sexes, only in women was this significant. Although running shoe age significantly contributed to the injury rate in this study, definitive conclusions are difficult to draw with respect to the benefit of running in newer shoes. Factors such as previous activity, arch height, cross training, and running surface were not significant for either sex in any model. We recommend that these results be viewed with caution, because a measure of exposure time to injury (for example, weekly running distance or time), running experience, and previous injuries were not recorded. Nevertheless, the data from this investigation provide a useful introduction to the number of injuries that occur in a programme designed to minimise the injury rate. Future research, incorporating adequately quantified risk factors for injury, including a measure of exposure time and previous injuries, should provide a better examination of this successful and popular training programme.

Take home message

Novice participants in a training programme for a 10 km run should remember to listen to the language of their body, use common sense, and be conservative, particularly if they are older than 50, run in old shoes, and are not fully rehabilitated from a previous leg or foot injury.

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REFERENCES

1 **Macera C**, Pate R, Powell K, *et al*. Predicting lower-extremity injuries among habitual runners. *Arch Intern Med* 1989;**149**:2565–8.
2 **Van Mechelen**. Running injuries: a review of the epidemiological literature. *Sports Med* 1992;**14**:320–35.
3 **Brill PA**, Macera CA. The influence of running patterns on running injuries. *Sports Med* 1995;**20**:365–8.
4 **Marti B**, Vader J, Minder C, *et al*. On the epidemiology of running injuries: the 1984 Bern Grand-Prix study. *Am J Sports Med* 1988;**16**:285–93.
5 **Walter SD**, Hart LE, McIntosh JM, *et al*. The Ontario cohort study of running-related injuries. *Arch Intern Med* 1989;**149**:2561–4.
6 **Jacobs S**, Berson B. Injuries to runners: a study of entrants to a 10,000-meter race. *Am J Sports Med* 1986;**14**:151–5.
7 **Macera C**. Lower extremity injuries in runners: advances in prediction. *Sports Med* 1992;**13**:50–7.
8 **Krivickas L**. Anatomical factors associated with overuse sports injuries. *Sports Med* 1997;**24**:132–45.
9 **Van Mechelen W**. Can running injuries be effectively prevented? *Sports Med* 1995;**19**:161–5.
10 **Macintyre J**, Taunton J, Clement D, *et al*. Running injuries: a clinical study of 4,173 cases. *Clin J Sports Med* 1991;**1**:81–7.
11 **Clement D**, Taunton J, Smart G, *et al*. A survey of overuse injuries. *Physician and Sports Medicine* 1981;**9**:47–58.
12 **Ballas M**, Tytko J, Cookson D. Common overuse running injuries: diagnosis and management. *Am Fam Physician* 1997;**55**:2475–80.
13 **Jones BH**, Knapik JJ. Physical training and exercise related injuries: surveillance, research and injury prevention in military populations. *Sports Med* 1999;**27**:111–25.
14 **Neely FG**. Intrinsic risk factors for exercise-related lower limb injuries. *Sports Med* 1998;**26**:253–63.
15 **Kvist M**. Achilles tendon injuries in athletes. *Sports Med* 1994;**18**:173–201.
16 **Wen D**, Puffer J, Schmalzried T. Lower extremity alignment and risk of overuse injuries in runners. *Med Sci Sports Exerc* 1997;**29**:1291–7.
17 **Ogon M**, Aleksiev A, Pope M, *et al*. Does arch height affect impact loading at the lower back level in running? *Foot Ankle Int* 1999;**20**:263–6.
18 **Glover B**, Shepherd J, Florence Glover S. *The runner's handbook*. New York: Penguin Books, 1996:554–78.
19 **James S**, Bates B, Osternig L. Injuries to runners. *Am J Sports Med* 1978;**6**:640–50.