

Review Article

Injuries in Crossfit practitioners: narrative review

Lesões em praticantes de Crossfit: revisão narrativa

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Moreira MO, Castello TM, Moraes MM, Silva JGL, Braga RAT. Injuries in Crossfit practitioners: narrative review / *Lesões em praticantes de Crossfit: revisão narrativa*. Rev Med (São Paulo). 2022 Nov-Dec;101(6):e-197455.

ABSTRACT: *Introduction:* CrossFit is a training program based on fitness development which has been gaining popularity, both in its competitive and non-competitive modes. The training uses three standards to guide physical conditioning: development of skills, such as endurance and strength; good performance in all tasks; and competency and training of pathways that determine metabolic conditioning. *Objective:* To assess the most frequent types of injuries associated with CrossFit training and the causes and risk factors for their occurrence. *Methodology:* The literature review was conducted between October and November 2021 in the PubMed, BVS, LILACS and IBICS databases, using the MeSH terms “high intensity interval training”, “sports injury” and “injury”. *Results:* After applying the inclusion and exclusion criteria, eight studies were used in the review and a table with the main findings of each one was created. The results found were divided into 4 groups, referring to: upper limbs; lower limbs; trunk and spine; and risk factors for injuries. Shoulder and knee injuries were the most prevalent, and there is a need for further studies on spinal and trunk injuries. As for risk factors for the occurrence of injuries, the correlations between CrossFit experience, training frequency, and participation in competition are not well defined. *Conclusion:* The studies found different values of prevalence, but agreed that shoulder injuries were more prevalent in the upper limbs, knee injuries in lower limbs, and lumbar injuries in the spine. Despite the scarcity of literature on the subject, there is a clear need for the supervision of trained professionals in order to avoid injuries.

Keywords: High-intensity interval training; Sports medicine; Athletic injuries.

RESUMO: *Introdução:* O CrossFit tem como pilar o desenvolvimento do condicionamento físico e está se difundindo entre a população, tanto em modalidades competitivas quanto não competitivas. O treinamento faz uso de três padrões para orientar o condicionamento físico: desenvolvimento de habilidades, como resistência e força; bom rendimento em toda atividade; e competência e desenvolvimento das vias determinantes do condicionamento metabólico. *Objetivo:* Reunir os tipos mais frequentes de lesões provocadas pela prática de CrossFit e as causas e os fatores de risco para o desenvolvimento destas. *Metodologia:* A revisão da literatura foi realizada ao longo dos meses de outubro e novembro de 2021, por meio das bases de dados PubMed, BVS, LILACS e IBICS, utilizando os termos MeSH “high intensity interval training”, “sports injury” e “injury”. *Resultados:* Foram inseridas 8 publicações neste estudo, após a aplicação dos critérios de inclusão e exclusão e foi confeccionada uma tabela com os principais achados de cada estudo. Os resultados encontrados foram subdivididos em 4 grupos relacionados a: MMSS; MMII; tronco e coluna; fatores de risco para lesões. As lesões de ombro e joelho são as mais prevalentes, e há necessidade de mais estudos sobre lesões de coluna e tronco. No que tange aos fatores de risco para o desenvolvimento de lesões, as correlações entre tempo de prática do CrossFit, frequência de treinos e participação de competições não são bem definidas. *Conclusão:* As prevalências das lesões divergem entre os estudos, todavia as lesões de ombro são mais predominantes em MMSS, joelhos, em MMII e região lombar, na coluna vertebral. Apesar da literatura escassa sobre o tema, torna-se evidente a necessidade de acompanhamento por meio de profissionais capacitados para evitar a ocorrência de lesões.

Palavras-chave: Treinamento intervalado de alta intensidade; Medicina esportiva; Traumatismos em atletas.

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INTRODUCTION

Crossfit is a training program based on fitness development which has been gaining popularity, both in its competitive and non-competitive modes^{1,2}. The program differs from other fitness training programs by using exercises that allow building body control and range of motion and that can produce power through the control of external objects³.

Crossfit uses three standards to guide the training, namely: skill development – endurance, strength, flexibility, power, speed, agility, coordination, balance, and accuracy –; good performance in all tasks; and competency and training of phosphagen, glycolytic and oxidative pathways, as the balance of the effects of these three pathways determines metabolic conditioning⁴.

Therefore, CrossFit combines metabolic conditioning, gymnastics, and weightlifting. Metabolic conditioning includes activities such as biking, running, and rowing, while cardiovascular fitness – with maintenance of strength, speed, and power – is developed through interval training, with alternating periods of work and rest in timed intervals. Gymnastics promotes body control, with the development of balance, strength, flexibility, agility, coordination, and accuracy; and weightlifting also develops strength, in addition to speed and power⁴.

