IJSPT

ORIGINAL RESEARCH

PREVALENCE OF MUSCULOSKELETAL PAIN IN MARATHON RUNNERS WHO COMPETE AT THE ELITE LEVEL

Renata Nakata Teixeira, MsC, PhD[1]
Adriana Lunardi, PT, MsC, PhD[1,2]
Ronaldo Aparecido da Silva, MsC, PhD[1]
Alexandre Dias Lopes, PT, MsC, PhD[2,3]
Celso R. F. Carvalho, PT, MsC, PhD[1]

ABSTRACT

Background: Musculoskeletal pain can be an important sign of overuse injury in elite athletes. However, its prevalence and whether it is associated with aspects of training in marathon runners who compete at the elite level is still not clear.

Purpose: The purpose of this research was to assess the prevalence, location and intensity of running-related musculoskeletal pain over the previous 12 months in marathon runners who compete at the elite level and to verify whether certain training characteristics are associated with musculoskeletal pain.

Design: Cross sectional study.

Methods: One hundred and ninety-nine elite marathon runners were verbally interviewed regarding their personal demographics, training routines, and the presence, location and intensity of musculoskeletal pain.

Results: The prevalence of any running-related musculoskeletal pain in elite distance runners was 75%, and the most frequently reported location was the lower leg (19.1%). The presence of pain was independent of age, experience, and volume of training.

Conclusions: Running-related musculoskeletal pain is highly prevalent in marathon runners who compete at the elite level.

Clinical Relevance: Studies about prevalence and location of musculoskeletal pain and factors-related in this population are important to contribute to the development of educational and preventive strategies.

Evidence Level: 2

Keywords: Athletic performance, lower extremity, overuse injury, running injury,

CORRESPONDING AUTHOR
Celso R. F. Carvalho
School of Medicine, University of São Paulo
Physical Therapy, School of Medicine,
University of São Paulo
Av. Dr. Arnaldo, 455 – room 1210
01246-903 – São Paulo – SP - Brazil
Phone: +55-11-3061-7317
FAX: +55-11-3085-0992 or +55-11-30917-462
E-mail: cscarval@usp.br

[1] Physical Therapy Department, School of Medicine, University of São Paulo, São Paulo, Brazil
[2] Cidade de São Paulo University, São Paulo, Brazil
[3] São Paulo Running Injury Group (SPRunIG), São Paulo, Brazil

INTRODUCTION

Running is a popular sporting activity that can be done everywhere and by almost everyone. For these reasons, it is considered one of the most accessible sporting activities, in terms of cost and ease of implementation, with the number of athletes from recreational to elite levels growing.[1] The positive effects of running on cardiovascular risk factors,[2] mental[3] and social aspects[4] are well known; however, running is not an activity without risk and has also been associated with musculoskeletal injuries.[5] The number of studies assessing the prevalence of injuries in runners has been increasing[6] and typically focus on the time that the athlete is unable to participate in sports activities.[5-7] However, according to Bahr (2009) it is also important to describe the incidence of pain related to overuse injuries in those who continue to compete[8].

Runners who compete at the elite level, defined as those competing at international and/or national level,[9] are a minority of the total number of participants in running events, however, they represent an important population to be studied because they are responsible for breaking records and also for the best performances. Their training is characterized by a high training volume, with weekly training loads of up to 160 km/week, which is also considered a risk factor for running-related injuries.[7] Moreover, it has been postulated that the pain perception in athletes is different from the pain perception in normally active persons and can influence the threshold at which pain is reported, especially by elite level athletes.

Despite several studies that have been conducted on running injuries, the prevalence of musculoskeletal pain in marathon runners who compete at the elite level is unclear. Therefore, assessing musculoskeletal pain before a race in elite runners would improve the understanding regarding the perception of musculoskeletal pain of these athletes and clarify two major questions: 1) Do elite distance runners compete despite the presence of musculoskeletal pain? and, 2) If they do, what is the threshold of pain intensity they report before a competition? Addressing these behavioral questions could contribute to the development and implementation of educational interventions that aim to prevent overuse injuries in populations of elite athletes.

The purpose of this study was to assess the prevalence, location and intensity of running-related musculoskeletal pain over the previous 12 months in marathon runners who compete at the elite level and to verify whether certain characteristics of their training are associated with musculoskeletal pain.

