

A SURVEY OF EXERCISE-RELATED LEG PAIN IN COMMUNITY RUNNERS

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ABSTRACT

Purpose/Background: Exercise-related leg pain (ERLP) is a common problem in runners. The purposes of this study were to 1) report ERLP occurrence among adult community runners; 2) determine ERLP impact on daily activities; and 3) determine if there is a relationship between ERLP occurrence and selected potential risk factors including sex, age, years of running, ERLP history, body mass index (BMI), orthotic use, menstrual function, and training variables.

Methods: Community runners registered for a local race were invited to complete a questionnaire including demographics and potential risk factors. Analyses of differences (t-test) and relationships (Chi-square) were conducted and relative risk (RR) values were calculated.

Results: 225 registered runners (105 male, 120 female) participated; 63.6% reported ERLP history, and 35.1% reported ERLP in the 3 months preceding the race with bilateral medial ERLP as the most common presentation. Of the 79 runners who experienced ERLP during the 3 months preceding the race, ERLP caused 41.8% to reduce their running and interfered with walking or stair climbing in < 10%. Chi square analyses showed no significant association of sex, menstrual function, orthotic use, or BMI with ERLP occurrence. Significant associations were observed between ERLP history and ERLP occurrence in the previous year (RR=3.39; 2.54-4.52 95% CI), and between ERLP in the 3 months preceding the race and both years running and training mileage. Greater ERLP occurrence was observed in runners with less than 3 years experience (RR = 1.53; 1.08-2.17 95% CI) and runners who ran fewer than 15 miles/week (RR = 1.47; 1.04-2.08 95% CI). Those runners with < 3 years running experience and a race pace of 9 min/mile or > were at greater risk for ERLP when compared to other participants (RR=1.53; 1.07-2.18 95% CI).

Conclusion: Interfering ERLP was common among this group of community runners. Risk factors included ERLP history, training mileage < 15 miles/week, and < 3 years running experience. Further investigation is warranted to identify factors which may increase a community runner's risk of developing ERLP.

Level of Evidence: 2b.

Key Words: Exercise-related leg pain, running, overuse injury

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INTRODUCTION

Over the past twenty years, there has been a steady increase in the number of participants in community-based running races in the United States. According to the Running USA website, the number of road race finishers has grown from less than 5 million persons in 1990 to over 13.8 million in 2011.¹ While the health benefits of running are well established, there is a risk of overuse injuries associated with running. Consequent to the increase in number of community runners is a concomitant increase in reported running injuries. Buist et al suggest that 30-80% of runners experience a running-related injury.² In a survey study of a group of over 1000 recreational runners, 22% reported the presence of musculoskeletal pain before a running race.³

Exercise-related leg pain (ERLP) is a complex of overuse-related injuries often referred to as “shin splints” and is characterized by pain between the knee and the ankle associated with exercise. Medical diagnoses that can cause pain complaints in this region include medial tibial stress syndrome (MTSS), chronic exertional compartment syndrome (CECS), tibial or fibular stress fractures, tendinopathies (posterior tibialis, anterior tibialis, peroneals, and achilles), nerve entrapment syndromes, and vascular syndromes.^{4,5} Of these conditions, MTSS, stress fractures, CECS, and tendinopathies are the most common causes of ERLP.⁴

The epidemiological data on ERLP consistently show it to be a commonly experienced overuse condition in adult runners. Orava and Puranen⁶ reported an 18% incidence of ERLP in a group of 2750 athletes presenting to a clinic with running related overuse injuries. In a group of 2002 athletes with running injuries, 12.8% reported the location of their pain complaints to be in their lower leg.⁷ Buist et al⁸ studied a group of 629 community runners training for a 4 mile road race and found that over an 8-week period, one-quarter of the subjects experienced a running related injury, and the lower leg was one of the top two sites of injury.