With the increasing adherence of the population and the growing number of CrossFit athletes, the idea that there is a high incidence of injuries among CrossFit practitioners gained prominence. However, CrossFit injury rates are comparable to those of other sports – such as weightlifting, gymnastics, and running –, which have a significantly lower injury incidence rate than sports such as soccer². There is a scarcity in the literature on injuries among CrossFit practitioners and athletes, which makes it relevant to assess these injuries, as well as their prevalence and associated risk factors, with the objective of developing preventive strategies.

Thus, the present study is an exploratory review that intends to conduct a survey on injuries among high-intensity functional training - CrossFit - practitioners, highlighting their types, possible causes, and associated risk factors.

METHODOLOGY

This study is a narrative review, based on scientific research published between 2017 and 2021, in Portuguese, English and Spanish, in the following databases: National Library of Medicine (PubMed), Virtual Health Library

(VHL), Latin American and Caribbean Health Sciences Literature (LILACS) and Índice Bibliográfico Español en Ciencias de la Salud (IBECS). The survey was conducted between October and November 2021. The descriptors used were, exclusively, “high intensity interval training” AND “sports injury” AND “injury”; this search resulted in 86 articles. After this result, the following steps were taken: reading all abstracts of the articles found; full reading of the articles selected after reading the abstracts; interpretative reading; and writing of the review. Among the publications, duplicates and articles that did not address the theme of the review, as identified after reading their title and abstract, were excluded. Thus, eight publications were selected, as they brought significant contributions to the present study. The results found – prevalence of injuries and risk factors – were compared in the discussion. The approval of the Research Ethics Committee was not necessary, as this was a narrative review.

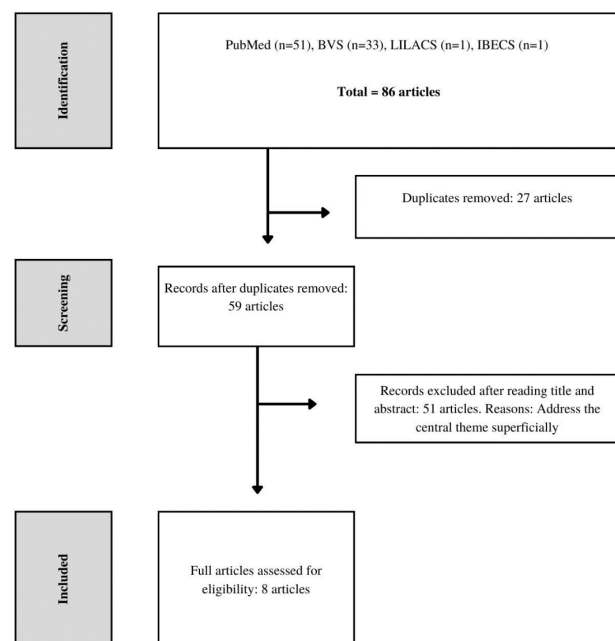


Figure 1. Flowchart of search and selection of articles (Elaborated by the authors).

RESULTS

After selecting the articles, a table with the main findings of each study (Chart 1) was created. The chart shows author, year of publication, sampling/participants and the main results of each study.

Chart 1. Main findings of the articles included in the literature review.

Author	Year	Sampling/Participants	Main findings
Minghelli et al. ¹	2019	n=270 Crossfit practitioners of both genders, from the south of Portugal, who did or did not take part in competitions.	Most common injuries: joint (30.8%) and muscle (23.1%). Location: 35.9% in the shoulder; 11.5% in the knee; 17.9% in the lumbar spine. Risk factors: participating in competitions and training less than twice a week increase the chance of injury.
Sugimoto et al. ³	2020	n=115 Pediatric patients with injuries caused or aggravated by CrossFit training, with medical records from a tertiary-level sports medicine clinic.	Prevalence of injuries: shoulder (joint) - more frequent in men (23.6%) than in women (10%); lower limbs - more frequent in women (58.3%) than in men (34.5%); Trunk – more frequent in those ≤ 19 years old (37.5%) than in those > 19 years old (17.7%).
Rynecki et al. ⁵	2019	NEISS* - estimate of the incidence of injuries. Calculation and comparison of incidence between 2007-2011 and 2012-2016 = 3,988,903 injuries.	Prevalence of injuries: more frequent in men (58%) aged 20 to 39 years (39%). Lower limbs: 35.3%, trunk 28.5%, and upper limbs 19.6%. Increase (144%) in all injuries (2012-2016 <i>versus</i> 2007-2011). Increase in HIIT interest (274%).
Szeles et al. ⁶	2020	n=406 Crossfit practitioners from a Brazilian city.	Prevalence of injuries: 32.8%. Most common injuries: muscle (45.34%); joints (24.7%) and tendinopathies (12.96%). Location: 19% in the shoulder; 11.7% in the knee; 15% in the lumbar spine. Risk factors: switching between “RX” and “scaled” training loads, previous injuries, and experience of less than one year increase the chance of injury.
Claudino et al. ⁷	2018	n=3597 Practitioners of both genders, teenagers, adults, older adults, and competitors.	Prevalence of injuries: between 19% and 74%. The shoulder is the most affected part, followed by the lumbar spine. Risk factors: more than 6 months of experience, incorrect execution, and aggravation of previous injury.
Teixeira et al. ⁸	2020	n=189 Practitioners of high-intensity functional exercise of both genders.	Prevalence of injuries: 35.4% in the shoulder, 20.3% in the lumbar spine and 12.7% in the knee. Causes: incorrect execution (34.2%), repetitive strain (29.1%) and high loads (17.7%). Incidence of 6.1 injuries per 1000 hours of training.
Vukanic et al. ⁹	2020	n=1 Participant in an extreme conditioning program at a gym, male.	Case report of an acetabular fracture after performing high-intensity physical training in a reduced time interval.
Sephien et al. ¹⁰	2020	n=1 The study does not classify the patient as a CrossFit practitioner or athlete.	First case report of complete pectoralis major tear through an atraumatic mechanism when performing a CrossFit exercise called “muscle-up”.

