ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/274091656

Definitions Used To Define A Running-Related Musculoskeletal Injury: A Systematic Review.

Article · March 2015

DOI: 10.2519/jospt.2015.5750 · Source: PubMed

CITATIONS
10

READS
279

5 authors, including:

Bruno Tirotti Saragiotto
University of Newcastle
59 PUBLICATIONS **218** CITATIONS
SEE PROFILE

Luiz Carlos Hespanhol Junior
Universidade Cidade de São Paulo
41 PUBLICATIONS **392** CITATIONS
SEE PROFILE

Simon S Yeung
The Hong Kong Polytechnic University
55 PUBLICATIONS **1,227** CITATIONS
SEE PROFILE

Alexandre Dias Lopes
University of Massachusetts Lowell
60 PUBLICATIONS **520** CITATIONS
SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Kinesio Taping to generate skin convolutions is not better than sham taping for people with chronic non-specific low back pain: a randomised trial View project

All content following this page was uploaded by Alexandre Dias Lopes on 04 May 2015.

The user has requested enhancement of the downloaded file.

TIÊ PARMA YAMATO, PT, MSc[1,2] • **BRUNO TIROTTI SARAGIOTTO,** PT, MSc[1,2]
LUIZ CARLOS HESPANHOL JUNIOR, PT, MSc[1,4] • **SIMON S. YEUNG,** PhD[5] • **ALEXANDRE DIAS LOPES,** PT, PhD[1]

Descriptors Used to Define Running-Related Musculoskeletal Injury: A Systematic Review

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

STUDY DESIGN: Systematic review.

OBJECTIVES: To systematically review the descriptors used to define running-related musculoskeletal injury and to analyze the implications of different definitions on the results of studies.

BACKGROUND: Studies have developed their own definitions of running-related musculoskeletal injuries based on different criteria. This may affect the rates of injury, which can be overestimated or underestimated due to the lack of a standard definition.

METHODS: Searches were conducted in the Embase, PubMed, CINAHL, SPORTDiscus, LILACS, and SciELO databases, without limits on date of publication and language. Only articles that reported a definition of running-related injury were included. The definitions were classified according to 3 domains and subcategories: (1) presence of physical complaint (symptom, body system involved, region), (2) interruption of training or competition (primary sports involved, extent of injury, extent of limitation, interruption, period of injury), and (3) need for medical assistance. Spearman rank correlation was performed to evaluate the correlation between the completeness of definitions and the rates of injury reported in the studies.

RESULTS: A total of 48 articles were included. Most studies described more than half of the subcategories, but with no standardization between the terms used within each category, showing that there is no consensus for a definition. The injury rates ranged between 3% and 85%, and tended to increase with less specific definitions.

CONCLUSION: The descriptors commonly used by researchers to define a running-related injury vary between studies and may affect the rates of injuries. The lack of a standardized definition hinders comparison between studies and rates of injuries. *J Orthop Sports Phys Ther 2015;45(5):366-374. Epub 26 Mar 2015. doi:10.2519/jospt.2015.5750*

KEY WORDS: *jogging, lower extremity, sports, terminology*

Running is one of the most popular physical activities worldwide.[15,65,72] Due to the various health benefits and low cost of running, the number of participants has gradually increased over the last few decades.[47,61] However, running injuries should not be taken lightly. The prevalence and incidence of running injuries have been reported at a wide variety of rates, depending on the injury and runner population studied.[23,58,61,62,69]

A sizable number of studies related to running have provided definitions of running-related musculoskeletal injuries (RRMIs) based on different criteria. Rates of injury could be overestimated or underestimated due to the use of different definitions. Examples of the influence of injury definition on the studies' results can be observed in some studies.[23,61,62,69] For instance, Bovens et al[3] used a broad definition of RRMI as "any physical complaint developed in relation with running activities and causing restriction in running distance, speed, duration or frequency," and found an incidence rate of 84.9%. On the other hand, Blair et al[2] only considered RRMI to be "an injury that cause[s] the runners to stop running for at least seven days," which lowered the incidence rate to 24%. This second definition is certainly more stringent than the first one, which does not specify the period of restriction or time off from running. Thus, the lack of a standard definition of running injury hinders comparisons between studies.[62] The fact that there is no universal definition of RRMI means that it is highly problematic to determine the true burden of injury in this population. As a result, statistical data from the different studies cannot

[1]Sao Paulo Running Injury Group (SPRunIG), Masters and Doctoral Program in Physical Therapy, Universidade Cidade de Sao Paulo, Brazil. [2]The George Institute for Global Health, Sydney Medical School, The University of Sydney, Sydney, Australia. [3]Department of Public & Occupational Health and EMGO+ Institute for Health and Care Research, VU University Medical Center, Amsterdam, the Netherlands. [4]Department of Rehabilitation Sciences, Hong Kong Polytechnic University, Hong Kong, China. Luiz Carlos Hespanhol Junior and Tiê Parma Yamato are supported by CAPES (Coordination for the Improvement of Higher Education Personnel), process number 0763/12-8 and 9574/13-1, respectively, Ministry of Education of Brazil. Bruno Tirotti Saragiotto is supported by CNPq (National Council of Technological and Scientific Development), process number 203148/2013-4, Ministry of Science and Technology of Brazil. The authors certify that they have no affiliations with or financial involvement in any organization or entity with a direct financial interest in the subject matter or materials discussed in the article. Address correspondence to Tiê Parma Yamato, The George Institute for Global Health, Level 13, 321 Kent Street, Sydney, NSW 2000 Australia. E-mail: tiparma@gmail.com Copyright ©2015 *Journal of Orthopaedic & Sports Physical Therapy®*

TABLE 1 Categories and Subcategories Created to Describe Running-Related Musculoskeletal Injury

Category/Subcategory	Description
Presence of physical complaint	
Symptom	Related to the key word in the beginning of the definition that was used to describe the injury itself
Body system	Referred to the injured system of the body for the authors to consider an RRMI
Region	Related to the area of the body that the authors described to consider their definition of RRMI
Need to interrupt training/competition	
Primary sports involved	Related to the moment that the injury occurred or the type of activity involved at the time of injury
Extent of injury	Related to the results of the RRMI to the runner
Extent of limitation	Referred to which factor was affected by the injury (associated with the extent of injury)
Interruption	Related to the time off considered by the authors for an RRMI
Description of the period of injury	Referred to the time considered by the authors to determine the occurrence of an injury
Seeking medical assistance (no subcategory)	...

Abbreviation: RRMI, running-related musculoskeletal injury.

be meaningfully compared in order to determine the variation in the incidence of RRMI.

Sports such as cricket, tennis, rugby, and soccer have their consensus definitions, and some studies have pointed out the importance of standardization in identifying the risk factors and incidence of injuries, as well as in the implementation of effective prevention programs.[17-19,23,45,49,55,61] While many researchers have suggested the need for a standard definition of RRMI,[43,54,61] no consensus has been reached so far. Thus, investigators[23,39,65] frequently define running injuries according to 3 main domains—(1) the presence of physical complaint, (2) the need to interrupt routine training and/or competition, and (3) seeking medical assistance—or just 1 or 2 of these domains.[1]

Therefore, the aim of this study was to conduct a systematic review of the literature on the descriptors used to define RRMI and to analyze the implications of different definitions on the rates of injury found in these studies. We believe that this is a first step to establishing a consensus definition of RRMI.

