Review Article

Overuse Injury versus Training Load Error: A Systematic Narrative Review Comparing the Terminology Accuracy

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Abstract

Objective: The aim was to determine the research question which addresses the accuracy of the terms Overuse injury & Training load error in sports injuries.

Literature Search: Google scholar, PubMed & AJSM databases were searched from inception to 2nd September 2023.

Study Selection Criteria: The studies were included if the participants were athletes regardless of the type of sport & gender. Studies consisting overuse injuries, training load errors & comparison among the two were included.

Data Synthesis: The quality of studies was assessed using JBI Critical Appraisal Tool. The level of evidence was defined as strong & of high quality.

Results: 2672 studies were identified along with 5 articles from sources other than database search. 14 studies met the inclusion criteria & were added to the review. 11 studies concluded that increased training performance is directly proportional to the increased risk of injury. 3 studies directly call out for our field to replace the term Overuse injury with Training Load Errors. One of the studies specifies by stating that all overuse injuries are training load errors. 5 studies specifies that, even though there are negative effects of training errors, proper training prescription can act as a protective agent against injury.

Conclusion: This review emphasizes the field of Sports Sciences to avoid the term Overuse Injury & replace it with Training Load Error.

Key Words: athletes, overuse injuries, sports, training load errors.

Introduction

Overuse injuries occurs as a result of repetitive stress followed by inadequate resting period (Johnson, James H[4]). It is an injury which is a result of gradual process of repetitive microtrauma & increased load on the musculoskeletal system, which leads to tissue damage caused as a result of insufficient time of recovery (Franco et al[7]).

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An overuse injury, is by definition an error in training prescription (Gabbett et al 10). While it may be challenging to predict & prevent certain injuries, the majority of injuries typically stem from excessive loads & a history of overuse (Franco et al[7]).

The number of overuse injuries are increasing not only because of the increasing number of participants in sports, but also because of the increased training intensity & duration (Jayanthi et al[13]). There is arising evidence for an association between training load & risk of overuse injuries (Drew M K & Finch C F[5]).

Evidence highlights that increased hour of training per week, has a directly proportional relationship with increased overuse injuries (Sugimoto et al[17]).

The definition of training load was taken from a review by Drew M K & Finch C F[4]. It is stated as follows:

The cumulative amount of stress placed on an individual from multiple training sessions over a period of time, external workload performed or the internal workload to that response.

As previously stated, Training load can either be internal or external.

Internal workload can be defined as, The physiological response of the body to any external loading (ex: Exercise). It is the amount of stress that an exercise places on the body & can be measured using methods such as heart rate, perceived exertion.

Whereas, External workloads are the physical demands or quantification of the workloads external to the athlete. External factor mainly training errors may lead to muscular imbalance (Drew M K & Finch C F[5]).

Hence understanding the terminologies 'Overuse injuries' & 'Training load error' & using the more accurate among the two terms, is necessary to develop prevention strategies & early interventions.

The need for this study is to identify an accurate term in order to develop strategies for preventing the injuries, because there is a misconception among coaches & athletes that, increased training loads may lead to best competition results, which in turn is causing increased risk of overuse injuries. Evidence has been viewed for a more accurate terminology, but no systematic narrative review is available for the information regarding the accuracy of 'Overuse injury' or 'Training load errors'

Therefore, this study aims in bridging this research gap by conducting a review on the terminology accuracy.

The objective of this study is to define the research question which addresses the accuracy of the terms 'Overuse injury' & 'Training load error' in sprots injuries.

This study aims to interpret existing literature to analyze the accuracy & effectiveness of these terms in defining & describing sports injuries.

Methods

Following the guidelines of PRISMA 2020 checklist, the review was conducted.

Inclusion Criteria:

The studies included in this review followed the PICO framework (Population or patient, Intervention, Comparison, Outcome(s)) based on the PRISMA guidelines:

1. The population included should be athletes of any sports regardless of professional or amateur level & gender studies.
2. Studies that had overuse injury & training load error & studies that focus on intervention strategies of overuse injuries or training errors were included.
3. Studies that compare different terminologies, definitions for overuse injury or training load errors were included.
4. Studies that assist the accuracy, relationship, consistency, prevalence & other relevant outcomes were included.

