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# Injury profile in CrossFit practitioners: systematic review

*Perfil de lesões em praticantes de CrossFit: revisão sistemática*

*Perfil de lesiones en los practicantes de CrossFit: revisión sistemática*

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**ABSTRACT |** CrossFit is a new form of physical training that has become popular since its inception. This study aimed to analyze the injury profile of CrossFit practitioners through a systematic review. PRISMA recommendations were applied to this systematic review. Electronic search was performed in the databases CINAHL, SciELO, Science Direct, SCOPUS, LILACS, PEDro, PubMed, SPORTDiscus and Web of Science. The methodological quality of the studies was assessed. Ten studies were selected. The prevalence of injuries in CrossFit practitioners ranged from 5 to 73.5%, and the overall injury incidence rate per 1000 training hours ranged from 1.94 to 3.1 injuries. The body region most affected by injuries was the shoulders, followed by the back and the knees. Regarding associated factors, the type of exercise performed and CrossFit training time were related to injuries. Besides that, sex was associated to the prevalence of injuries, with men showing more injuries than women. Age was not related to injury prevalence. It was concluded that the most commonly affected body region among CrossFit practitioners was the shoulders, predominantly in males and with previous injuries, often obtained in other modalities. In addition, CrossFit can be safely practiced by individuals aged 18-69.

Keywords | Exercise; High-Intensity Interval Training; Wounds and Injuries; Review.

**RESUMO |** O *CrossFit* se apresenta como um novo método de treinamento físico que vem ganhando popularidade desde sua criação. O objetivo deste estudo foi analisar o perfil de lesões em praticantes de *CrossFit* por meio de uma revisão sistemática da literatura. Utilizaram-se as recomendações da Declaração PRISMA para condução da revisão sistemática. A busca foi realizada nas bases de dados CINAHL, SciELO, *Science Direct*, SCOPUS, LILACS, PEDro, PubMed, *SPORTDiscus* e *Web of Science*. Avaliou-se a qualidade metodológica dos estudos, entre os quais dez foram considerados elegíveis. A prevalência de lesões nos praticantes de *CrossFit* variou de 5 a 73,5%, e a taxa de lesão variou de 1,94 a 3,1 lesões a cada 1.000 horas de treinamento. A região corporal mais acometida por lesões nos estudos selecionados foram os ombros, seguidos pelas costas e joelhos. Em relação aos fatores associados às lesões, destacou-se o tipo de exercício realizado e o tempo de prática de *CrossFit*. O sexo apresentou associação com a prevalência de lesões: estudos demonstraram que os homens apresentaram maior número de lesões em relação às mulheres. A idade esteve entre os fatores que não estiveram associados às lesões. Conclui-se que os ombros são a região corporal mais comumente acometida entre os praticantes de *CrossFit*, em indivíduos do sexo masculino e com lesões prévias, muitas vezes obtidas em outras modalidades.

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Telefone: (48) 3664-8677 – Finance source: Nothing to declare – Conflict of interests: Nothing to declare – Presentation: Aug. 9th, 2017 – Accepted for publication: May 24th, 2018.

Constatou-se, ainda, que o *CrossFit* pode ser praticado com segurança por indivíduos de 18 a 69 anos.
Descritores | Exercício; Treinamento Intervalado de Alta Intensidade; Ferimentos e Lesões; Revisão.

**RESUMEN |** *CrossFit* es un nuevo método de entrenamiento físico y ha ganado popularidad desde su creación. El objetivo de este estudio fue analizar el perfil de lesiones en practicantes de *CrossFit* a través de una revisión sistemática. La Declaración PRISMA fue utilizada para la preparación de esta revisión. Se realizó una búsqueda bibliográfica en las siguientes bases de datos: CINAHL, SciELO, *Science Direct*, SCOPUS, LILACS, PEDro, PubMed, *SPORTDiscus* y *Web of Science*. Se evaluó la calidad metodológica de los estudios, entre los cuales diez estudios fueron considerados elegibles. La prevalencia de lesiones en los practicantes de *CrossFit* tuvo una variación del 5 al 73,5%, y la tasa de lesiones de 1,94 a 3,1 lesiones a cada 1000 horas de entrenamiento. La región corporal más lesionada fueran los hombros, seguido por las espaldas y rodillas. En relación a los factores asociados a las lesiones, se destacan el tipo de ejercicio fue realizado y el tiempo de práctica del *CrossFit*. En relación al género, los hombres presentaron más lesiones. La edad no estuvo asociada a las lesiones. Se concluye que la región corporal más comúnmente acometida entre los practicantes de *CrossFit* fueron los hombros, en individuos masculinos y con lesiones previas, muchas veces obtenidas en otras modalidades. Además, el *CrossFit* puede ser practicado con seguridad por individuos de 18 a 69 años.
Palabras clave | Ejercicio; Entrenamiento de Intervalos de Alta Intensidad; Heridas y Lesiones; Revisión.