METHODS

Eligibility Criteria and Review Process

Searches were conducted in the databases Embase (1980 to July 2013), PubMed (1946 to July 2013), CINAHL (1988 to July 2013), SPORTDiscus (1977 to July 2013), LILACS (1985 to July 2013), and SciELO (1998 to July 2013), with no limits on date of publication or language, using subject headings, synonyms, relevant terms, and variant spellings for each database (see **APPENDIX A** for the full search strategy for Embase, available online at www.jospt.org). Only articles that gave a definition of musculoskeletal injury related to the runner population were included. Articles considered for inclusion were analyzed in 2 phases, first the title and abstract and second the full text. In the first phase, articles were excluded if the title and abstract did not mention the runner population or running itself. In the second phase, articles were excluded if the full text did not provide a definition of RRMI. In each of these phases, 2 independent reviewers (T.P.Y. and B.T.S.) conducted the assessments. If they did not reach a consensus, a third reviewer (A.D.L.) helped to decide whether the article should be included. This review was conducted in accordance with the PRISMA statement.

Data Collection and Methodological Quality

The following data were extracted from the articles that were selected for this review: first author's name, year of publication, study design, type of runner assessed, sample size, and the definition of RRMI. Two independent reviewers performed the data extraction and methodological quality assessment, and a third reviewer helped to reach a consensus when necessary. The methodological quality of the articles related to the definitions of RRMI was assessed by 4 criteria, which were based on previous studies[36,61] and adapted for the current review, there being no valid scale or criteria to assess methodological quality across the different study designs of the included studies: (1) description of the inclusion criteria for the study participants, (2) definition of the type of runner being studied, (3) same method of RRMI data collection for all runners, and (4) data collected directly from the participants or by health professionals. The criteria used to assess the methodological quality of the included studies are described in detail in **APPENDIX B** (available online at www.jospt.org). The assessment of the methodological quality of the articles related to the definitions of RRMI was calculated by adding the score of the 4 items, which were assigned 1 for "yes" and 0 for "no" answers, for a maximum possible score of 4.

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

Data Analysis

We reported the data from the definitions of RRMI and injury rates of the studies descriptively. To analyze the structure of the definitions of RRMI in each article, the definitions were divided according to their similarities and characteristics. As suggested by previous studies, definitions related to sports injuries tend to be based on 3 main domains: (1) presence of physical complaint, (2) interruption of training and/or competition, and (3) seeking medical assistance.[1,13,17] To be more precise in dividing the definitions, we clustered them into similar subcategories within the 3 main domains, as shown in **TABLE 1**. We created these subcategories to organize and understand the structure of the definitions regarding each main domain.

For the secondary aim of this study, a Spearman rank correlation was performed to examine the correlation between the rates of injury and the completeness of the definitions. A correlation coefficient of 0.00 to 0.19 was interpreted as very weak, 0.20 to 0.39 as weak, 0.40 to 0.69 as moderate, 0.70 to 0.89 as strong, and 0.90 to 1.00 as very strong correlation.[16,56] The level of significance was set at .05.

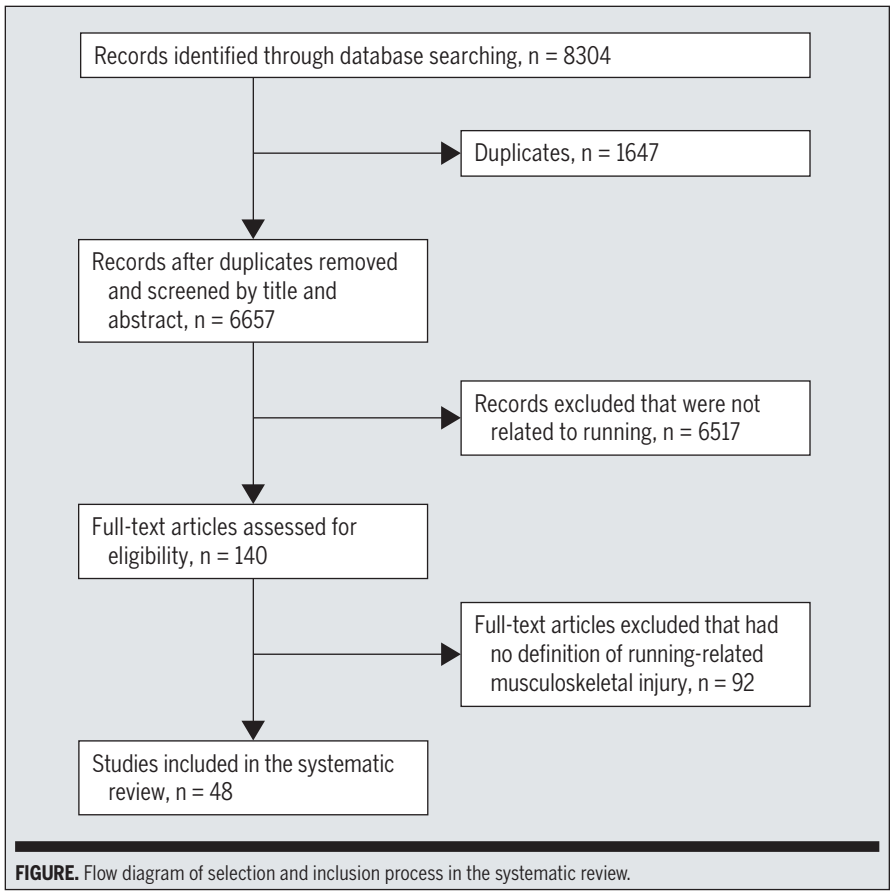

FIGURE. Flow diagram of selection and inclusion process in the systematic review.

RESULTS

The electronic search retrieved 8304 studies. Based on the inclusion and exclusion criteria, 48 articles were selected for the study. The **FIGURE** shows a flow chart of the complete process of article inclusion.

Among the 48 articles selected, there were 22 prospective cohort studies,[4,7,9,14,25,31,33,37-39,42,44,48,51,52,55,58,64-66,68,70] 16 cross-sectional studies,[11,12,21,22,24,26,27,32,40,41,46,47,53,57,60,71] 5 randomized controlled trials,[5,8,10,50,63] 2 nonrandomized controlled trials,[3,28] 2 retrospective studies,[2,34] and 1 case-control study.[59] The methodological quality assessment, using the 4 criteria of the definition of RRMI, found that 22 studies achieved a full score of 4, 22 studies a score of 3, 3 studies a score of 2, and 1 study a score of 1. Therefore, most of the articles met at least 3 of the 4 criteria. The methodological assessment of the included studies is described in **TABLE 2**.

For the domain of presence of physical complaint, 45 studies described the symptom associated with the injury. Among these, most studies (64%) defined the symptom as injury or pain. For the subcategory of body system, 25 studies specified the body system involved, and the musculoskeletal system was included in 23 of them. In total, 18 studies described the body region of injury, of which 16 used either lower extremity or back as the region. It should be noted that 30 studies did not mention the body region of injury.