Exclusion criteria:

1. Articles where the studies were related to surgical & pharmacological methods were excluded.
2. Studies conducted on animal population were excluded.
3. Studies that were based on non-primary research articles were excluded.

4. Language restrictions were applied & studies of languages other than English was excluded from the review.

Information Sources:

On 12th April 2023, a comprehensive literature review was conducted using multiple sources. Google scholar, PubMed & AJSM were explored to identify relevant studies published for the topic.

On 3rd May 2023, a more detailed study was conducted on literature review using NIH & Scopus. The keywords were chosen carefully to ensure broad coverage of the topic.

Snowball search technique was conducted to identify more studies by searching the reference lists, with the eligibility criteria of availability of full text reviews & using Google scholar, PubMed & Sci Hub to identify & screen the studies.

To identify any new articles found between the previous search date & the update & to ensure currency of the findings, an update of the database search was done on 22nd May 2023.

Once the exploration of the studies was completed, a detailed study of the articles was done starting from 3rd June 2023 up to 29th August 2023.

To ensure an update of the database, a second search was done on 2nd September 2023, to search for any new articles found between the previous search date & the update. The same search strategy was used including the 'snowball' technique.

Date of coverage of articles included in the study commenced from the time frame of 2014 up to 2023.

Search strategy:

Initially, an electronic search was conducted in the following databases:

Google scholar, PubMed & AJSM.

Databases were searched from 4th April 2023 to 30th May 2023 to develop the search strategy. Very important keywords were developed for the search. They are as follows:

and, athletes, overuse injuries, sports, training load errors.

Secondly, a search strategy was developed for the databases.

A detailed search strategy for the databases PubMed, AJSM & Google scholar are presented in Flowchart 1 & Flowchart 2.

After the initial selection, a snowball technique was used & search was conducted in the reference list to find more relevant studies.

At the end of the search strategy, literature review studies were cross checked to identify whether the study being conducted was included in any previous literature reviews.

The studies whose full text could not be obtained were downloaded from Sci Hub.

The data representing the dates of coverage & filters applied in search strategy is presented in Table 2.

Data selection & data collection process was conducted independently (DG).

Assessment of Risk of Bias:

The Risk of Bias for each included study was assessed using the Joanna Briggs Institute Critical Appraisal Tool (JBI). This tool consists of various questions designed for different study methods that assesses the Risk of Bias of a published article, including Cross sectional studies, systematic reviews, text & opinion & various other study designs.

To assess the Risk of Bias of a study, JBI tool was used to answer a series of questions about the study design, conduct & reporting.

Each question is rated with Yes, No, Unclear & Not applicable.

After the ratings of the individual questions were determined, the overall appraisal was obtained.

The detailed JBI Risk of Bias assessment of each study is given in Table 3.

Results

Article Identification:

A total of 2672 articles were retrieved through three database searches. After removing the

duplicates of studies that did not meet the inclusion criteria, screening the titles & abstracts, a total of 23 articles met the inclusion criteria & were considered for a full – text review. Review of full text of these 23 articles resulted in the removal of 9 additional articles & 14 studies met the inclusion criteria in the review identified in the search strategy.

The summary of the included articles in the review is presented in Table 4 & Supplementary Appendix.

Description of the Included Articles:

The largest number of studies included, reviewed the relationship between overuse injuries, training load errors & debates about the terminology accuracy among the two.

Of the 14 articles included in the review, 11 studies [4,5,6,8, 9,10,11,12,13,14,17] concluded that increased training performance is directly proportional to the increased risk of injury.

3 studies [5,11,12] directly call out for our field to replace the term 'Overuse' injury with 'Training load errors'

This is because, the term 'Overuse' is causing confusion & fear among the coaches & athletes to reduce their training loads which in turn is leading the athlete to participate in competitions without adequate training or preparations [5,11]. This may expose the tissues to deconditioning, which in turn may increase the risk of injury [5,11].

Another study implies, more than 60% of running injuries could be attributed to training error & in fact all overuse injuries are training load errors [12].

Five studies [4,5,6,10,11] suggest that, despite the increased risk of injury associated with increased training performance, there is equal evidence to suggest that the proper prescription of training load can help in protecting against injury.

One of the studies highlighted a key factor stating that, external load only partially quantifies training load errors & can thus provide a partial quantification of the risk injury [4].

One of the articles specifies that, as the training load increases there is a high risk of overuse injury, but decreased training load should also be considered as one of the reasons for overuse injury [11].