Risk factors for overuse injuries can be categorized as intrinsic/extrinsic and modifiable/non-modifiable. Intrinsic factors are those contained within a person, including sex, race, bone structure, bone density, muscle length, muscle strength, joint range

of motion, diet, and body composition. Extrinsic factors are those outside of a person, including training volume (frequency, duration, and intensity), types of conditioning activities, specific sport activities, training surface, shoes, and environmental conditions. Modifiable risk factors are those factors that can be altered by prevention strategies. Nonmodifiable risk factors cannot be changed but may be useful in identifying and monitoring at risk individuals.^{9,10}

Few studies have assessed risk factors for overuse injury in adult community runners. Marti et al¹¹ performed a research study on 4258 male finishers of the 1984 Bern Grand-Prix 16 kilometer running event. The authors concluded that overuse injuries were common, with leg pain the most common complaint. Identified risk factors included higher training mileage and novice status.¹¹ Walter et al¹² followed a cohort of 1680 community runners over 12 months, and found that 48% of the runners experienced at least one injury during the year. These researchers found the two most significant risk factors for musculoskeletal injuries in runners were increased weekly training mileage and previous injury.¹² Macera et al¹³ enrolled 583 runners and followed them over a 12 month period. The most important risk factors for lower extremity musculoskeletal injuries were running more than 40 miles/week and previous injury.¹³ In a series of articles on running injuries associated with the 2005 Rotterdam marathon,¹⁴ the researchers found 28% of participants reported an injury within the month preceding the marathon, and a history of injury was strongly associated with recurrence of injury.¹⁴ ERLP accounted for the largest percentage of running injuries in this study (32.7%), and running less than 40 miles per week was found to be protective of overuse injury.¹⁴

There is variation in the populations studied and the suggested risk factors for ERLP. Studied populations include collegiate athletes, high school athletes, community athletes, and military personnel. Reported risk factors specific for ERLP include being female,¹⁵⁻¹⁷ high or low BMI,¹⁶ excessive foot pronation,^{15,18-24} and menstrual dysfunction including oligomenorrhea or amenorrhea.²⁵

ERLP is a common problem in running athletes and the question of the influence of risk factors on the development of leg pain in community runners

continues to remain unanswered as there are divergent and limited study results. Accordingly, there is a pressing need for further investigation regarding the identification of risk factors for the development of ERLP. The purposes of this study are 1) to report the occurrence of ERLP among adult community runners and its impact on running; 2) to determine the impact of ERLP on daily activities, specifically walking and stair climbing; and 3) to determine if there is a relationship between occurrence of ERLP and selected potential risk factors including sex, age, years of running, ERLP history, body mass index (BMI), orthotic use, menstrual function, and training parameters.

METHODS

This cross sectional study was approved by the Saint Louis University Institutional Review Board. Runners registered for either the half or full Lewis & Clark Marathon in the St. Louis metropolitan area in the fall of 2009 were invited to participate in the study. The criteria for inclusion in the study were adult community runners between the ages of 18 and 79 years old registered for the race and who had no lower extremity weight-bearing restrictions. For participant recruitment, members of the research team were stationed at three area running stores where runners picked up their race packets three days preceding the race. Registered runners were invited to participate in the study and, if interested, completed the informed consent process.

Risk factor data were collected from each participant through the use of sex-specific questionnaires. The first questionnaire was completed at the race packet pick-up site and took approximately 5-7 minutes to complete. This paper form included questions concerning participant demographics (age, ethnicity, height/weight) and training parameters (weekly mileage, pace, running surface, and cross-training habits). The questionnaire also included history of ERLP in the past three months, the past year, or at any time; the location of ERLP; the impact of ERLP on training, walking, running, and stair climbing; and orthotic use. Additionally, female participants were asked questions pertaining to menstrual function and the use of estrogen hormonal therapy. At the initial encounter, participants provided a contact e-mail address to allow them to receive a web link to the follow-up questionnaire. Two weeks after the first

questionnaire was completed, all participants were sent an e-mail that provided a web link to a second questionnaire. Responses from both questionnaires were used in determining instrument reliability.

Prior to data collection, usability of the initial paper questionnaire was assessed using five adult community distance runners. These individuals completed the questionnaire and participated in a focus group to obtain information on ease of survey completion, question clarity, and question routing. Based on the individuals' feedback, minor changes were made in the questionnaire. For both the men's and women's questionnaire, the Flesch-Kincaid Grade Level was sixth grade and the Flesch Reading Ease test was over 70, with 60-70 being easily understandable to a 13-15 year old student.

For the reliability analysis, responses from the initial and two-week questionnaire were compared using intraclass correlation coefficients (ICC, Mixed Model Type II) for continuous items and both Kappa values and percentage agreement for dichotomous items. Analyses of differences between groups (ERLP- no ERLP) were conducted using t-tests. Analyses of relationships between factors were conducted using Chi-square, and relative risk values were calculated. Significance was established a priori at $p < 0.05$.