For the domain of need to interrupt training/competition, 26 studies described that the injury must be running related, that is, the primary sport involved was running. For the rest of the studies, the reader could only presume that the injuries reported were related to running. For extent of injury, 10 studies defined the injury as something that caused a reduction, another 10 studies used the term *restriction*, and 7 studies did not provide details for this category. For the subcategory extent of limitation, 16 studies defined this as limitation in training, 14 as limitation in running, and 9 defined it as a decrease in training mileage or distance. For the subcategory interruption, 10 studies stated that the injury should cause an interruption of the runner's normal routine training for at least 1 week or 3 consecutive training sessions. Another 5 studies stated that the interruption should be for 1 day or 1 training session, 1 or more days, 2 days, or more than 2 weeks. The subcategory description of the period of injury was

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

TABLE 2 Assessment of the Quality of the Methodological Data of the Articles Included in the Review

	Quality Assessment Criteria*				
Study	1	2	3	4	Score
Blair et al[2]	1	1	1	1	4/4
Bovens et al[3]	1	1	0	1	3/4
Bredeweg et al[4]	1	1	1	1	4/4
Bredeweg et al[5]	1	1	1	1	4/4
Buist et al[8]	1	1	1	1	4/4
Buist et al[10]	1	1	1	1	4/4
Buist et al[9]	1	1	1	1	4/4
Buist et al[7]	1	1	0	1	3/4
Caldwell[11]	0	1	1	1	3/4
Chorley et al[12]	0	1	1	1	3/4
Fields et al[14]	1	0	1	1	3/4
Hespanhol Junior et al[21]	1	1	1	1	4/4
Hino et al[22]	0	1	1	1	3/4
Hoffman and Fogard[24]	1	1	0	1	3/4
Hootman et al[25]	1	0	1	1	3/4
Hutson[26]	1	1	1	1	4/4
Jacobs and Berson[27]	1	1	1	1	4/4
Jakobsen et al[28]	0	1	1	1	3/4
Knobloch et al[31]	0	1	1	1	3/4
Koplan et al[32]	0	1	1	1	3/4
Koplan et al[33]	0	1	0	1	2/4
Lloyd et al[34]	0	1	1	1	3/4
Lun et al[37]	1	1	1	1	4/4
Lysholm and Wiklander[38]	1	1	1	1	4/4
Macera et al[39]	1	1	1	1	4/4

Table continues on page 370.

infrequently reported. Only 4 studies described this. One study related it to the last 6 months, 2 studies to the previous year, and another study to the previous 5 years. Finally, only 8 studies established "seek medical help" as a criterion for RRMI.

The most cited descriptors used to define RRMI in the 48 studies are described in **TABLE 3**. Eight studies added to their definitions of RRMI an additional classification regarding severity of injuries, illustrated in **APPENDIX C** (available online at www.jospt.org). The injury rates of the 48 studies, as well as the complete data extraction of the definitions of injury, are presented in **APPENDIX D** (available online at www.jospt.org).

The injury rates ranged between 3% and 85% in the included studies. When the correlation between the injury rates and the completeness of the definitions was tested, there was a negative weak correlation ($P<.027$, $r = -0.35$). These results indicate that studies that found higher rates of injury were correlated with fewer subcategories reported in their definitions.

DISCUSSION

We selected 48 articles that met the inclusion criteria and extracted the definitions of RRMI, which were divided into the following subcategories: symptom, body system, region, primary sports involved, extent of injury, extent of limitation, interruption, description of the time of injury, and medical assistance/medication. Most of the articles described more than half of the subcategories adopted, which shows that definitions of RRMI offered a detailed description of the characteristics of a running-related injury, but without standardization; in other words, from the results of this study, it is clear that there is no consensus regarding the definition of RRMI.

All studies defined RRMI based on a key word that described the injury itself, which has been classified as "symptom" in this review. Among the various synonyms used for symptom, there were a wide variety of meanings. The symptoms described as ailments, complaints, diseases, and disorders were more closely associated with "a disease itself or condition of being ill, which causes changes to body function."[35] The studies that used these terms tended to consider not only RRMI, but also took diseases into account. Other terms, such as *pain*, *problem*, *injury*, and *incapacity*, were associated with something that "is not in line with the good functioning of the body or part thereof,"[35] which may better represent a musculoskeletal lesion, such as in the consensus definitions of injuries in rugby and soccer. The consensus for rugby and soccer considers an injury to be any physical complaint reported by a player that results from a match or from training, regardless of the need for medical attention or interruption to training.[17,18]

For the category body system, we found terms such as *musculoskeletal*, *physical*, *metabolic*, and *neurological disorder*. The differences between these words can be significant for the definition of RRMI. The strict involvement of

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

the musculoskeletal system[17] seems to be the most adequate criterion when dealing with any definition related to running, because it comprises any injury associated with the locomotor apparatus. In addition, the most common running injuries reported in the literature were related to the musculoskeletal system.[36]

Regarding the anatomical region, the areas mentioned were the lower extremity, the lumbar region, and some other part of the body. Most studies did not describe the injury location in their definitions, which could lead to a higher rate of injuries in different regions not related to running activities.[39,61] In the category of primary sports involved, in which the injury occurred, there were significant differences between the studies. While half of the studies reported that the primary sport should necessarily be associated with running, some studies considered the primary sport as any exercise. This information may influence the injury rate and limits the comparison of results. Thus, the description of a definition of RRMI should take into account the relationship with running, as seen in the consensus definition of injury for rugby,[18] soccer,[17] tennis,[49] and cricket,[45] which included the need for the injury to be a consequence of the practice of the sport in question.

Analyzing the category extent of injury, we found different meanings for the terms cited in this definition. Words such as *restriction*, *limitation*, and *reduction* describe facts that cause a restriction of and/or decrease in sport activity.[35] In contrast, the terms *prevent*, *interrupt*, and *stop* characterize the injury as forcing the participant to stop the activity,[35] restricting the extent of injury, as shown in the findings by Blair et al[2] and Pazin et al,[47] who found 24% and 37.7% prevalence of injury, respectively. The terms *impair*, *interfere*, *affect*, and *alter* describe something that can cause a change[35] and characterize the extent of injury in a less restrictive manner, as they try to describe any change in the runner's routine. For example, Hutson[26] recorded all medical reports and injuries during a running race, using the term *impair* in his definition of injury. Hutson[26] found a rate almost double (60%) the prevalence of injuries in runners compared to the study by Pazin et al,[47] which aimed to identify physical, demographic, and training characteristics and their association with the prevalence of injuries.

The category extent of limitation referred to the consequence of the extent of injury and pinpointed how the injury affected the runner's training or competition. Thus, the inclusion of the terms *distance*, *duration*, *frequency of training*, and *performance* enabled readers to comprehend the extent of limitation associated with the injury.

When the definition included interruption, it was important to describe the time frame that was used. Definitions that considered a long interruption of 2 weeks, for example, could restrict the number of injured runners, whereas definitions that included a short interruption could include a larger number of injured runners. A definition that included a relatively long interruption could find lower

TABLE 2 Assessment of the Quality of the Methodological Data of the Articles Included in the Review (continued)

	Quality Assessment Criteria*				
Study	1	2	3	4	Score
Marti et al[40]	0	1	1	1	3/4
McKean et al[41]	1	1	0	1	3/4
Nielsen et al[44]	1	1	1	1	4/4
Nielsen et al[42]	1	1	1	1	4/4
Parker et al[46]	1	1	0	1	3/4
Pazin et al[47]	1	1	1	1	4/4
Pileggi et al[48]	1	1	1	1	4/4
Pollock et al[50]	1	1	1	0	3/4
Rauh et al[52]	1	1	1	1	4/4
Rauh et al[51]	1	1	1	0	3/4
Roberts[53]	0	1	1	0	2/4
Satterthwaite et al[55]	1	1	0	1	3/4
Tang et al[57]	1	1	1	1	4/4
Taunton et al[58]	0	1	1	1	3/4
Taunton et al[59]	0	0	1	0	1/4
van Mechelen et al[63]	1	1	1	1	4/4
van Middelkoop et al[65]	1	1	0	1	3/4
van Middelkoop et al[64]	1	1	0	1	3/4
van Middelkoop et al[66]	1	1	0	1	3/4
Valliant[60]	1	1	1	1	4/4
Walter et al[68]	1	1	1	1	4/4
Wen et al[71]	1	1	1	1	4/4
Wen et al[70]	0	1	0	1	2/4

**(1) Description of the inclusion criteria for the study participants; (2) Definition of the type of runner being studied; (3) Same method of running-related musculoskeletal injury data collection for all runners; (4) Data collected directly from the participants or by a health professional. One point was given for "yes" answers, and zero points were given for "no" answers, with a maximum total of 4 points.*