Highly specialized athletes (i.e., athletes who had training experience of > 8 months) had greatest risk of injury, was the spotlight of one of the studies. A notable finding of this study was that, highly specialized athletes had a lower rate of acute injuries [13].

A contradicting study stated as follows,

Training load is just one factor among an array of factors that may contribute to overuse injury occurrence. Defining overuse injuries astraining load errors is a negation of their multifactorial nature [15].

Assessment of the Article Quality:

The Risk of Bias assessment was completed using the JBI Critical Appraisal Tool & the detailed quality of evidence is presented in Table 3.

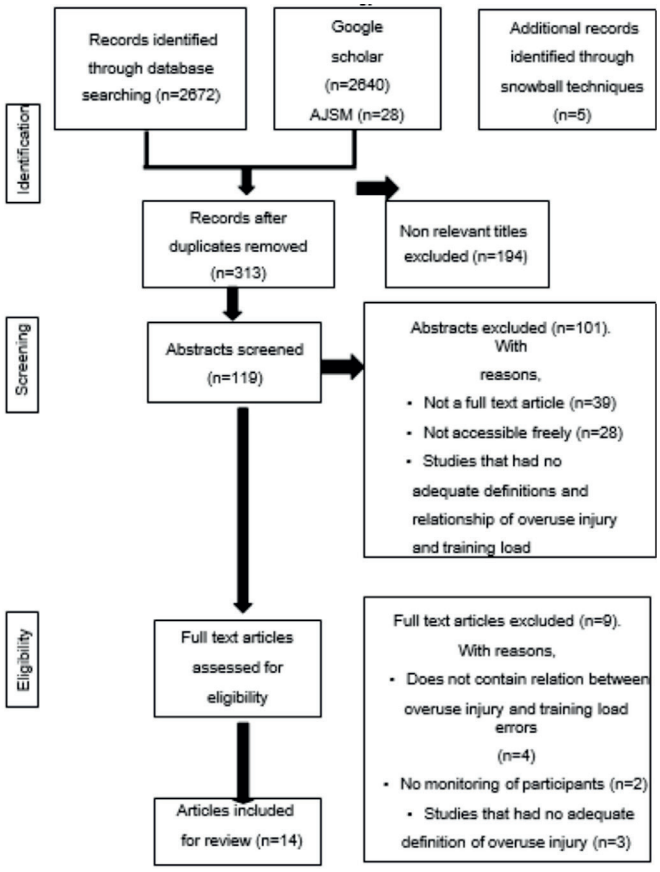
9 studies were of high score of evidence (>70% of criteria met).

3 studies reached moderate score (50-70% of criteria met).

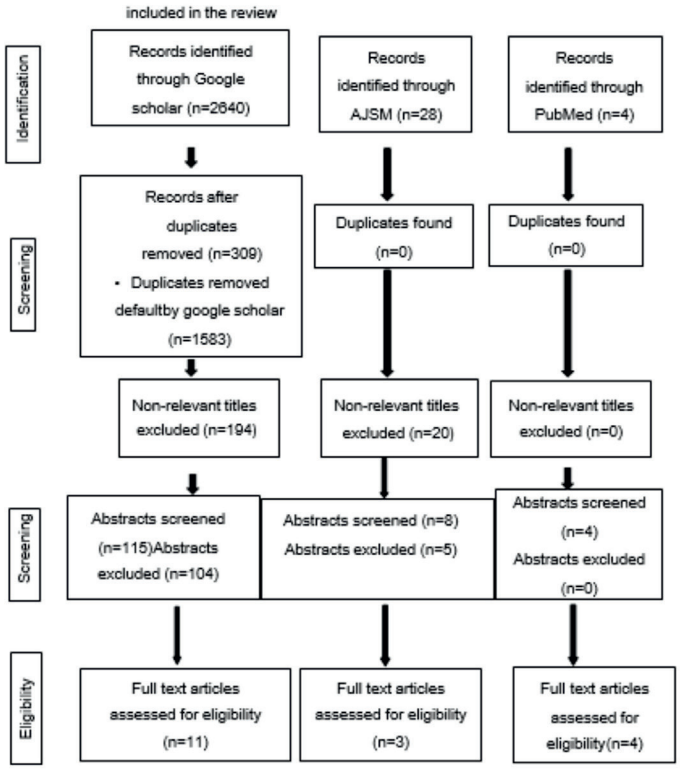
1 study demonstrated a low quality of evidence (≤50% of criteria met).