Source: Elaborated by the authors.

*NEISS: National Electronic Injury Surveillance System

DISCUSSION

Main injuries in the upper limbs (UL) caused by CrossFit training

Regarding injuries in the upper limbs, a cross-sectional study using a US database queried from 2007 to 2016 identified the prevalence of injuries associated with high-intensity functional exercises. Upper limb injuries corresponded to 19.6% of the total injuries, regardless of location and type of injury⁵.

Among upper limb injuries, the shoulder is the most affected site in men (23.6%). These injuries are most often associated with gymnastics and may be related to the need for advanced technical skills to perform the movements combined with the practitioner's lack of prior training. Olympic weightlifting also places significant stress on the shoulder through heavy overhead presses³. In agreement, another study showed that the most prevalent types of injuries were joint (cartilage, meniscus, ligament injury/sprain, dislocation) and muscle (tendon, contusion) lesions, more frequently in the shoulder (35.9%)¹. This review also

found results indicating that the prevalence of injuries during CrossFit training was 32.8%, with higher frequency of injuries in the shoulder (19%)⁶.

Furthermore, a meta-analysis also found that the shoulder was the most common injury site, especially in gymnastic movements, with a rate of 1.9 injuries per 1000 hours of training ($n = 187$); the most common causes of injuries were inadequate form of movement and aggravation of previous injury⁷. Another study showed a higher prevalence of shoulder injuries (35.4%) and a higher rate of injuries per time, with 6.1 injuries per 1000 training hours ($n = 189$), indicating as the main causes of injuries incorrect execution, repetitive strain, and high loads⁸.

Thus, shoulder injuries are the most prevalent upper limb injuries^{1,6,7,8}, with varying results between studies, both in the injury rates and in their causes, which include technique^{3,7,8}, training period³, type of exercise performed³, load used⁸, and presence of previous injuries⁷. This demonstrates that more consistent studies on CrossFit should be conducted to elucidate the prevalence and the correlation of these traumas to gender, age and associated risk factors, so that prevention measures can be developed.

Main injuries in the lower limbs (LL) caused by CrossFit training

Regarding LL injuries, a cross-sectional study identified the incidence of injuries associated with high-intensity functional exercises. Lower limb injuries corresponded to 35.3% of the total injuries, regardless of location and type of injury⁵.

There is a higher rate of lower limb injuries in female CrossFit athletes (58.3%), and the knee joint is the most affected site (30%). These lesions may occur due to complex movements done without the necessary strength in the hip abductor muscles, as well as weightlifting and repetitive jumping³. Another study also points out that knee injuries are among the most common ones (11.5%) and associates these lesions with Olympic weightlifting and gymnastic movements¹. In agreement, studies found that knee injuries represented 12.7%⁸ and 11.7%⁶ of lower limb injuries.

Although hip injuries are not very prevalent in high-intensity exercises similar to CrossFit (2-4%), a case report described a fracture of the acetabulum (cavity that articulates with the femur, in the hip) sustained during a high intensity exercise that consisted in pushing a machine with weights. The lesion was caused by incorrect execution of the movement⁹.

Therefore, knee injuries are the most prevalent lower limb injuries^{1,3,6,8}, with varying results between studies, both in the injury rates and in their causes, which include technique⁹, type of exercise performed^{1,3} and strength required³. However, some case reports describe uncommon trauma⁹, demonstrating the need for more

consistent studies on CrossFit, not only to elucidate the prevalence and the correlation of the most common injuries to gender, age and associated risk factors, but also to know other possible injuries that can affect CrossFit athletes and practitioners.