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

TABLE 3 Main Terms Cited by the Articles for Each of the Categories and Subcategories

Category/Subcategory	Term	Studies, n
Presence of physical complaint		
Symptom	Injury	19
	Pain	10
	Complaint	6
Body system	Musculoskeletal	23
	Without description	23
Region	Lower extremity	16
	Without description	30
Need to interrupt training/competition		
Primary sports involved	Without description	22
	Running related	13
Extent of injury	Reduction	10
	Restriction	10
	Without description	7
Extent of limitation	Training	16
	Running	14
	Distance	9
Interruption	At least 1 wk	10
Description of the period of injury	Last 6 mo	1
	5-y recall period	1
Seeking medical assistance (no subcategory)	Seek medical help	8

injury rates. For instance, an injury rate of 20% was reported by Buist et al,[10] who defined injury as any musculoskeletal complaint in the lower extremities or back region that restricts running for at least a week. On the other hand, another study reported an injury rate of 25.9% when a running injury was defined as any musculoskeletal pain of the lower limb or back causing a restriction of running for at least 1 day.[7]

Only a few studies included a specific period as a description of the period of injury. Considering that these studies are based on retrospective information, it is necessary to consider that the authors gathered information dependent on the runner's memory (retrospective information). A study reported that memory bias can reach 30% each year[29]; therefore, it is suggested that the set period for retrospective questioning be short to avoid memory bias.[20,43] We suggest that this short period be a maximum of 6 months, so that the results are not at risk in relation to risk of bias.

According to some studies, runners were considered to have RRMI if they had to seek medical assistance, and in 1 study runners were considered to have RRMI if they had taken medication. Although the requirements of seeking medical assistance or taking medication were seldom used in studies, it is worth noting that when they were used as criteria for classifying a runner as injured,[68] the injury rate was different from that of studies that only considered interruption to training or presence of pain.[28] An example of this can be seen in the definition by Walter et al,[68] in which the authors classified as injured only those subjects who decreased mileage, took medication, or visited a health professional, identifying a prevalence of 48% of injuries. This differed from the definition used by Jakobsen et al,[28] who found an incidence of 75.6% of injuries after defining RRMI as any injury to the musculoskeletal system sustained during running and preventing the runner from taking part in training or competition. However, it is believed that this factor can be used to complement the definition of injury, as seen in the consensus definition of injury in other modalities.[17,18,45,49]

Only a few studies added to their definitions of RRMI a classification regarding the degree or severity of injury, despite the importance of this factor. It is believed that this classification is important to distinguish different levels of severity. Two studies only defined RRMI by descriptions for classifications of severity.[46,48] The classification of severity should be a complementary factor in the definition, allowing not only the identification of the injury itself but also comparisons between studies with results that have similar levels of injury.

Some studies have examined the impact of injury definition on injury rates and risk factors for different sports and found a direct relationship.[6,19,29,30,67] In this study, we found a weak correlation between the rates of injury and the completeness of the definitions, indicating that injury rates reported tended to increase with less specific definitions.

This study has some limitations. First, we could not find a clear association between the objectives of the studies or the study designs and the definitions of RRMI, perhaps due to the different study designs and types of runners in the studies. Second, for lack of a reliable tool to divide the definitions, we created subcategories of the 3 main domains of sport injury, based on RRMI definition reports in the literature; however, these subcategories were not used or validated in previous studies. Finally, for lack of a reliable methodological assessment tool for different study designs, the au-

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

thors developed 4 criteria to assess the methodological quality of the included studies.

In general, most studies used similar terms in their definitions, such as the presence of physical complaint (eg, injury, musculoskeletal, and lower extremities) and the need to interrupt running (eg, training reduction). The hypothesis that the definition of injury may vary according to the purpose and the population of the study should be verified in future studies. To our knowledge, this is the first time that data regarding the running-injury definition have been collected. This systematic review may expose the problem of having so many definitions for the same type of injury. We suggest, considering the findings of this review, that a consensus for the definition of RRMI be reached, so that future studies can provide more consistent and reliable findings of injuries and comparisons can be made between injury rates.[45,49] This would also provide relevant information to characterize the most frequent injuries, risk factors, and other elements to be considered in RRMI-prevention programs for runners.

CONCLUSION

The different definitions found to describe an RRMI in this systematic review are based on 2 main domains: informing the presence of physical complaint (injury, musculoskeletal, and lower extremity) and the need for a period of interruption (reduction of training or competition). The findings of this review indicate that the descriptors commonly used by investigators to define RRMI vary between studies and may affect the rates of injury found in the literature. Study results related to the rates of running injuries, such as risk factors, could be affected by the lack of a standardized definition. ◉

KEY POINTS

FINDINGS: This systematic review provides evidence that the descriptors commonly used by investigators to define RRMI are wide and varied.

IMPLICATIONS: The comparison of study results related to rates of injuries is problematic due to the lack of a standard definition of RRMI.

CAUTION: The categories used to classify the definitions of RRMI were not validated, so these results may be influenced by the classification adopted.

ONLINE APPENDICES

The search strategy, methodological quality assessment of the articles analyzed, injury classification according to severity, and data from the included articles with definitions of RRMI are available online at www.jospt.org.

REFERENCES

1. Bahr R. No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. *Br J Sports Med*. 2009;43:966-972. http://dx.doi.org/10.1136/bjsm.2009.066936
2. Blair SN, Kohl HW, Goodyear NN. Rates and risks for running and exercise injuries: studies in three populations. *Res Q Exerc Sport*. 1987;58:221-228. http://dx.doi.org/10.1080/02701367.1987.10605453
3. Bovens AM, Janssen GM, Vermeer HG, Hoeberigs JH, Janssen MP, Verstappen FT. Occurrence of running injuries in adults following a supervised training program. *Int J Sports Med*. 1989;10 suppl 3:S186-S190. http://dx.doi.org/10.1055/s-2007-1024970
4. Bredeweg SW, Kluitenberg B, Bessem B, Buist I. Differences in kinetic variables between injured and noninjured novice runners: a prospective cohort study. *J Sci Med Sport*. 2013;16:205-210. http://dx.doi.org/10.1016/j.jsams.2012.08.002
5. Bredeweg SW, Zijlstra S, Buist I. The GRONORUN 2 study: effectiveness of a preconditioning program on preventing running related injuries in novice runners. The design of a randomized controlled trial. *BMC Musculoskelet Disord*. 2010;11:196. http://dx.doi.org/10.1186/1471-2474-11-196
6. Brooks JH, Fuller CW. The influence of methodological issues on the results and conclusions from epidemiological studies of sports injuries: illustrative examples. *Sports Med*. 2006;36:459-472. http://dx.doi.org/10.2165/00007256-200636060-00001
7. Buist I, Bredeweg SW, Bessem B, van Mechelen W, Lemmink KA, Diercks RL. Incidence and risk factors of running-related injuries during preparation for a 4-mile recreational running event. *Br J Sports Med*. 2010;44:598-604. http://dx.doi.org/10.1136/bjsm.2007.044677
8. Buist I, Bredeweg SW, Lemmink KA, et al. The GRONORUN study: is a graded training program for novice runners effective in preventing running related injuries? Design of a randomized controlled trial. *BMC Musculoskelet Disord*. 2007;8:24. http://dx.doi.org/10.1186/1471-2474-8-24
9. Buist I, Bredeweg SW, Lemmink KA, van Mechelen W, Diercks RL. Predictors of running-related injuries in novice runners enrolled in a systematic training program: a prospective cohort study. *Am J Sports Med*. 2010;38:273-280. http://dx.doi.org/10.1177/0363546509347985
10. Buist I, Bredeweg SW, van Mechelen W, Lemmink KA, Pepping GJ, Diercks RL. No effect of a graded training program on the number of running-related injuries in novice runners: a randomized controlled trial. *Am J Sports Med*. 2008;36:33-39. http://dx.doi.org/10.1177/0363546507307505
11. Caldwell J. Experience from the 1980 midnight sun marathon: injuries & training. *Alaska Med*. 1981;23:18-21.
12. Chorley JN, Cianca JC, Divine JG, Hew TD. Baseline injury risk factors for runners starting a marathon training program. *Clin J Sport Med*. 2002;12:18-23.
13. Clarsen B, Myklebust G, Bahr R. Development and validation of a new method for the registration of overuse injuries in sports injury epidemiology: the Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire. *Br J Sports Med*. 2013;47:495-502. http://dx.doi.org/10.1136/bjsports-2012-091524
14. Fields KB, Delaney M, Hinkle JS. A prospective study of type A behavior and running injuries. *J Fam Pract*. 1990;30:425-429.
15. Fields KB, Sykes JC, Walker KM, Jackson JC. Prevention of running injuries. *Curr Sports Med Rep*. 2010;9:176-182. http://dx.doi.org/10.1249/JSR.0b013e3181de7ec5
16. Fowler J, Jarvis P, Chevannes M. *Practical Statistics for Nursing and Health Care*. West Sussex, UK: John Wiley & Sons; 2002.
17. Fuller CW, Ekstrand J, Junge A, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Scand J Med Sci Sports*. 2006;16:83-92. http://dx.doi.org/10.1111/j.1600-0838.2006.00528.x
18. Fuller CW, Molloy MG, Bagate C, et al. Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union. *Br J Sports Med*. 2007;41:328-331. http://dx.doi.org/10.1136/bjsm.2006.033282
19. Hamilton GM, Meeuwisse WH, Emery CA, Shrier I. Examining the effect of the injury definition on risk factor analysis in circus artists. *Scand J Med Sci Sports*. 2012;22:330-334. http://dx.doi.org/10.1111/j.1600-0838.2010.01245.x
20. Herbert R, Jamtvedt G, Mead J, Hagen KB. *Practical Evidence-Based Physiotherapy*. London,

