

THE STUDY OF PREVALENCE, MANAGEMENT AND OUTCOME OF MUSCULOSKELETAL INJURIES IN RUNNERS: A COMPREHENSIVE SYSTEMATIC REVIEW

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ABSTRACT

Background: Running's popularity has surged globally, doubling in the last decade, due to its accessibility and health benefits. However, it carries a high injury risk, especially in lower extremities, with rates varying by distance. Understanding injury prevalence and risk factors is essential. This study aims to serve a comprehensive systematic review to analyze the prevalence, management and outcome of musculoskeletal injuries in runners based on literatures of the last 10 years.

Methods: The review adhered to PRISMA 2020 standards and analyzed full-text English literature from 2014 to 2024. It excluded editorials, review papers from the same journal, and submissions lacking a DOI. Literature sources included PubMed, SagePub, SpringerLink, and Google Scholar.

Result: A total of 655 articles were retrieved from online databases (PubMed, SagePub, SpringerLink and Google Scholar). After three rounds of screening, ten articles directly relevant to the systematic review were selected for full-text reading and analysis.

Conclusion: Musculoskeletal injuries in runners are common. Tailored interventions like gait retraining and targeted exercises can reduce their incidence and severity. Further research is needed to assess long-term effects and develop standardized prevention and management protocols for diverse running populations.

Keyword: Running-related injury, musculoskeletal injuries, risk factors, rehabilitation

INTRODUCTION

Running has become increasingly popular globally over the past 50 years due to its low cost and minimal equipment requirements. In the past decade, the number of runners has doubled and continues to grow. Running benefits the entire body by improving endurance, reducing the risk of cardiovascular diseases, and aiding in weight loss. However, it also carries a high risk of injuries, particularly in the lower extremities. Around 80% of running-related musculoskeletal injuries (RRMIs) were caused from overload. Tendons and ligaments are especially vulnerable due to their slow adaptation to increased training loads.^{1,2}

The incidence of RRMIs varies significantly due to differing injury definitions and running types. Runners face a high risk of injury, with rates between 7.7 to 17.8 per 1000 hours of running. Injury rates also differ based on running distance: short-distance runners (up to 15 km) have an incidence of 14.3% to 44.7%, while long-distance runners (half-marathons or marathons) experience higher rates, ranging from 16.7% to 79.3%.³

Incidence measures new injury cases and is found in prospective studies, while prevalence measures how widespread injuries are and is found in retrospective studies. Approximately 50% of runners experience an injury annually, and 25% are injured at any given time, with overuse injuries being most common, particularly in the knee, ankle/foot, and shank.⁴ There is debate over the prevalence of specific injuries like patellofemoral pain syndrome and medial tibial stress syndrome. Acute injuries like ankle sprains also show conflicting prevalence data across studies.^{5,6}

Previous studies have shown that risk factors for RRMIs vary across different populations of runners. Inexperienced runners are twice as likely to get injured compared to experienced runners, and men and women have different risk profiles. Risk factors also differ between short-distance and long-distance runners. Short-distance runners are at higher risk if they have a BMI over 30, are aged 45-65, exhibit non-competitive behaviors, or have had a previous injury. Conversely, long-distance runners are at higher risk with a BMI over 26 and a history of previous injuries, but factors such as older age, interval training, and higher weekly training mileage are protective. Given these variations, it is hypothesized that the risk factors for RRMIs will differ between short- and long-distance runners.⁷⁻⁹

RRMIs can lead to significant consequences, including financial costs and disruptions to exercise and work. Understanding common RRMIs is crucial for developing effective prevention and rehabilitation programs. This study aims to serve a comprehensive systematic review to analyze the prevalence, management and outcome of musculoskeletal injuries in runners based on literatures of the last 10 years.

METHODS

Protocol

The author carefully followed the rules laid out in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020. This was done to make sure the study met all its standards. The selection of this methodological approach was specifically aimed at ensuring the precision and reliability of the conclusions drawn from the investigation.

CRITERIA FOR ELIGIBILITY

This systematic review analyze the prevalence, management and outcome of musculoskeletal injuries in runners based on literatures of the last 10 years. This study meticulously analyzed data on literatures to provide insights and enhance patient treatment strategies. The primary objective of this paper is to highlight the collective significance of the identified key points.

Inclusion criteria for this study entail: 1) Papers must be in English, and 2) Papers must have been published between 2014 and 2024. Exclusion criteria comprise: 1) Editorials; 2) Submissions without a DOI; 3) Previously published review articles; and 4) Duplicate entries in journals.