RESULTS

Of the 5200 runners registered, 225 runners (4.3%) consented to participate, including 105 male (47%) and 120 (53%) female runners. Most study participants were registered for the half-marathon (186/225, 82.7%). Participants had an overall mean age of 39.6 years (range 18-78 years), mean BMI of 23.6 kg/m² (range 18.0-37.3 kg/m²), and mean years running of 8.5 (range 0-69 years). There was a significant difference ($p = .03$) in mean age of men (42.0 years) as compared to women (37.5 years), and in mean BMI of men (24.7 kg/m²) as compared to women (22.7 kg/m², $p = 0.000$). There was no difference in mean years of running between men and women. There were significant differences between the marathon and half-marathon participants in mean age (marathon runners = 44.5 years, half-marathon runners = 38.5 years; $p = .002$) and in years running (marathon runners = 15.8 years, half marathon runners = 7.0 years; $p = .000$).

Mean weekly training mileage in the 3 months preceding the race was 24.7 miles (range 4-70 miles) and mean training pace was 9.7 min/mile (range 5.8-15.0 min/mile). ERLP history was reported by 143 (63.6%) of the 225 athletes; 111 (49.3%) reported ERLP in the year preceding the race, and 79 (35.1%) reported ERLP in the 3 months preceding the race. Bilateral medial leg pain was the most common presentation of ERLP reported.

The effect of ERLP on running, walking, and stair climbing was examined in the runners who experienced ERLP during the 3 months preceding the race. This 3 month time frame was used in order to maximize runner recall of the effect of ERLP. For the 79 runners who experienced ERLP during the 3 months preceding the race, ERLP caused 21 (26.5%) to reduce their running training, and 12 (15.2%) to stop their running training for at least one week. Although half of the 79 runners reported the occurrence of ERLP pain with walking and stair climbing, less than 10% reported that it limited their ability to walk or climb stairs.

Analyses of differences revealed no significant differences between those with and without ERLP history for the continuous variables of age, BMI, and years running. Comparing those who had and had not reported ERLP in the past year, there was a significant difference in age ($p = .017$) with those who had experienced ERLP being slightly younger (mean age = 37.8 years) than those who had not experienced ERLP (mean age = 41.3). No significant differences were found for BMI, years running, or race pace comparing those who had and had not reported ERLP in the past year. There was a significant difference ($p = .024$) in average training mileage compar-

ing those who had and had not reported ERLP in the three months preceding the race, with the group who had reported ERLP training fewer miles (mean = 22.3) than those without ERLP (mean = 26.0). There were no significant differences in age, BMI, years running, race pace, average days running /week, and average days cross training/week. (Table 1).

Chi square analyses showed no significant association of sex, menstrual function, orthotic use, or categorical BMI with ERLP occurrence. Significant associations were observed between a history of ERLP and an occurrence of ERLP in the past year ($p = 0.000$). Runners with a history of ERLP were at significantly greater risk for an occurrence of ERLP in the past year (RR = 3.39; 2.54-4.52 95% CI). There was also a significant association between ERLP in the 3 months preceding the race and categorical variables of years running ($p = 0.024$) and average training mileage ($p = .041$). Those runners with less than 3 years experience had greater ERLP occurrence than those who ran for 3 years or more (RR = 1.53; 1.08-2.17 95% CI). Those runners who ran fewer than 15 miles/week had greater ERLP occurrence than those who ran 15 miles/week or greater (RR = 1.47; 1.04-2.08 95% CI). Those runners with less than 3 years running experience and an expected race pace of 9 min/mile or slower were at greater risk for ERLP when compared to all other participants (RR = 1.53; 1.07-2.18 95% CI). Additionally, those runners with less than 3 years running experience and an expected race pace of 9 min/mile or slower were at greater risk for ERLP compared to those runners who had run 3 years or more and had an expected race pace of less than 9 min/mile (RR = 1.73; 1.02-2.90 95% CI). Runners with less experience and slower pace also trained signifi-

Table 1. Characteristics of Subjects by ERLP Occurrence During 3 Months Preceding Race*

	ERLP	No ERLP
Age	37.8 (10.6)	40.5 (11.2)
BMI	23.1 (2.9)	23.8 (3.4)
Years Running	7.5 (8.8)	8.9 (9.9)
Average Training Mileage*	22.3 (9.6)	26.0 (12.6)
Race Pace	9.8 (1.4)	9.6 (1.6)
Running Days/Week	4.0 (0.9)	4.1 (1.1)
Cross Training Days/Week	2.3 (1.3)	2.2 (1.2)
* $p = .024$		

cantly fewer miles/week (17 vs. 27, $p=0.000$). Contingency tables, relative risk values, chi-square, and associated p values are provided Table 2.