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

UK: Elsevier; 2005.
21. Hespanhol Junior LC, Costa LO, Carvalho AC, Lopes AD. A description of training characteristics and its association with previous musculoskeletal injuries in recreational runners: a cross-sectional study. *Rev Bras Fisioter*. 2012;16:46-53. http://dx.doi.org/10.1590/S1413-35552012000100009
22. Hino AAF, Reis RS, Rodriguez-Añez CR, Fermino RC. Prevalência de lesões em corredores de rua e fatores associados. *Rev Bras Med Esporte*. 2009;15:36-39.
23. Hoeberigs JH. Factors related to the incidence of running injuries. A review. *Sports Med*. 1992;13:408-422. http://dx.doi.org/10.2165/00007256-199213060-00004
24. Hoffman MD, Fogard K. Factors related to successful completion of a 161-km ultramarathon. *Int J Sports Physiol Perform*. 2011;6:25-37.
25. Hootman JM, Macera CA, Ainsworth BE, Martin M, Addy CL, Blair SN. Predictors of lower extremity injury among recreationally active adults. *Clin J Sport Med*. 2002;12:99-106.
26. Hutson MA. Medical implications of ultra marathon running: observations on a six day track race. *Br J Sports Med*. 1984;18:44-45. http://dx.doi.org/10.1136/bjsm.18.1.44
27. Jacobs SJ, Berson BL. Injuries to runners: a study of entrants to a 10,000 meter race. *Am J Sports Med*. 1986;14:151-155.
28. Jakobsen BW, Króner K, Schmidt SA, Kjeldsen A. Prevention of injuries in long-distance runners. *Knee Surg Sports Traumatol Arthrosc*. 1994;2:245-249. http://dx.doi.org/10.1007/BF01845597
29. Junge A, Dvorak J. Influence of definition and data collection on the incidence of injuries in football. *Am J Sports Med*. 2000;28:S40-S46.
30. Kerr HA, Curtis C, Micheli LJ, et al. Collegiate rugby union injury patterns in New England: a prospective cohort study. *Br J Sports Med*. 2008;42:595-603. http://dx.doi.org/10.1136/bjsm.2007.035881
31. Knobloch K, Yoon U, Vogt PM. Acute and overuse injuries correlated to hours of training in master running athletes. *Foot Ankle Int*. 2008;29:671-676. http://dx.doi.org/10.3113/FAI.2008.0671
32. Koplan JP, Powell KE, Sikes RK, Shirley RW, Campbell CC. An epidemiologic study of the benefits and risks of running. *JAMA*. 1982;248:3118-3121. http://dx.doi.org/10.1001/jama.1982.03330230030026
33. Koplan JP, Rothenberg RB, Jones EL. The natural history of exercise: a 10-yr follow-up of a cohort of runners. *Med Sci Sports Exerc*. 1995;27:1180-1184.
34. Lloyd T, Triantafyllou SJ, Baker ER, et al. Women athletes with menstrual irregularity have increased musculoskeletal injuries. *Med Sci Sports Exerc*. 1986;18:374-379.
35. *Longman Dictionary of Contemporary English*. 4th ed. London, UK: Pearson; 2003.
36. Lopes AD, Hespanhol Junior LC, Yeung SS, Costa LO. What are the main running-related musculoskeletal injuries? A systematic review. *Sports Med*. 2012;42:891-905. http://dx.doi.org/10.1007/BF03262301
37. Lun V, Meeuwisse WH, Stergiou P, Stefanyshyn D. Relation between running injury and static lower limb alignment in recreational runners. *Br J Sports Med*. 2004;38:576-580. http://dx.doi.org/10.1136/bjsm.2003.005488
38. Lysholm J, Wiklander J. Injuries in runners. *Am J Sports Med*. 1987;15:168-171.
39. Macera CA, Pate RR, Powell KE, Jackson KL, Kendrick JS, Craven TE. Predicting lower-extremity injuries among habitual runners. *Arch Intern Med*. 1989;149:2565-2568. http://dx.doi.org/10.1001/archinte.1989.00390110117026
40. 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;16:285-294.
41. McKean KA, Manson NA, Stanish WD. Musculoskeletal injury in the masters runners. *Clin J Sport Med*. 2006;16:149-154.
42. Nielsen RO, Buist I, Parner ET, et al. Foot pronation is not associated with increased injury risk in novice runners wearing a neutral shoe: a 1-year prospective cohort study. *Br J Sports Med*. 2014;48:440-447. http://dx.doi.org/10.1136/bjsports-2013-092202
43. Nielsen RO, Buist I, Sørensen H, Lind M, Rasmussen S. Training errors and running related injuries: a systematic review. *Int J Sports Phys Ther*. 2012;7:58-75.
44. Nielsen RO, Cederholm P, Buist I, Sørensen H, Lind M, Rasmussen S. Can GPS be used to detect deleterious progression in training volume among runners? *J Strength Cond Res*. 2013;27:1471-1478. http://dx.doi.org/10.1519/JSC.0b013e3182711e3c
45. Orchard JW, Newman D, Stretch R, Frost W, Mansingh A, Leipus A. Methods for injury surveillance in international cricket. *Br J Sports Med*. 2005;39:e22. http://dx.doi.org/10.1136/bjsm.2004.012732
46. Parker DT, Weitzenberg TW, Amey AL, Nied RJ. Group training programs and self-reported injury risk in female marathoners. *Clin J Sport Med*. 2011;21:499-507. http://dx.doi.org/10.1097/JSM.0b013e3182377080
47. Pazin J, Duarte MF, Poeta LS, Gomes MA. Corredores de rua: características demográficas, treinamento e prevalência de lesões. *Rev Bras Cineantropom Desempenho Hum*. 2008;10:277-282.
48. Pileggi P, Gualano B, Souza M, et al. Incidência e fatores de risco de lesões osteomioarticulares em corredores: um estudo de coorte prospectivo. *Rev Bras Educ Fís Esporte (Impr)*. 2010;24:453-462.
49. Pluim BM, Fuller CW, Batt ME, et al. Consensus statement on epidemiological studies of medical conditions in tennis, April 2009. *Clin J Sport Med*. 2009;19:445-450. http://dx.doi.org/10.1097/JSM.0b013e3181be35e5
50. Pollock ML, Gettman LR, Milesis CA, Bah MD, Durstine L, Johnson RB. Effects of frequency and duration of training on attrition and incidence of injury. *Med Sci Sports*. 1977;9:31-36.
51. Rauh MJ, Koepsell TD, Rivara FP, Margherita AJ, Rice SG. Epidemiology of musculoskeletal injuries among high school cross-country runners. *Am J Epidemiol*. 2006;163:151-159. http://dx.doi.org/10.1093/aje/kwj022
52. Rauh MJ, Margherita AJ, Rice SG, Koepsell TD, Rivara FP. High school cross country running injuries: a longitudinal study. *Clin J Sport Med*. 2000;10:110-116.
53. Roberts WO. A 12-yr profile of medical injury and illness for the Twin Cities Marathon. *Med Sci Sports Exerc*. 2000;32:1549-1555.
54. Ryan MB, MacLean CL, Taunton JE. A review of anthropometric, biomechanical, neuromuscular and training related factors associated with injury in runners. *Int SportMed J*. 2006;7:120-137.
55. 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;33:22-26. http://dx.doi.org/10.1136/bjsm.33.1.22
56. Streiner DL, Norman GR. *Health Measurement Scales: A Practical Guide to Their Development and Use*. 4th ed. New York, NY: Oxford University Press; 2008.
57. Tang N, Kraus CK, Brill JD, Shahan JB, Ness C, Scheulen JJ. Hospital-based event medical support for the Baltimore Marathon, 2002–2005. *Prehosp Emerg Care*. 2008;12:320-326. http://dx.doi.org/10.1080/10903120802099112
58. 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;37:239-244. http://dx.doi.org/10.1136/bjsm.37.3.239
59. 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;36:95-101. http://dx.doi.org/10.1136/bjsm.36.2.95
60. Valliant PM. Personality and injury in competitive runners. *Percept Mot Skills*. 1981;53:251-253. http://dx.doi.org/10.2466/pms.1981.53.1.251
61. 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;41:469-480; discussion 480. http://dx.doi.org/10.1136/bjsm.2006.033548
62. van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. *Sports Med*. 1992;14:82-99. http://dx.doi.org/10.2165/00007256-199214020-00002
63. van Mechelen W, Hlobil H, Kemper HC, Voorn WJ, de Jongh HR. Prevention of running injuries by warm-up, cool-down, and stretching exercises. *Am J Sports Med*. 1993;21:711-719.
64. Van Middelkoop M, Kolkman J, Van Ochten