SEARCH STRATEGY

The keywords used for this research are “running-related injury”, “musculoskeletal injuries”, “risk factors”, and “rehabilitation”. The Boolean MeSH keywords inputted on databases for this research are: (*"running-related"*[All Fields] AND (*"injury"*[All Fields] OR *"injured"*[All Fields] OR *"injuries"*[MeSH Subheading] OR *"injuries"*[All Fields] OR *"wounds and injuries"*[MeSH Terms] OR (*"wounds"*[All Fields] AND *"injuries"*[All Fields])) OR *"wounds and injuries"*[All Fields] OR *"injurious"*[All Fields] OR *"injury s"*[All Fields] OR *"injured"*[All Fields] OR *"injuries"*[All Fields] OR *"injury"*[All Fields]) AND (*"musculoskeletal"*[All Fields] AND (*"injury"*[All Fields] OR *"injured"*[All Fields] OR *"injuries"*[MeSH Subheading] OR *"injuries"*[All Fields] OR *"wounds and injuries"*[MeSH Terms] OR (*"wounds"*[All Fields] AND *"injuries"*[All Fields]) OR *"wounds and injuries"*[All Fields] OR *"injurious"*[All Fields] OR *"injury s"*[All Fields] OR *"injured"*[All Fields] OR *"injuries"*[All Fields] OR *"injury"*[All Fields])) AND (*"risk factors"*[MeSH Terms] OR (*"risk"*[All Fields] AND *"factors"*[All Fields]) OR *"risk factors"*[All Fields])) OR (*"rehabilitant"*[All Fields] OR *"rehabilitants"*[All Fields] OR *"rehabilitate"*[All Fields] OR *"rehabilitated"*[All Fields] OR *"rehabilitates"*[All Fields] OR *"rehabilitating"*[All Fields] OR *"rehabilitation"*[MeSH Terms] OR *"rehabilitation"*[All

Fields] OR "rehabilitations"[All Fields] OR "rehabilitative"[All Fields] OR "rehabilitation"[MeSH Subheading] OR "rehabilitation s"[All Fields] OR "rehabilitational"[All Fields] OR "rehabilitator"[All Fields] OR "rehabilitators"[All Fields])) AND (y_10[Filter])

DATA RETRIEVAL

The authors assessed the studies by reviewing their abstracts and titles to determine their eligibility, selecting relevant ones based on their adherence to the inclusion criteria, which aligned with the article's objectives. A consistent trend observed across multiple studies led to a conclusive result. The chosen submissions had to meet the eligibility criteria of being in English and a full-text.

This systematic review exclusively incorporated literature that met all predefined inclusion criteria and directly pertained to the investigated topic. Studies failing to meet these criteria were systematically excluded, and their findings were not considered. Subsequent analysis examined various details uncovered during the research process, including titles, authors, publication dates, locations, study methodologies, and parameters.

QUALITY ASSESSMENT AND DATA SYNTHESIS

Each author independently evaluated the research presented in the title and abstract of the publication to determine which ones merited further exploration. The subsequent stage involved assessing all articles that met the predefined criteria for inclusion in the review. Decisions on including articles in the review were based on the findings uncovered during this evaluation process.