METHODS

All runners were recruited during the period of packet pick-up in the week prior to the marathon events staged in 2011. The eligibility criteria were as follows: 1) completion of a marathon in the past 18 months with a time under 2:35:00 for men and 3:00:00 for women, according to the competition regulations for the elite category; 2) enrollment in the elite category. The athletes were assessed only once even if they had participated in more than one event. All athletes who agreed to participate in the study gave written informed consent prior to enrollment. The study protocol was approved by the local human research ethics committee (protocol number 6411/11) in accordance with guidelines for research involving humans.

To assess the prevalence of musculoskeletal pain over the previous 12 months, the runners were verbally interviewed about the presence of musculoskeletal pain by using a previously used questionnaire.[10] The International Association for the Study of Pain (IASP) considers pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.[11] Those runners who answered "yes" were asked to mark the place (or more than one place, if necessary) of pain on a figure that had 28 points (Figure 1). They were allowed to note more than one location of pain. Next, the runners scored the pain intensity, using a visual analogue scale ranging from zero (no pain) to ten (intolerable pain), at each location noted on the figure. According to the reported score, the pain intensity was classified as mild (1 or 2), moderate (3 to 7), or intense (8 to 10). Subjects also answered questions regarding personal information and training volume, specifically, experience in marathons, weekly training volume, and best time in a marathon.

All information was obtained through verbal interviews conducted by a trained team of health care

professionals. To avoid misunderstanding, the researchers were previously trained to read the questions to the athletes and to repeat them when necessary, i.e., when the athlete did not understand in the first reading. Subjects reported pain by pointing out the body location where they usually experienced pain.

Statistical analyses

Descriptive analysis was performed using simple frequency distribution. Categorical data were expressed in percentages. Continuous data were described in measures of central tendency and dispersion. The evaluation of the normality of the continuous data (age, experience, frequency, weekly training volume and fastest time in the marathon) was calculated by the Kolmogorov-Smirnov test. Normal distribution data were presented as the mean and standard deviation, and non-normal distribution data were reported using the median and a 25%-75% interquartile range. The comparison of variables between groups of athletes with and without self-report of pain was performed using Chi-Square and Mann Whitney test for non-normal distribution. The significance level was set at $p < 0.05$. SigmaPlot 12.1 (San Jose, CA, USA) statistical software was used for all analyses

RESULTS

One hundred and ninety-nine athletes participated in the study. The mean age of the runners in this sample was 34 years (30-39 years). Subjects reported running an average of 180 km/wk (160-200 km/wk) (Table 1). There was no difference between the runners with and without pain in demographic measures or training behaviors (Table 1).

Among the 199 respondents, 149 (75%) reported the presence of musculoskeletal pain in the last 12 months, and the most frequently reported locations of running-related musculoskeletal pain were as follows: lower leg (19.1%), knee (15.3%), Achilles tendon (14.5%) and the thigh (12.8%). The shoulder, clavicle, and thoracic spine were the least reported locations, representing 4.8% of the total complaints (Table 2). Fifty-eight individuals (38.6%) reported two distinct locations of pain, 23 (15.3%) reported three locations of pain, and six (4%) reported more than four locations of pain (Table 2).

Regarding the pain intensity assessed by a visual numerical scale (from 0 to 10), 58 athletes (29%) reported intense pain (from 8 to 10), 83 (42%) reported moderate pain (from 3 to 7), 58 (29%) reported mild pain, and 50 (25%) reported the absence of pain (from 0 to 2). Independent of the pain intensity, the prevalence of pain was more commonly reported (61.7%) in four segments of the lower limbs; however, there was no statistical difference among them (Figure 1).

DISCUSSION

To the best of the authors' knowledge this is the first study to describe the prevalence of running-related musculoskeletal pain in marathon runners who compete at the elite level. In this study, the areas

Table 1. *Characteristics of the training routine among athletes and comparison between the athletes with and without pain*

	All (n=199)	Pain (n=149)	No pain (n=50)	p-value
Gender (M/F)	164/35	128/21	36/14	0.04
Age (years)	34 (30-39)	34 (29-39)	34 (30-39)	0.73
Running experience (years)	11 (8-16)	11 (8-16)	11 (8-17.5)	0.72
Running distance (km/wk)	180 (160-200)	180 (160-190)	180 (160-200)	0.98
Personal best time in marathon	2h:28mim (2h:12min-2h:50min)	2h:29min (2h:12min-2h:48min)	2h:29min (2h:14min-2h:48min)	1.00

Continuous data are presented as the mean with the 95% confidence interval (in parenthesis). The categorical data are expressed in number of runners.