## INTRODUCTION

It is noteworthy that there is a fairly recent interest of researchers and the general public in physical activities in which high intensity is prevalent[1]. Studies show that high intensity training provides more benefits to physical fitness and health while having shorter duration, when compared to traditional training methods[1,2].

Thus, CrossFit presents itself as a new method of physical training that has gained popularity since its creation and implementation at the beginning of the new millennium[3]. It aims to promote physical fitness through the development of components such as aerobic capacity, muscular strength and endurance, speed, coordination, agility and balance[4], through sports and functional exercises, comprising weightlifting exercises, gymnastic and aerobic conditioning movements, which can be executed at high intensity[5].

In the world, there are about 12,000 certified and registered fitness centers and gyms that offer CrossFit[3]; of these, approximately 440 are in Brazil, involving approximately 40,000 practitioners and athletes[6]. Research shows a significant growth in the number of practitioners of this modality in various populations, such as healthy or obese individuals and athletes, due to its challenging and motivational nature[7-9]. Evidence shows that about 5% of CrossFit practitioners present a dependency relationship, which is significantly associated with the incidence/frequency of injuries[4].

The American College of Sports Medicine (ACSM) suggests potential benefits of CrossFit, but also highlights significant injury risks in extreme conditioning programs like the aforementioned[10]. These programs involve the execution of some exercises that, if performed incorrectly or excessively, can cause musculoskeletal injuries, ligament injuries, and even rhabdomyolysis[10]. In this way, concerns over the potential injury risk associated with the intense and repetitive nature of CrossFit and the necessary technical requirements for performing the exercises safely have grown in academia and in the practice of modality[11].

Gathering information from studies available in the literature on injuries of CrossFit practitioners allows us to get to know data related to the prevalence and rates of injury by hours of training, most commonly injured body regions, and injury-related factors, aiming to develop and implement preventive actions in its practice, considering the increase of the number of practitioners and, consequently, of environments that allow for the practice of CrossFit. In addition, a systematic review with analysis of these aspects for clinical decision making in the fields of medicine and physical therapy is valuable. Since the currently published reviews on *CrossFit* injuries[12,13] were limited to investigating the injury rate by comparing it with other types of physical exercises and sports, no studies were found addressing the various aspects these injuries have, such as rate and prevalence, commonly affected body regions and related factors, hence resulting in an injury profile[14,15]. Thus, the

objective of this study was to analyze the injury profile of CrossFit practitioners through a systematic review of the literature.

## METHODOLOGY

This is a systematic review of the literature following the recommended criteria of the PRISMA Statement – Preferred Reporting Items for Systematic Reviews and Meta-Analyses[16].

### Search Strategy

Representing a significant part of global scientific production, the search for studies was performed on the electronic databases related to Sport and Physical Exercise Sciences, and Physical Therapy: CINAHL via EBSCO, SciELO (Scientific Electronic Library Online), Science Direct, SCOPUS (Elsevier), LILACS (Literatura Latino-Americana e do Caribe em Ciências da Saúde), PEDro (Physiotherapy Evidence Database), PubMed (National Library of Medicine and National Institutes of Health), SPORTDiscus via EBSCO, and Web of Science – Coleção Principal (Thomson Reuters Scientific).

The search took place in May 2017 and ended on 11 May of the same year. In order to include all production conducted on the topic in the databases selected, and because of the recent creation and development of CrossFit, the only term used for article search was "Crossfit", in the same way the study by Meyer et al.[13] was conducted.

The search in the database Web of Science was performed in Core Collection, the basic search field with the term "Crossfit", the item Topic selected and Timespan set as all years.