Of the 225 participants who completed the first questionnaire, 127 (59 males, 68 females) completed the two-week questionnaire. ICC values ranged from .89-.99 for continuous items. For the dichotomous items, Kappa values ranged from .41 to 1.0 with 81% of the values .60 or greater. Percent agreement for these same items ranged from .70-1.0 with 85% of the values at 80% agreement or greater. Reliability ranges are reported by question category in Table 3.

DISCUSSION

The first purpose of this study was to report the occurrence of ERLP among a group of adult community runners. Approximately two-thirds of the 225 runners reported a history of ERLP at some time in their running career, and 50% reported an occurrence of ERLP within the previous year. These data support the contention that ERLP is a “common” condition in running athletes.^{4,26} It is problematic to compare the occurrence data in this study with other studies of overuse injuries in community runners because of 1) the definition of injury, 2) the diagnostic classification used for injuries, and 3) the

Table 2. Number of Community Runners, Relative Risk (RR) Values and 95% Confidence Intervals (CI) for Proposed Risk Factors

ERLP History				
	Number of Runners with ERLP	Number of Runners with No ERLP	RR (95% CI)	Chi-Square (p value)
ERLP Occurrence in the Last Year				
Yes	110	1	3.39 (2.54-4.52)	118.5 $p = .000$
No	33	80		
ERLP History 3 Months Preceding the Race				
	Number of Runners with ERLP	Number of Runners with No ERLP	RR (95% CI)	Chi-Square (p value)
Running Experience				
< 3 years*	32	37	1.53 (1.08-2.17)	5.39 $p = .024$
≥ 3 years	47	108		
Training Mileage				
< 15 miles/week*	35	44	1.47 (1.04-2.08)	4.52 $p = .041$
≥ 15 miles/week	44	102		
Running Experience and Race Pace				
< 3 years and ≥ 9 min/mile*	27	30	1.53 (1.07-2.18)	5.03 $p = .036$
All Other Participants	52	116		
Running Experience and Race Pace				
< 3 years and ≥ 9 min/mile*	27	30	1.73 (1.02-2.90)	4.53 $p = .047$
> 3 years and < 9 min/mile	14	37		
ERLP = exercise related leg pain *Referent Group				

Table 3. Reliability Ranges By Question Category

	ICC	Kappa	% Agreement
Demographics	.99	NA	NA
Training History	.89-.97	.45-.81	90.0-93.1
ERLP History	NA	.44-1.0	77.8-100.0
Orthotic Use	NA	.54-1.0	70.0-100.0
Menstrual History (women only)	.95	.41-1.0	84.6-100.0

population studied. For example, Buist et al⁸ defined a running related injury (RRI) as “any musculoskeletal pain of the lower limb causing a restriction in running (mileage, pace, duration) for at least 1 day.” These authors reported that the lower leg was the most common site of injury among a group of 629 community runners who had signed up for an 8-week running training program. 67 of the 629 runners (10.6%) reported a RRI in the “lower leg” (calf and shin) which restricted their running for at least 1 day. The authors of the current study found that during the 3 months preceding the race, 79 of the 225 runners (35.1%) reported an episode of ERLP, and 33 of the 79 runners (41.2%) reported that the ERLP caused them to decrease training mileage or stop training altogether. In other studies of community runners, either the injuries were not reported by site or diagnosis,² or only injured runners presenting to a clinic were studied.^{6,7}

A second purpose of this study was to determine the impact of ERLP on daily activities, specifically walking and/or stair climbing. In the 79 runners that had experienced ERLP in the 3 months preceding the community race, 40% reported a period where they either reduced or ceased running training as a result of ERLP, and in a small cadre of runners (8-10%), ERLP interfered with their daily activities specifically walking and/or stair climbing. No previous study has examined the effect of ERLP on daily activities in community runners, and although the numbers of runners with daily activity limitations in this study is small (< 10%), when one considers the worldwide population of community runners, the number of individuals limiting daily activities as a result of ERLP may be substantial.