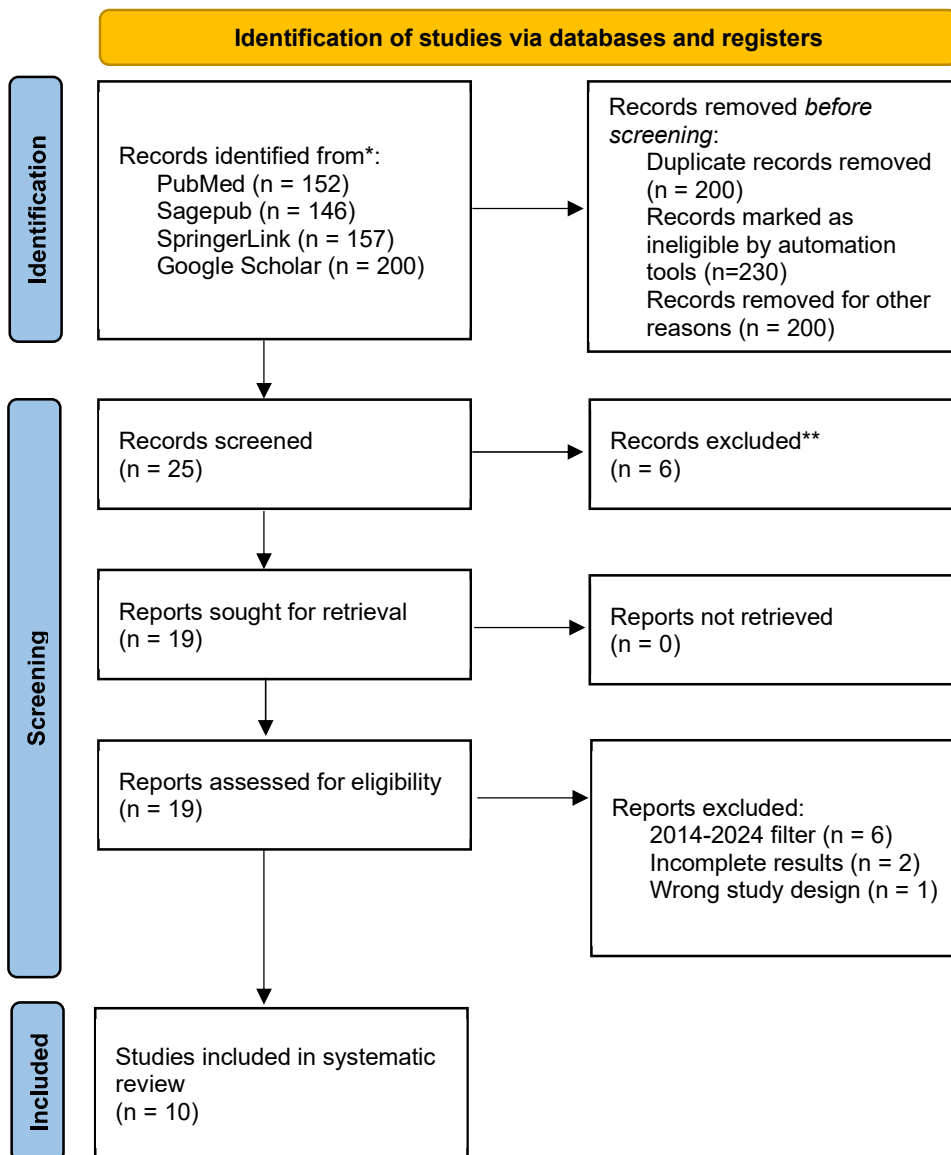


Figure 1. Article search flowchart

RESULT

The initial number of articles retrieved from online databases (PubMed, SagePub, SpringerLink, and Google Scholar) is 655 articles. After conducting three levels of screening, ten articles that directly relate to the current systematic review have been chosen for further assessment through full-text reading and analysis. Table 1 presents the selected literature included in this analysis.

Table 1. The literature included in this study

No.	Author	Origin	Method	Sample	Result
1.	Begizew, et al. ¹⁰ (2019)	Ethiopia	Prospective study	229 male and female 10,000-meter long-distance runners	The incidence of running-related injuries was found to be 62.4%, with 0.35 injuries per 100 running hours or 3.54 injuries per 1000 running hours. The knee was the most commonly injured anatomical site (33.6%), with strains being the most common type of injury (36.4%). Participants with previous injuries had significantly higher odds of injury (OR = 8.20, CI = 2.14-31.40). Conversely, runners who trained 40-50 km and 50-60 km per week had significantly lower odds of injury, as did those who wore running shoes for eight to eleven months.
2.	Fokkema, et al. ¹¹ (2019)	Netherlands	Prospective cohort study	347 novice runners	Results showed that 347 participants (48.8%) experienced a running-related injuries (RRI) during follow-up, with a median duration of eight weeks. Participants with previous RRIs were more likely to have a poor prognosis, while calf injuries showed a trend towards a relatively good prognosis.
3.	Franke, et al. ¹² (2019)	Netherlands	Prospective cohort study	161 runners	Of the 161 runners included in the study, 9 out of 10 reported experiencing a running-related injury (RRI) or illness symptom during the study period. Over any 2-week period, between 5.6% and 14.8% of runners reported new RRIs, and