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

J, Bierma-Zeinstra SM, Koes B. Prevalence and incidence of lower extremity injuries in male marathon runners. *Scand J Med Sci Sports*. 2008;18:140-144. http://dx.doi.org/10.1111/j.1600-0838.2007.00683.x

65. van Middelkoop M, Kolkman J, van Ochten J, Bierma-Zeinstra SM, Koes BW. Course and predicting factors of lower-extremity injuries after running a marathon. *Clin J Sport Med*. 2007;17:25-30. http://dx.doi.org/10.1097/JSM.0b013e3180305e4d

66. Van Middelkoop M, Kolkman J, Van Ochten J, Bierma-Zeinstra SM, Koes BW. Risk factors for lower extremity injuries among male marathon runners. *Scand J Med Sci Sports*. 2008;18:691-697. http://dx.doi.org/10.1111/j.1600-0838.2007.00768.x

67. Waldén M, Hägglund M, Ekstrand J. Injuries in Swedish elite football—a prospective study on injury definitions, risk for injury and injury pattern during 2001. *Scand J Med Sci Sports*. 2005;15:118-125. http://dx.doi.org/10.1111/j.1600-0838.2004.00393.x

68. Walter SD, Hart LE, McIntosh JM, Sutton JR. The Ontario cohort study of running-related injuries. *Arch Intern Med*. 1989;149:2561-2564. http://dx.doi.org/10.1001/archinte.1989.00390110113025

69. Wen DY. Risk factors for overuse injuries in runners. *Curr Sports Med Rep*. 2007;6:307-313.

70. Wen DY, Puffer JC, Schmalzried TP. Injuries in runners: a prospective study of alignment. *Clin J Sport Med*. 1998;8:187-194.

71. Wen DY, Puffer JC, Schmalzried TP. Lower extremity alignment and risk of overuse injuries in runners. *Med Sci Sports Exerc*. 1997;29:1291-1298.

72. Williams PT. Relationship of distance run per week to coronary heart disease risk factors in 8283 male runners. The National Runners' Health Study. *Arch Intern Med*. 1997;157:191-198. http://dx.doi.org/10.1001/archinte.1997.00440230063008

MORE INFORMATION
WWW.JOSPT.ORG

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

GO GREEN By Opting Out of the Print *Journal*

JOSPT subscribers and APTA members of the Orthopaedic and Sports Physical Therapy Sections can **help the environment by "opting out"** of receiving *JOSPT* in print each month as follows. If you are:

- **A *JOSPT* subscriber:** Email your request to **jospt@jospt.org** or call the *JOSPT* office toll-free at **1-877-766-3450** and provide your name and subscriber number.
- **APTA Orthopaedic or Sports Section member:** Go to http://www.apta.org/, log in, and select **My Profile**. Next click on **Email Management/GoGreen**. Toward the bottom of the list, you will find the **Publications** options and may opt out of receiving the print *JOSPT*. **Please save this preference.**

Subscribers and members alike will continue to have access to *JOSPT* online and can retrieve current and archived issues anytime and anywhere you have Internet access.

APPENDIX A

SEARCH STRATEGY FOR THE EMBASE DATABASE

1. running/exp
2. marathon runner/exp
3. jogging/exp
4. treadmill exercise/exp
5. runner/syn
6. runners
7. jogger
8. joggers
9. run
10. marathon running/syn
11. marathon
12. exercise/syn
13. treadmill/syn
14. treadmill running/syn
15. OR/ 1-14
16. sport injury/exp
17. sports injuries
18. athlete injury/syn
19. athlete trauma/syn
20. athletic injuries/syn
21. athletic injury/syn
22. athletic trauma/syn
23. sport accident/syn
24. sport trauma/syn
25. sports injury/syn
26. sports trauma/syn
27. OR/ 16-26
28. AND/ 15,27
29. limits/ article
30. limits/ article in press
31. limits/ humans
32. limits/ embase

APPENDIX B

DESCRIPTION OF THE CRITERIA USED TO ASSESS THE QUALITY OF THE METHODOLOGICAL DATA OF THE ARTICLES RELATED TO THE DEFINITIONS OF RUNNING-RELATED MUSCULOSKELETAL INJURY