M=male, F=female, km= kilometer, h= hours, min=minutes.

Table 2. *Anatomical locations* of reported pain, according to intensity of pain*

	INTENSITY OF PAIN			
Location of pain	**Mild**	**Moderate**	**Intense**	**Total**
Lower leg	1	29	15	45
Knee	3	19	14	36
Calcaneus tendon	2	13	19	34
Thigh	3	23	4	30
Lumbar spine	--	13	7	20
Ankle	1	12	2	15
Inguinal region	1	6	7	14
Feet/toes	1	4	7	12
Hip	1	7	1	9
Pelvic/sacral/gluteus	1	4	3	8
Shoulder/clavicle	--	3	1	4
Thoracic spine	1	2	--	3
Neck/cervical spine	--	1	1	2
Sternum/ribs	1	1	--	2
Wrist	1	--	--	1

Data are presented as number of runners reporting pain.

Mild= 1 or 2 on visual analog scale; Moderate= 3 to 7 on visual analog scale; Intense= 8 to 10

*Athletes were allowed to report as many regions of pain as they experienced

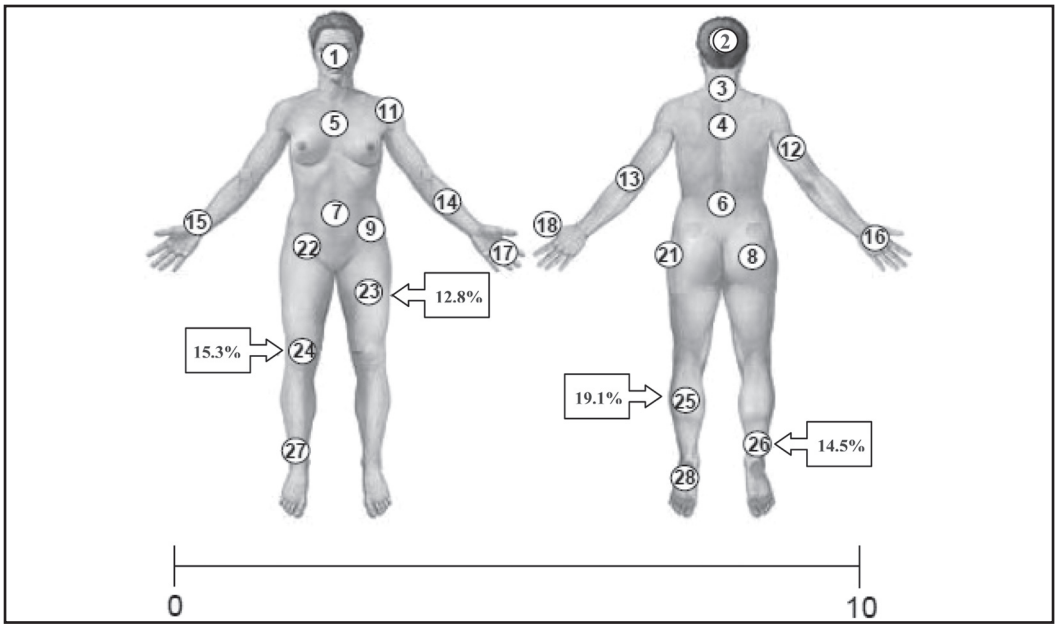

Figure 1. *Points of musculoskeletal pain (numbers reported on the body region) and prevalence (% reported in arrow boxes) of those most frequently reported by the runners. All areas of pain were reported using a 10cm visual analog scale (shown below).*

with highest prevalence of musculoskeletal pain were the lower legs, knees, calcaneal tendon, and thigh. In addition, most athletes reported moderate pain, as reported and assessed by a visual analog scale. The presence of pain was not associated with age, quantity of training and running experience.