Based on the current results indicating that a significant proportion of runners with ERLP are restricting their running training as a result of ERLP and some are even limiting walking and/or stair climbing, the need for better understanding of and attention to overuse injury in this region and population is warranted. The well-documented health benefits of running and walking and the associated potential to reduce the burden of chronic disease on society are compelling reasons to keep individuals active in their selected recreational pursuits including walking and running.

The third purpose of this study was to determine if there is a relationship between occurrence of ERLP and selected potential risk factors. A significant association between sex or categorical BMI and the occurrence of ERLP was not identified in this population. This finding is in contrast with other investigators who have reported that a risk factor for ERLP include being female¹⁵⁻¹⁷ and either high or low BMI.¹⁶ One difference that may account for the conflicting results is the population studied. Both the Bennett et al study¹⁵ and the Rauh et al study¹⁷ were of high school cross country runners, and the Neely study¹⁶ was a narrative review of exercise-related overuse injury in primarily military populations.

The authors found that a history of ERLP was highly associated with a recurrence of ERLP. This is consistent with the findings of other injury risk studies in community runners.¹²⁻¹⁴ This has also been consistently shown in studies of ERLP in high school and collegiate runners.²⁷⁻²⁹ In fact, history of ERLP is one of very few factors that has been consistently shown to be a risk factor for occurrence of ERLP across populations.

There were significant associations between both years running and training mileage and ERLP occurrence. Runners with less than 3 years experience had greater ERLP occurrence than those who ran 3 years or more. This finding is in agreement with two other studies which reported novice runners were at higher risk of overuse injury.^{8,13} Macera et al¹³ also found that less than 3 years running experience was a risk factor for a running related injury. The current results indicated that those runners who ran fewer than 15 miles/week also had greater ERLP occurrence, however, greater training distance was not found to be a risk factor for ERLP. This is in contrast to several other studies that have shown a positive association between greater training distance and running related injury.^{12,13}

Overall, the results indicate that slower novice runners who trained fewer miles/week were the population at greatest risk for ERLP. Specifically, those runners with less than 3 years running experience and an expected race pace of 9 min/mile or slower were at greater risk for ERLP compared to those runners who had run 3 years or more and had an expected race pace of less than 9 min/mile. These findings are consistent with Buist et al⁸ who found

that “novice runners” were most at risk of running-related injury. In his narrative review of running injury epidemiology, van Mechelen³⁰ concluded that running experience may result in fewer running related injuries as a result of tissue adaptation, or this may be a result of a natural selection of less injury prone runners over time.¹¹

There are several limitations of this study which may influence the generalizability of the current findings. First, recruitment of subjects was done at the time of race packet pick-up, and involved personal invitations to runners to participate. The motivation of persons which caused them to participate or not participate is unknown. It may be that athletes who had experienced ERLP were more likely to volunteer than those unaffected by this pain syndrome, thus the reader should use caution with generalizing the results of the study. Second, this study relied on self-report of ERLP without specific medical diagnoses. The current study focus was on the experience of ERLP in community runners and the effect of ERLP on training and daily activities rather than the effect of specific diagnoses. Third, the ERLP definition used in the current study was “pain below the knee and above the ankle associated with exercise.” While this was explained to participating runners, pictures were provided which outlined the pain zones, and any questions were answered, the authors acknowledge that the runners’ self-report was based on their interpretation of and experience with ERLP. Fourth, this study was a cross section of community runners in one Midwestern metropolitan area and is not necessarily generalizable to other geographical regions. Fifth, as the athletes recruited for this study participated in the race, there is a possibility that the prevalence of ERLP in runners is higher than reported as runners who registered but did not participate in the race did not participate. These runners may have been injured. Finally, the authors recognize the multifactorial nature of running injuries and other potential risk factors including running form, flexibility, and strength that were not examined in the current study.

CONCLUSION

ERLP was commonly reported among this group of community runners registered for a local community

road race event as over 50% had experienced at least one episode of ERLP in the past year. The most common presentation of ERLP was bilateral medial pain. Of those experiencing an episode of ERLP in the 3 months preceding the race, 40% reported it interfered with running, and in less than 10%, it interfered with walking and stair climbing. Age, sex, and BMI were not associated with a history of ERLP. The risk factors for the occurrence of ERLP identified in this study included a history of ERLP, training mileage less than 15 miles/week, and less than 3 years running experience. Further investigation is warranted to identify factors which may singularly or in combination increase a community runner’s risk of developing ERLP.

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