		Answer	
Criterion	**Description of Assessment Criteria and Examples**	**Yes**	**No**
(1) Definition of eligibility criteria for participating runners	Studies must have included in the Methods section the inclusion and exclusion criteria used for the study participants Studies that clearly defined the eligibility criteria were given a "yes" answer, and studies that did not provide a clear definition received a "no" answer	High quality	Low quality
(2) Definition of type of runner being studied	Studies that reported the type of runners or described the general characteristics of training, allowing the identification of the type of runner being assessed, received a "yes" answer for this criterion. Studies that were conducted in running competitions (which can determine the type of runner) and described the distance of the race also received a "yes" answer for this criterion. The studies that did not describe the type of runner were given a "no" answer	High quality	Low quality
(3) Same method of data collection	If the same method of data collection was used for all runners who took part in the study, the item received a "yes" answer. If data collection was not standardized, the item received a "no" answer	High quality	Low quality
(4) Data collected directly from the subjects or by a health professional	Studies in which the interview or questionnaire was applied directly to the runner or in which the medical assessment was conducted during the study received a "yes" answer. Studies in which the interview or questionnaire was applied to someone other than the runner (trainer, physical therapist, etc) or studies in which the medical assessment was conducted prior to the study period and reported in a medical chart, interview, or questionnaire (retrospective data collection) received a "no" answer	High quality	Low quality

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

APPENDIX C

CLASSIFICATION ACCORDING TO SEVERITY OF INJURIES

Study	Type of Study	Participants	Classification of Severity of RRMIs (8/45)
Bredeweg et al[5]	RCT (study protocol)	432 novice runners	Pain without limitation, no RRI; pain that caused a restriction of running, scored as an RRI; pain that made running impossible, scored as an RRI
Buist et al[8]	RCT (study protocol)	532 novice runners	Pain without limitation, no RRI; pain that caused a restriction of running, scored as an RRI; pain that made running impossible, scored as an RRI
Chorley et al[12]	Cross-sectional	1548 marathon runners	A 5-point scale that was based on the degree of activity modification required: (1) mild: slowed pace, same weekly routine; (2) slowed pace and decreased weekly mileage; (3) moderate: stopped running for less than 1 wk; (4) stopped running for 1-4 wk; (5) severe: stopped running for more than 1 mo
Knobloch et al[31]	Prospective cohort	291 elite runners	An injury that results in a runner receiving medical attention was referred to as a "medical attention" injury, and an injury that resulted in a runner being unable to take part in running training or competition as a "time loss" injury
Marti et al[40]	Cross-sectional	4358 participants in a 16-km race	Grade I, injuries involved maintenance of full training activity in spite of symptoms; grade II, a reduction of training activity; and grade III, full training interruption or interruption of running of at least 2 wk in duration
Parker et al[46]	Cross-sectional	378 marathon runners	(1) No change in running pace or routine; (2) slowed pace while running, same weekly routine; (3) slowed pace while running and decreased weekly mileage; (4) stopped running for less than 1 wk; (5) stopped running for 1-4 wk; (6) stopped running for more than 1 mo
Pileggi et al[48]	Prospective cohort	18 runners	The injuries were classified according to interference with training at levels 1 (no interruption), 2 (reduced training volume), and 3 (interruption for at least 2 wk) and according to symptoms: acute (symptoms persisting for up to 2 wk), subacute (symptoms lasting 2-6 wk), and chronic (symptoms for more than 6 wk)
van Mechelen et al[63]	RCT	327 recreational runners	(1) The subject had to stop running, (2) the subject could not run, (3) the subject could not go to work, (4) the subject needed medical attention, or (5) the subject suffered from pain or stiffness during 10 subsequent days while running

Abbreviations: RCT, randomized controlled trial; RRI, running-related injury; RRMI, running-related musculoskeletal injury.

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

SIMPLIFIED DATA EXTRACTION FROM THE ARTICLES AND DEFINITIONS OF RUNNING-RELATED MUSCULOSKELETAL INJURY

			Categories and Subcategories of the Definitions of Running-Related Musculoskeletal Injury								
			Presence of Physical Complaint			Need to Interrupt Training/Competition					Seeking Medical Assistance
Study/Study Type	Participants	Injury Rate	Symptom (45/48)	Body System (25/48)	Region (18/48)	Primary Sports Involved (26/48)	Extent of Injury (41/48)	Extent of Limitation (41/48)	Interruption (15/48)	Description of the Period of Injury (4/48)	Medical Assistance/ Medication (8/48)
Tang et al[57] Cross-sectional	1144 marathoners	3%	Injury/ illness	...	...	A long course route/ finish line	...	...	...	...	Medical aid station
van Mechelen et al[63] RCT	327 recreational runners	15%	Injury	...	...	Running related	...	...	...	...	...
Bredeweg et al[4] Prospective cohort	210 novice runners	16.2%	Complaint	Musculoskeletal	Lower extremities or back	...	Restriction	Running	1 wk	...	...
van Middelkoop et al[64] Prospective cohort	726 marathoners	18.2%	Injury	Musculoskeletal	Lower extremities	Running related	Reduction	Distance, speed, duration, or frequency	...	...	...
Buist et al[10] RCT	532 novice runners	20.8%	Complaint	Musculoskeletal	Lower extremities or back	Running related	Restriction	Running	1 wk	...	...
Buist et al[9] Prospective cohort	532 novice runners	21%	Pain	Musculoskeletal	Lower extremities or back	Running related	Restriction	Running	1 wk/3 consecutive training sessions	...	...
Satterthwaite et al[55] Prospective cohort	1054 marathoners	23.8%	Injury/ illness	...	...	...	Affected	Premarathon training	...	...	...
Blair et al[2] Retrospective	438 runners from a club	24%	Injury	...	...	...	Stop	Running	7 d	..	...

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

			Categories and Subcategories of the Definitions of Running-Related Musculoskeletal Injury								
			Presence of Physical Complaint			Need to Interrupt Training/Competition					Seeking Medical Assistance
Study/Study Type	Participants	Injury Rate	Symptom (45/48)	Body System (25/48)	Region (18/48)	Primary Sports Involved (26/48)	Extent of Injury (41/48)	Extent of Limitation (41/48)	Inter-ruption (15/48)	Descrip-tion of the Period of Injury (4/48)	Medical Assistance/ Medication (8/48)
Hespanhol Junior et al[21] Cross-sectional	200 recre-ational runners	25%	Pain	Muscu-lo-skeletal	...	Running related	Prevent	Training	1 training session	...	...
Wen et al[70] Prospective cohort	355 novice runners	25.3%	Injury/pain	...	Anatomic part	...	Stop/slow/ modify	Training/ pace	...	...	...
Buist et al[7] Prospective cohort	629 novice and recreational runners	25.9%	Pain	Muscu-lo-skeletal	Lower limb or back	Running related	Restriction	Running	1 d	...	...
Nielsen et al[44] Prospective cohort	927 novice runners	27%	Complaint	Muscu-lo-skeletal	Lower ex-tremity or back	Caused by running	Restricted	Running	1 wk	...	...
Nielsen et al[42] Prospective cohort	930 novice runners	27%	Complaint	Muscu-lo-skeletal	Lower ex-tremity or back	Caused by running	Restricted	Running (volume, duration, pace, or fre-quency)	1 wk	...	...
van Middelkoop et al[66] Prospective cohort	726 marathoners	28%	Injury	Muscu-lo-skeletal	Lower extremi-ties	Running related	Reduction	Distance, speed, duration, or fre-quency	...	...	...
Hino et al[22] Cross-sectional	295 street runners	28.5%	Pain/aggra-vation	...	...	...	Limit/ remove	Training/ competi-tion	...	Last 6 mo	...
Pollock et al[50] RCT	157 inmates	29%	Incident	...	...	Training	Prevented	Jogging	1 wk	...	...
Rauh et al[52] Prospective cohort	3233 cross-country runners	29%	Problem	...	...	Athletic partici-pation	Removed/ missed	Practice/ com-petitive event	...	...	...
Taunton et al[58] Prospective cohort	844 recre-ational runners	29.5%	Pain	...	...	After exercise	...	...	...	...	...