Table 1. Abbreviations

Abstract	Abbreviation
AJSM	American Journal of Sports Medicine
PICO	Population, Intervention, Comparison, outcome
NIH	National Institute of Health
JBI	Joanna Briggs Institute
PRISMA	Preferred reporting items of systematic reviews & meta-analysis
RoB	Risk of Bias
NOS	Newcastle Ottawa Scale
A : C	Acute: Chronic

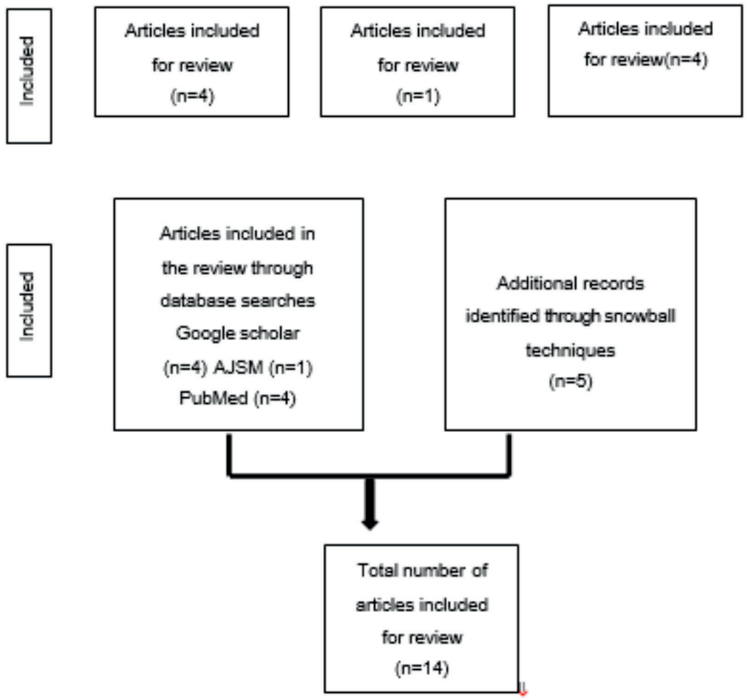


FLOWCHART 1. The detailed search strategy included in the review



FLOWCHART 2. The detailed search strategy for individual search engines

FLOWCHART 2. cont….



Discussion

Relationship Between Overuse Injury & Training Load Errors:

The number of sports played, joint ROM, muscular strength, physical characteristics & overuse injuries are not associated with each other. This suggests that, training volume maybe a more important key factor in overuse injury risk than the number of sports played. Increased training hours may cause repetitive stress to developing body, which may lead to overuse injuries to various body regions (Sugimoto D et al[17]).

Goldilocks approach to training follows the principle of - Not too little, not too much (Gabbett T J et al[10]).

The term "Overuse" injury may cause a misconception among the athletes as well as coaches & trainers to reduce the training load, which may lead to tissue deconditioning. Thus, the athlete may participate in competitions unprepared. This in turn may lead to increased injury risk [5,11].

The increased training load among highly specialized athletes (i.e., training for > 8 months) are at a higher risk of overuse injury occurrence, as the tissue & structure of the body regions is exposed to repetitive stress & trauma [9,13].

Adverse events of exercise trainings are dose related (i.e., prescription of training load) by "experts", with the highest incidence of injury occurring when training loads were highest (Gabbett T J[9]).

During training, due to increased external workloads, Musculoskeletal structures must have exposed themselves to stress, because of which the stress-frequency combination slips into the injury region. This occurs only when an individual's training program is exceeded beyond their current limit (Hreljac A[12]).

Training Load as a Protective Agent Against Injury:

Many reviews focused on the negative impact of training load whereas, few studies also highlighted a very important factor of the protection of bodily structures via proper training prescription.

Four studies included in the review showed evidence for "Protectant against injury" principle [4,5,9,10,18].

Contemporary publication highlighted that; moderate chronic loads are protective whereas high & low loads are not [9,10].

Acute-Chronic Workload Ratio:

Acute workload is the amount of training performed in a short period of time, usually one week [i.e., Banister's fatigue].