					6.3% to 13.8% reported new illness symptoms. The prevalence of RRIs ranged from 29.2% to 43.5%, while illness symptoms ranged from 28.3% to 71.2%. The most prevalent RRIs were in the lower leg and knee, while common illness symptoms included rhinorrhea/sneezing and coughing. Incidence and prevalence of illness symptoms peaked during the influenza-like illness epidemic of the winter of 2015–2016.
4.	Kluitenberg, et al. ¹³ (2015)	Netherlands	Prospective cohort study	1,696 runners	Participants completed a baseline questionnaire covering potential risk factors and kept running diaries. RRIs were recorded if they hindered running for three consecutive sessions. Results showed that 10.9% of runners experienced RRIs during the program. Multivariable analysis revealed that higher age, BMI, previous musculoskeletal complaints unrelated to sports, and lack of running experience were associated with RRIs.
5.	Hsu, et al. ¹⁴ (2020)	Taiwan	Retrospective cross sectional study	718 runners	The study found that after the marathon, injuries on the lower extremities were most commonly reported in the knees (28%), posterior calves (20%), thighs (13%), ankles (10%), and feet (8%). Male athletes had a higher risk of thigh injury compared to female athletes, and underweight runners were more prone to thigh injuries.
6.	González-Lázaro, et al. ¹⁵ (2021)	Spain	Retrospective study	6167 mountain runners	Results showed 28 injuries, with most occurring in the ankle (32%), followed by the

					knee (14%) and foot/toe (11%). The overall injury rate was 1.6 injuries per 1000 hours of running and 5.9 injuries per 1000 runners, with no fatalities reported.
7.	Lieberthal, et al. ¹⁶ (2019)	Australia	Cross-sectional study	37 male runners with no history of achilles tendon pain	Results showed that 46% of these asymptomatic runners had at least one abnormal tendon. Those with tendon pathology had significantly more years of running training (median 20 years) compared to those without pathology (median 7 years). No other significant differences were found between the groups.
8.	Bonacci, et al. ¹⁷ (2018)	Australia	Randomised clinical trial	16 participants	Results at 12 weeks showed a substantial improvement in the gait retraining group compared to the foot orthoses group. The anterior knee pain scale scores and reports of worst pain in the past week indicated a significant between-group difference favoring the gait retraining intervention. The number needed-to-treat was calculated as 2, suggesting that for every two patients treated with gait retraining, one would benefit significantly compared to foot orthoses.
9.	Pollock, et al. ¹⁸ (2022)	United Kingdom	Prospective study	46 athletes	The study analyzed 70 hamstring injuries in 46 athletes (24 women and 22 men, average age 24.6 years). BAMIC grade and intratendon classifications were found to correlate with increased TRFT. The mean TRFT for the entire cohort was 18.6 days. For intratendon classifications, the mean TRFT was 34 days for 2c injuries and 48 days

					for 3c injuries. The overall reinjury rate was low at 2.9%, with no reinjuries reported in the intratendon classifications. Key MRI variables such as the length and cross-sectional area (CSA) of muscle edema, CSA of tendon injury, and loss of tendon tension were associated with longer TRFT. The longitudinal length of tendon injury within the intratendon classes did not affect TRFT.
10.	McKay, et al. ¹⁹ (2020)	Italy	Retrospective study	24 female runners	Twenty-four female runners (aged 19–45) participated in the study. Significant improvements ($p < 0.05$) within group C were observed for the composite YBT and DN for both injured and non-injured legs, YBT (injured leg posterior medial), LEFS, NPRS, and SLMS. Additionally, significant differences ($p < 0.05$) were found between group A and group C, with the stretching group showing significant YBT anterior reach improvements for both legs and the LEFS.

Begizew, et al.¹⁰ (2019) highlighted the need for runners, coaches, and medical professionals to recognize specific risk factors for running-related injuries and underscores the importance of interventions to prevent injuries among Ethiopian long-distance runners.

Fokkema, et al.¹¹ (2019) concluded that RRIs in novice runners tend to have relatively long durations, with only calf injuries associated with a good prognosis. This highlights the importance of injury prevention measures and adequate support during and after an RRI, particularly for runners with a history of injury.

Franke, et al.¹² (2019) showed that The most prevalent RRIs were in the lower leg and knee, while common illness symptoms included rhinorrhea/sneezing and coughing. Incidence and prevalence of illness symptoms peaked during the influenza-like illness epidemic of the winter of 2015–2016. A high proportion of runners reported RRIs or illness symptoms leading up to a half or full marathon, with a significant number experiencing new symptoms over short time periods.

Kluitenberg, et al.¹³ (2015) found that many novice runners participating in a short-term running program suffer from RRIs. Higher age, BMI, previous musculoskeletal complaints unrelated to sports, and lack of running experience were associated with RRIs. These findings underscore the importance of considering identified risk factors for screening and prevention efforts in RRIs.

Hsu, et al.¹⁴ (2020) found that the rates of knee, calf, thigh, and foot injuries were significantly increased in the Taroko Gorge Marathon. Male athletes had a higher risk of thigh injury compared to female athletes, and underweight runners were more prone to thigh injuries.