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

			Categories and Subcategories of the Definitions of Running-Related Musculoskeletal Injury								
			Presence of Physical Complaint			Need to Interrupt Training/Competition					Seeking Medical Assistance
Study/Study Type	Participants	Injury Rate	Symptom (45/48)	Body System (25/48)	Region (18/48)	Primary Sports Involved (26/48)	Extent of Injury (41/48)	Extent of Limitation (41/48)	Interruption (15/48)	Description of the Period of Injury (4/48)	Medical Assistance/ Medication (8/48)
Koplan et al[32] Cross-sectional	1423 recreational runners	35%	Ailment	Musculoskeletal	...	...	Reduce	Weekly mileage	...	...	Take medicine or visit a health professional
Lloyd et al[34] Retrospective	207 university runners	37%	Ailment	Musculoskeletal	...	...	Interrupt	Running program	...	...	Seek medical help
Pazin et al[47] Cross-sectional	115 distance runners	37.7%	Injury	Musculoskeletal	...	...	Interruption	Training	2 d	...	...
Chorley et al[12] Cross-sectional	1548 marathoners	38%	Disorder/ illness	Musculoskeletal, metabolic or neurologic	...	During running training	Alter	Training	...	...	...
Rauh et al[51] Prospective cohort	421 cross-country runners	38.5%	Problem/ injury	Musculoskeletal	Lower extremity or back	...	Removed/ missing	Practice/ training	...	...	...
Hootman et al[25] Prospective cohort	3090 adults of a running/ walking program	40% in men, 35% in women	Injury	...	Lower extremity	After starting a running without jumping program	...	...	...	5 y	Consultation with a physician
Wen et al[71] Cross-sectional	304 runners of a marathon-training program	44.8%	Injury/pain	...	Anatomic part	...	Stop/slow/ modify	Training/ pace	...	...	...
Marti et al[40] Cross-sectional	4358 participants of a race	45.8%	Injury	...	...	...	Reduction/ interruption	Training	2 wk	...	...
McKean et al[41] Cross-sectional	2886 participants of a race	46%	Event	...	...	...	Affected	Training/ competition	...	(16) previous year	...

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

			Categories and Subcategories of the Definitions of Running-Related Musculoskeletal Injury								
			Presence of Physical Complaint			Need to Interrupt Training/Competition					Seeking Medical Assistance
Study/Study Type	Participants	Injury Rate	Symptom (45/48)	Body System (25/48)	Region (18/48)	Primary Sports Involved (26/48)	Extent of Injury (41/48)	Extent of Limitation (41/48)	Interruption (15/48)	Description of the Period of Injury (4/48)	Medical Assistance/ Medication (8/48)
Jacobs and Berson[27] Cross-sectional	451 participants in a race	46.6%	Pain	...	Lower extremities or lower back	...	Restriction/ prevented	Distance, speed/ running	...	...	...
Walter et al[68] Prospective cohort	1288 short- and long-distance runners	48%	...	...	...	...	Reduce	Mileage	...	...	Take medicine or see a health professional
Pileggi et al*[48] Prospective cohort	18 amateur runners	50%	...	...	...	...	...	...	...	...	...
Parker et al*[46] Cross-sectional	378 female marathoners	50.8%	...	...	...	...	...	...	...	...	...
Hoffman and Fogard[24] Cross-sectional	500 ultramarathon runners	52.2%	Injury	...	...	...	Interfere	Training	...	(16) previous year	...
Macera et al[39] Prospective cohort	583 recreational runners	53% in men, 49% in women	Injury/ problem	Musculoskeletal	Lower extremities	Running related	Reduction	Weekly distance	...	...	Visit a health professional or use of medication
Koplan et al[33] Prospective cohort	535 participants in a race	53%	Ailment	Musculoskeletal	...	...	Reduce/ cease/ interfere	Exercise/ work or school activities	...	...	...
Caldwell[11] Cross-sectional	84 marathoners	58%	Problem	Physical	...	...	Affected	Performance	...	...	...
Hutson[26] Cross-sectional	25 ultramarathon runners	60%	Injury	...	...	...	Impair	Performance	...	...	...
Valliant[60] Cross-sectional	41 male runners	63.4%	Damage/ pain	Physiological/ bodily	...	...	Interfered	Training/ competition	...	...	...

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

			Categories and Subcategories of the Definitions of Running-Related Musculoskeletal Injury									
			Presence of Physical Complaint			Need to Interrupt Training/Competition					Seeking Medical Assistance	
Study/Study Type	Participants	Injury Rate	Symptom (45/48)	Body System (25/48)	Region (18/48)	Primary Sports Involved (26/48)	Extent of Injury (41/48)	Extent of Limitation (41/48)	Inter-ruption (15/48)	Descrip-tion of the Period of Injury (4/48)	Medical Assistance/ Medication (8/48)	
Lysholm and Wiklander[38] Prospective cohort	60 sprinters and dis-tance and marathon runners	65%	Injury	...	...	...	Hampered	Training/ competi-tion	1 wk	...	...	
Jakobsen et al[28] NRCT	41 recreational runners	75%	Injury	Musculo-skeletal	...	During running	Prevented	Training/ competi-tion	...	...	...	
Lun et al[37] Prospective cohort	87 recreational runners	79%	Symptom	Musculo-skeletal	Lower limb	...	Reduction/ stoppage	Training	...	...	...	
Bovens et al[3] NRCT	115 novice runners	85%	Complaint	Physical	...	Running related	Restriction	Distance, speed, duration, or fre-quency	...	...	...	
Knobloch et al[31] Prospective cohort	291 elite runners	0.08/1000 km	Complaint	Physical	...	Competi-tion/ training	...	...	...	...	...	
Roberts[53] Cross-sectional	81 277 marathoners	18.9/1000 h	Disability	...	...	...	Interfere	Function	...	...	Medical assistance re-quested or rendered	
Taunton et al[59] Retrospective case-control	2002 patients of a sports medicine center	Only injured runners included	Pain/symp-toms/ injury	...	...	Running related	Stop/ reduce	Running mileage	...	...	Seek medical assistance	
van Middelkoop et al[65] Prospective cohort	165 marathoners	Only injured runners included	Injury	Musculo-skeletal	Lower extremi-ties	Running related	Reduction	Distance, speed, duration, or fre-quency	...	...	...	

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on May 2, 2015. For personal use only. No other uses without permission.
Copyright © 2015 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

			Categories and Subcategories of the Definitions of Running-Related Musculoskeletal Injury								
			Presence of Physical Complaint			Need to Interrupt Training/Competition					Seeking Medical Assistance
Study/Study Type	Participants	Injury Rate	Symptom (45/48)	Body System (25/48)	Region (18/48)	Primary Sports Involved (26/48)	Extent of Injury (41/48)	Extent of Limitation (41/48)	Inter-ruption (15/48)	Descrip-tion of the Period of Injury (4/48)	Medical Assistance/ Medication (8/48)
Buist et al[8] RCT (protocol)	532 novice runners	NR	Ailment	Musculo-skeletal	Lower ex-tremities or back	Running related	Restriction	Running	1 wk/3 con-secutive training sessions	...	...
Bredeweg et al[5] RCT (protocol)	432 novice runners	NR	Ailment	Musculo-skeletal	Lower ex-tremities or back	Running related	Restriction	Running	1 wk/3 con-secutive training sessions	...	...
Fields et al[14] Prospective cohort	40 runners from a rac-ing club	NR	Problem	Musculo-skeletal	...	During running	Interrupted	Training	1 d or more	...	...

Abbreviations: NR, not reported; NRCT, nonrandomized controlled trial; RCT, randomized controlled trial.
**These articles described only the severity of the injury.*