## ELIGIBILITY CRITERIA

Only original articles about injuries with athletes and practitioners of CrossFit were considered, including studies with quantitative, qualitative or mixed approach, with summaries and texts available in full online until 11 May 2017. No time limit was set. Review articles, case studies, conference abstracts, editorials and letters were excluded.

Eligibility of the studies occurred by means of the PICOS criteria and are detailed in Table 1.

Table 1. Criteria for inclusion and exclusion of the studies selected for review

| | | Inclusion | Exclusion |
|---|---|---|---|
| P | Participate | Any individual practitioner of CrossFit | Individuals practicing other forms of physical exercise |
| I | Intervention | *CrossFit* | Massages, manual therapy, stretching, alternative therapies, weight training, hiking or running, High Intensity Interval Training (HIIT) |
| C | Comparison | With healthy individuals or not, with groups of other physical exercises, or Control Group without intervention | – |
| O | Outcome | Injuries, trauma | – |
| S | Study | Randomized and non-randomized controlled study | Case studies, review, review with meta-analysis |

### Selection of studies and data extraction

The studies were selected by three reviewers (FHD, TCS, TTS), independently. Initially, analysis of the article titles identified through the search strategy was conducted, followed by examination of the abstracts. Subsequently, analysis of the full text of the articles selected in the previous steps was performed. Disagreements between reviewers were resolved by consensus.

For determining injury profile in CrossFit, data analysis was conducted while considering the following categories: prevalence and type of injury, body region affected by injury, injury rate by training time and whether factors were related to injuries or not.

### Assessment of the methodological quality of the studies

In order to assess the methodological quality of the studies, the recommendations of STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) were followed, by means of the STROBE Statement – Checklist of items that should be included in reports of cross-sectional studies[17,18]. This checklist has 22 items that received a score from 0 (does not meet) to 1 (meets), the total score was obtained from the sum of the item

scores and, according to the final score of the study, a classification in accordance with Mataratzis et al.[19] was defined: a) when the study met more than 80% of the criteria as established by STROBE, indicating better quality of studies; b) – when 50% to 80% of STROBE criteria were met; and c) when less than 50% of the criteria were met.

## RESULTS

The search resulted in 684 entries. After duplicate exclusion (n=75) and title reading, 100 articles were selected for the abstract. In this step, other 79 were excluded 79, with 21 left for full reading. Finally, 10 studies were part of the final review (Figure 1).