Main injuries in the trunk and spine caused by CrossFit training

Regarding trunk injuries, a study was the first case in the literature that reported a complete tear of the pectoralis major muscle in a young woman through an atraumatic mechanism. The injury occurred during a “muscle up” CrossFit exercise (transitional movement between hanging and lifting the body weight on a bar or on rings, with the arms stretched out supporting the body weight), in the “dip” position (when the person returns to the lower position), which is present in other gymnastic movements¹⁰.

Spine injuries are more common in athletes aged 19 years and younger than in those over 19 years old. Examples of these injuries are generalized back pain, injury to the sacroiliac joint (region of the terminal bone at the base of the spine – sacrum – with the hip bone – iliac) and spondylolysis (stress fracture in the posterior portion of the bones in the spine)³. These injuries are most often associated with inadequate weightlifting technique and weight, in addition to low trunk stability, excessive weight, and lack of supervision, which can be an aggravating factor³. Another study pointed to the lumbar spine as one of the sites with the highest prevalence of injuries (17%)¹. Likewise, other studies indicate a prevalence of 15% to 28.5% of lumbar spine injuries in CrossFit training^{5,6,8}. A study with almost 4 million reports found that lumbar spine injuries are the second most common lesions in high-intensity functional training athletes, second only to lower limb injuries^{5,6,8}.

Thus, discussions on the prevalence and incidence of trunk-related injuries are still incipient, even though these lesions exist. More consistent studies on spinal injuries should be conducted to establish correlations between these injuries and the practitioner's gender, training time and associated risk factors, as the studies found are limited to the correlation between spinal injuries and the age group of athletes and practitioners³.

Risk factors for injuries in CrossFit

Crossfit practitioners who participated in competitions were less likely to have an injury than those who did not (odds ratio = 2.64), and those who trained less than twice a week were more likely (odds ratio = 3.24) to have an injury than those who trained three or more times a week¹. This is because practitioners who train less develop less muscle strength and flexibility and have less technical skills to perform exercises properly¹. Practitioners who

participate in competitions probably have the supervision of a coach, longer training experience, and adequate technical skills. In addition, they benefit from more individualized training, regarding both the exercises and the load. Practitioners who train less than 3 times a week have a more acute and chronic muscle response to lower loads of exercise than those who train more times a week, which can lead to fatigue and impair their musculoskeletal stability^{1,8}.

On the other hand, a study indicates that participants who practiced CrossFit for more than 6 months had higher injury rates than those who practiced for less than 6 months, and that greater experience was related to the level of activity⁷. However, the author reported that the articles used in their meta-analysis did not achieve a high level of evidence at low risk of bias⁷; therefore, these findings should be considered with caution. Another study found that having at least 1 year of CrossFit experience reduces the risk of injury by approximately half⁶.

Another risk factor for injuries is alternating “scaled” and “RX” training loads, which are beginner and advanced categories, respectively⁶. Thus, extra attention should be paid to transition period between the categories. In addition, the presence of previous injuries increases the chances of CrossFit-related injuries by 3 times⁶.

Therefore, the correlations of CrossFit experience^{6,7}, frequency of training per week^{1,8} and participation in competitions¹ with the occurrence of injuries, although

studied, are not well defined and clarified, since the authors found different results on the subject.

CONCLUSION

The present review, according to its objective and method, described studies on CrossFit and high-intensity interval training. Despite of their relevant results, there is a limited number of studies. In addition, the studies found different values of prevalence, but agreed that shoulder injuries were more prevalent in the upper limbs, knee injuries in lower limbs, and lumbar injuries in the spine. Despite of the occurrence of lesions in other sites such as trunk and hip, these injuries are rarely discussed, which limits their prevention. In addition, the authors found different results regarding the risk factors associated with injuries, such as experience, weekly frequency, and participation in competitions.

Thus, more consistent studies should be conducted to clarify the gaps presented in this study on injuries in CrossFit and high-intensity interval training. However, important findings were presented, such as the need for the supervision of trained professionals and for attention to the technique of the movements, to the weights used, and to the progression of exercises and loads according to the individuality of each person, in order to prevent injuries.

Authors participation: Milena Oliveira Moreira – Participation in the choice of the topic, writing of the text, formatting, and review. Thales Martins Castello – Participation in the writing the text. Mariana Mauricio Moraes – Participation in the writing the text. João Guilherme Lino da Silva – Participation in the writing of the text. Renato Andrade Teixeira Braga – Guidance on the definition of the topic addressed and on the writing method, assistance in the process of inclusion and exclusion of articles, participation in the writing of the study and text review.

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Received: May 17, 2022
Accepted: August 17, 2022