González-Lázaro, et al.¹⁵ (2021) found that musculoskeletal injury incidence during these races is low, with most injuries being minor and affecting lower extremities, particularly ankles.

Lieberthal, et al.¹⁶ (2019) showed that there is a high prevalence of Achilles tendon pathology among asymptomatic male runners, with years of running being a significant associated factor. Clinicians should consider running history when evaluating Achilles tendon ultrasound findings.

Bonacci, et al.¹⁷ (2018) demonstrated the feasibility of a larger trial comparing gait retraining with foot orthoses for runners with patellofemoral pain. The findings provided preliminary evidence that a 6-week gait retraining program can have a clinically meaningful impact on reducing pain in this population, potentially offering a more effective treatment alternative to foot orthoses.

Pollock, et al.¹⁸ (2022) showed that the implementation of BAGIC in British Athletics hamstring rehabilitation results in low reinjury rates and favorable recovery times. Important MRI variables linked to extended recovery include the length and CSA of muscle edema, CSA of tendon injury, and loss of tendon tension.

McKay, et al.¹⁹ (2020) concluded that Iliotibial Band Syndrome (ITBS) is a specific type of RRI that affects runners. The group undergoing experimental hip strengthening exercises showed consistent improvements across all outcome measures and never scored lower than the other two groups.

DISCUSSION

Musculoskeletal injuries (MSK-I) are a common issue among runners, with several studies indicating high incidence rates across different types of running and levels of experience. For instance, Begizew et al. (2019) found a 62.4% incidence rate of running-related injuries (RRIs) among Ethiopian long-distance runners, with 33.6% of these injuries occurring in the knee. Similarly, Fokkema et al. (2019) reported that nearly half (48.8%) of novice runners experienced RRIs, primarily affecting the lower leg and knee, echoing findings by Franke et al. (2019) and Hsu et al. (2020), who observed significant injury rates in these regions. These studies highlight the lower extremities, particularly the knee, as the most vulnerable areas for runners.^{10-12,14}

The outcomes of MSK-I in runners are influenced by various factors, including the type and severity of the injury, the intervention method, and the runner's history of previous injuries. For example, Pollock et al. (2022) showed that using the British Athletics Muscle Injury Classification (BAGIC) for hamstring injuries resulted in low reinjury rates and favorable recovery times, particularly when MRI variables such as muscle edema and tendon injury were considered.¹⁸

The findings from these studies underscore the need for targeted prevention and management strategies for RRIs. Coaches, medical professionals, and runners themselves must recognize specific risk factors such as age, BMI, and running history to tailor interventions effectively. For example, runners with a history of injuries may benefit from more intensive rehabilitation and support programs, while novice runners might require more structured training plans to build resilience and reduce injury risk. Moreover, the effectiveness of gait retraining and hip strengthening exercises suggests that biomechanical adjustments can play a significant role in managing and preventing RRIs. As such, incorporating these strategies into regular training and rehabilitation protocols could help mitigate the high prevalence of injuries observed across different running populations.¹⁷

The management of RRIs varies widely, with studies examining different approaches to prevention and treatment. Bonacci et al. (2018) explored the effectiveness of a 6-week gait retraining program versus foot orthoses for runners with patellofemoral pain, finding that gait retraining had a significant positive impact on reducing pain. This suggests that targeted gait modifications can be an effective treatment strategy. Additionally, McKay et al. (2020) evaluated various exercise programs for Iliotibial Band Syndrome (ITBS), concluding that experimental hip strengthening exercises yielded the most consistent improvements in outcomes.^{17,19}

On the other hand, Kluitenberg et al. (2015) and Hsu et al. (2020) emphasized the importance of addressing risk factors such as higher age, BMI, and lack of running experience. These studies suggest that personalized training regimens and preventive measures, including proper footwear and moderated training distances, are crucial for reducing injury risk.^{13,14}

In terms of prognosis, Fokkema et al. (2019) noted that previous RRIs were linked to poorer outcomes, highlighting the importance of comprehensive rehabilitation and support for injured runners. Conversely, González-Lázaro et al. (2021)

found that while the incidence of injuries in mountain running races was relatively low, the majority were minor, with the ankle being the most commonly affected site.^{11,15}

CONCLUSION

Musculoskeletal injuries in runners are prevalent and present significant challenges in terms of management and outcomes. Understanding the specific risk factors and adopting tailored intervention strategies, such as gait retraining and targeted strengthening exercises, can significantly reduce the incidence and severity of these injuries. Further research is needed to explore the long-term effects of these interventions and to develop standardized protocols for preventing and managing RRIs in diverse running populations.

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