Chronic workload is the amount of training / workload performed over a longer period of time, typically four weeks [i.e., Banister's fitness]

The ratio between acute workload to the chronic workload is defined as the Acute-Chronic workload ratio [9,10]. These acute & chronic workloads can predict injury (Gabbett T J et al[10]).

If the A-C workload ratio is ≥ 1.5, it indicates the association of increased risk of injury [9,10].

If the acute workload is less & the chronic workload is high, then the athlete's sporting performance improves & the athlete is well prepared.

However, if the fatigue is greater than fitness, the A-C workload ratio may reverse, leading to overuse injury (Gabbett T J et al[10]). Thus, this ratio indicates both athlete's risk of injury & preparedness to perform [5,9,10,15].

The Acute-Chronic workload ratio is considered to be one of the 'Best practice' to monitor athlete's workload [5,10].

Prevention or Intervention Strategies:

One of the major strategies to prevent overuse injury is to perform cross training. Evidence states, athletes who are involved in multiple sports have increased benefits to reduce injury risk (Sugimoto D et al[17]).

Returning safely from injury is a crucial step in an athlete's career. Hence, it is highly advisable to the therapists & coaches to learn & understand about the previous history & the amount of training performed in the current week relative to the preceding four weeks.

Weekly increase in workloads by > 10% causes injury, hence in order to prepare for competition demands, an athlete needs to gradually increase their workloads, so that their fitness levels are greater than fatigue levels (Gabbett T J et al[10]).

Hulin *et al*., illustrated that, the chronic workload of an athlete combined with the acute loads have a higher protective capacity.

To reduce injury risk, practitioners should aim within a range of approximately 0.8 – 1.3 A-C workload ratio.

Awareness Education on the Relationship between Overuse Injury & Training Load Errors:

Spike in training workloads leads to increased injury risk. Hence, the understanding among clinical staff, the coach, athlete & support staff about the spikes in training loads with the adequate management strategies is of greater importance.

Every staff must have knowledge regarding the association of overuse injury & training load errors, in order to prevent injury risk.

Multiple educational approaches should be used to teach the staff & athletes regarding the types of workloads, injury risk & proper training load prescription in order to avoid injuries (Drew M K & Finch C F[5]).

Strengths of the Review:

The research question is clearly identified & stated which provides a clear view of the review.

Five studies included in the review were searched through Snowball technique, leading to low risk of studies not being included & also low risk of bias.

Moreover, the studies were assessed for their quality of evidence, hence the Risk of Bias is low.

Using JBI tool for Risk of Bias assessment strengthens the review results.

The review was of high-quality, as it followed the PRISMA 2020 Checklist guidelines.

Most of the included studies met the criteria for the risk of bias assessment being considered as high-quality, hence the quality of level of evidence is high.

Limitations of the Review:

The search strategy was limited to articles in English, potentially eliminating some high-quality studies from the results.

One of the major limitations of the review was that, all the study data were reviewed by individual researcher, increasing the possibility of errors.

JBI Risk of Bias assessment has a major drawback, as the evaluation of evidence was performed by independent researcher.

Clinical Implications:

More research is needed to develop standardized definitions & measurement methods for training load errors.

Conclusion

This systematic review extends the studies conducted by M K Drew et al[5] & Tim J Gabbett et al[11] examining the relationship & terminology accuracy between Overuse injury & Training load errors.

Our results demonstrate that, evidence for relationship between Overuse injury & Training load errors in competitive athletes has been substantially strengthened in the past 8 years & continuous to grow stronger.

Overall, the term Training load error is more accurate & informative than the term Overuse Injury when describing injuries that occurs from repetitive stress.

As evidently stated by M K Drew & C Purdam[5], this review concludes by emphasizing the field of Sports Sciences to avoid the term Overuse Injury & replace it with Training Load Error.

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Ethical Clearance:[1] JSS College of Physiotherapy, Mysore, Karnataka, India.The study protocol was approved by the Internal Review Committee of JSS College of Physiotherapy in Mysore, Karnataka, India on 15th June 2023.

Conflict of interest and Source of Funding

The authors certify that they have no affiliations with or financial involvement in any organization in the subject matter or materials discussed in the article.

"We affirm that the authors have no financial affiliation (including research funding) or involvement with any commercial organization that has a direct financial interest in any matter included in this manuscript.

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