Based upon the high prevalence of musculoskeletal pain observed in this population, it would be important to adopt interventions focusing on the athletes' education aiming to promote more information about the risks and consequences of continuing training despite the presence of pain. This could help to decrease the prevalence of overuse injuries and contribute to the development of injury-prevention strategies. However, this hypothesis needs to be confirmed in future studies.

The prevalence of pain among the elite marathon runners assessed in this study was nearly four times higher than that in another study that assessed musculoskeletal pain in recreational runners (39 ± 11 years old and BMI of 24.3 ± 2.8 kg/m^2) who ran an average of 30 kilometers per week.[10] A possible explanation for this difference could be the higher training volume undertaken by the marathon runners who compete at the elite level. In recreational runners, musculoskeletal pain has been associated with weekly training volume and the number of years of running;[1,10,12,13,14,15,16,17] however, this association was not observed in this study, likely because the sample was homogeneous in terms of the training volume and the number of years of running. Others factors such as preferred running surface and use of different running shoes,[15] atypical foot pronation and inadequate hip muscle stabilization[16] have been identified as causative factors for overuse running injuries and may also be associated with musculoskeletal pain. However, these factors were not assessed in this study.

Assessing the prevalence of musculoskeletal pain in elite marathon runners seems important considering the frequent association between several influences such as biomechanical factors[1,17,18] and training conditions[19,20] and a predisposition to injury. Accordingly, although the pain locations and intensities reported by the runners may suggest musculoskeletal overuse injuries,[21] further investigations are required to further describe the possible interaction between musculoskeletal pain and excessive physical exertion. The areas where the marathon runners who compete at the elite level reported the greatest musculoskeletal pain were the lower legs, knees, calcaneus tendon and thigh. These findings were expected, given the high prevalence of musculoskeletal injuries in the lower limbs that have been described in long-distance runners.[18,21,22,23,24] The high frequency of pain in the lower limbs may have occurred mainly due to the impact of running on joints, which varies from one and a half to three times the body weight,[25] and the related forces that contribute to soft tissue injuries that range from inflammation to structural degeneration.[26]

There are several limitations to this study that should be noted. First, other domains, such as impairment, disability, strength, amplitude of movement, agility, coordination and balance were not assessed. However, based on the authors' previous experience with elite athletes, the inclusion of such evaluations would not be well accepted prior to competition because most athletes claim that they must rest and be focused. Second, the reports of musculoskeletal pain were obtained retrospectively, introducing the possibility of memory bias. Third, it is not possible to infer causation from any of the variables assessed because this was a cross-sectional study. Last, the athletes were not queried regarding how much time, if any, was missed from their training due to pain level.

CONCLUSION

Three-quarters of the marathon runners who compete at the elite level reported running-related musculoskeletal pain. Studies on musculoskeletal pain in elite athletes are particularly important because such studies may reveal the ways in which these athletes respond to musculoskeletal pain. Consequently, the findings may contribute to the development of educational and preventive strategies.

REFERENCES

1. Fredericson M, Misra AK. Epidemiology and aetiology of marathon running injuries. *Sports Med.* 2007;37(4):437-439.
2. Hur S, Kim SR. The Effects of Exercise Therapy on CVD Risk Factors in Women. *J Phys Ther Sci.* 2014;26(9):1367-1370.
3. Rauh MJ, Barrack M, Nichols JF. Associations between the female athlete triad and injury

among high school runners. *Int J Sports Phys Ther*. 2014;9(7):948-958.

4. Sabourin BC, Stewart SH, Watt MC, Krigolson OE. Running as interoceptive exposure for decreasing anxiety sensitivity: Replication and extension. *Cogn Behav Ther.* 2015; 44(3):1-11.
5. Taunton JE, Ryan MB, Clement DB, McKenzie DC, Lloyd-Smith DR, Zumbo BD. A retrospective case-control analysis of 2002 running injuries. *Br J Sports Med.* 2002;36(2):95-101.
6. Schueller-Weidekamm C, Schueller G, Uffmann M, Bader T. Incidence of chronic knee lesions in long-distance runners based on training level: findings at MRI. *Eur J Radiol.* 2006;58(2):286-293.
7. Saragiotto BT, Di Pierro C, Lopes AD. Risk factors and injury prevention in elite athletes: a descriptive study of the opinions of physical therapists, doctors and trainers. *Braz J Phys Ther.* 2014;18(2):137-143.
8. Bahr R. No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. *Br J Sports Med*. 2009;43(13):966-972.
9. wann C, Moran A, Piggott D. Defining elite athletes: Issues in the study of expert performance in sport psychology**.** *Psychol Sport Exerc*. 2015; 16 (1): 3-14.
10. Lopes AD, Costa LO, Saragiotto BT, Yamato TP, Adami F, Verhagen E. Musculoskeletal pain is prevalent among recreational runners who are about to compete: an observational study of 1049 runners. *J Physiother.* 2011;57(3):179-182.
11. Merskey H, Albe-Fessard DG, Bonica JJ, Carmon A, Dubner R, Kerr FWL, Lindblom U, Mumford JM, Nathan PW, Noordenbos W, Pagni CA, Renaer MJ, Sternbach RA, Sunderland S. Pain terms: a list with definitions and notes on usage. Recommended by the IASP Subcommittee of Taxonomy. *Pain*. 1979;6(3):249-252.
12. van Gent RN, Siem D, van Middelkoop M, van Os AG, Bierma - Zeinstra SMA, Koes BW. Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review. *Br J Sports Med*. 2007;41(8):469-480.
13. Ferber R, A. Hreljac, K.D. Kendall Suspected mechanisms in the cause of overuse running injuries: a clinical review. *Sports Health*. 2009;1(3):242-246.
14. Bahr R. No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. *Br J Sports Med*. 2009;43(13):966-972.
15. Knechtle B, Assadi H, Lepers R, Rosemann T, Rüst CA. Knechtle B, Assadi H, Lepers R, Rosemann T, Rüst CA. Relationship between age and elite marathon race time in world single age records from 5 to 93 years. *BMC Sports Sci Med Rehabil*. 2014;31(6).
16. Macera CA, Pate RR, Powell KE, Jackson KL, Kendrick JS, Craven TE. Predicting lower-extremity injuries among habitual runners. *Arch Intern Med*. 1989;149(11):2565-2568.
17. Meeusen R, Duclos M, Gleeson M, Rietjens G, Steinacker J, Urhausen A Prevention, diagnosis and treatment of the Overtraining Syndrome. ECSS position statement 'task force'. *Eur J Sport Sci*. 2006;6(1),1-14.
18. van Gent RN, Siem D, van Middelkoop M, van Os AG, Bierma-Zeinstra SM, Koes BW. Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review. *Br J Sports Med*. 2007;41(8):469-480.
19. Macera CA. Lower extremity injuries in runners. Advances in prediction. *Sports Med*. 1992;13(1):50-57.
20. Johnston CA, Taunton JE, Lloyd-Smith DR, McKenzie DC. Preventing running injuries. Practical approach for family doctors. *Can Fam Physician*. 2003;49:1101-9.
21. Marti B, Vader JP, Minder CE, Abelin T. On the epidemiology of running injuries. The 1984 Bern Grand-Prix study. *Am J Sports Med*. 1988;16(3):285-294.
22. Taunton JE, Ryan MB, Clement DB, McKenzie DC, Lloyd-Smith DR, Zumbo BD. A prospective study of running injuries: the Vancouver Sun Run "In Training" clinics. *Br J Sports Med*. 2003;37(3):239-244.
23. Satterthwaite P, Norton R, Larmer P, Robinson E. Risk factors for injuries and other health problems sustained in a marathon. *Br J Sports Med*. 1999;33(1):22-26.
24. Hirschmüller A, Frey V, Konstantinidis L, Baur H, Dickhuth HH, Südkamp NP, Helwig P. Prognostic value of Achilles tendon Doppler sonography in asymptomatic runners. *Med Sci Sports Exerc*. 2012;44(2):199-205.
25. Lopes AD, Hespanhol Júnior LC, Yeung SS, Costa LO. What are the main running-related musculoskeletal injuries? A Systematic Review. *Sports Med.* 2012;1(42):891-905.
26. Yeung W, Yeung SS. A systematic review of interventions to prevent lower limb soft. *Br J Sports Med*. 2001;35(6):383–389.