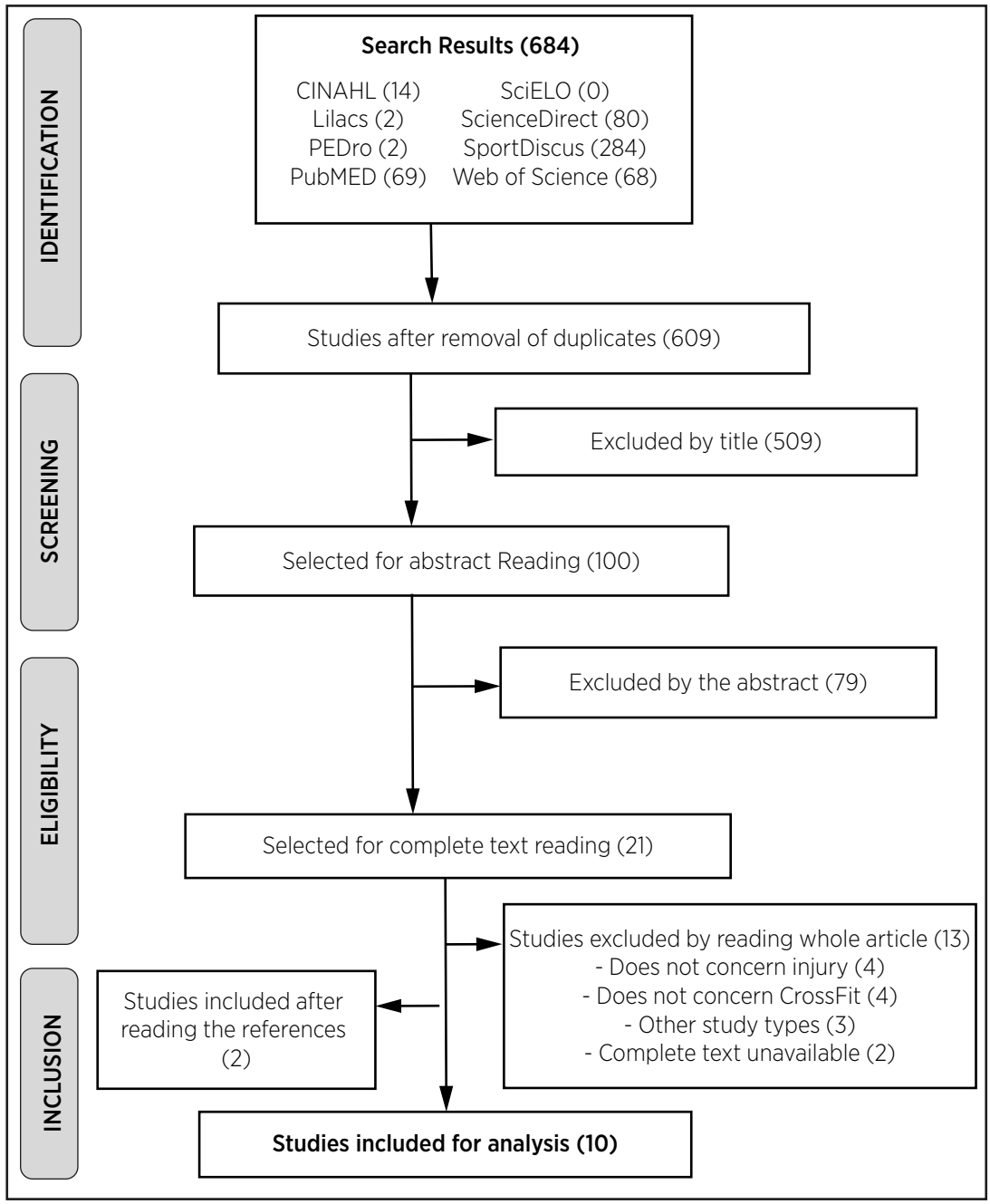


Figure 1. Flowchart of the selection process of the studies included

The sample size of the selected studies ranged from 34 to 1,393, totaling 3,307 research subjects, 2,244 being of male and 871 of female sex (192 subjects did not have their sex reported). The subjects were characterized as CrossFit practitioners in six studies, athletes in three studies, and soldiers in one. The average age of the research subjects ranged from 26.8 to 38.9 years, and the age group ranged from 18 to 69 years.

The prevalence of injuries in the studies ranged from 5 to 73.5%. The rate of injuries every 1,000 hours of CrossFit training ranged from 1.94 to 3.1 injuries (Chart 1).

Chart 1. *CrossFit* injuries: Author, sample and main results related to injuries

| Author | Sample | | | | Results – Injuries | | | |
|---|---|---|---|---|---|---|---|---|
| | n | Sex | | Age average (years) | Population | Prevalence (n/%) | Type of injury | Injury rate (every 1,000 hours of training) |
| | | Men | Women | | | | | |
| Grier et al.[20] | 1393 | 1248 | 145 | 26.8 | Soldiers | 5% | – | – |
| Hak et al. [21] | 132 | 93 | 39 | 32.3 | Athletes | 97 (73.5%) | – | 3.10 injuries |
| Weisenthal et al.[22] | 386 | 231 | 150 | 18 to 69 | Practitioners | 75 (19.4%) | Inflammation, sprain and dislocation | – |
| Chachula, Cameron, Svoboda[23] | 54 | 40 | 14 | 17 to 50 | Practitioners | 24 (44%) | Joints | – |
| Huynh et al.[24] | 34 | 25 | 9 | 35.5 | Practitioners | 12 (35%) | Rhabdomyolysis | – |
| Sprey et al. [6] | 566 | 323 | 243 | 31.4 | Practitioners | 176 (31%) | – | – |
| Summitt et al.[25] | 187 | – | – | – | Practitioners | 44 (23.7%) | – | 1.94 injuries |
| Aune, Powers[26] | 247 | 139 | 108 | 38.9 | Athletes | 85 (34%) | – | 2.71 injuries |
| Montalvo et al.[27] | 191 | 94 | 97 | 31 | Athletes | 50 (26.17%) | More acute than chronic | 2.3 injuries |
| Moran et al.[3] | 117 | 51 | 66 | 35 | Practitioners | – | Acute and of Gradual start | 2.10 injuries |

Caption: (–): Not reported

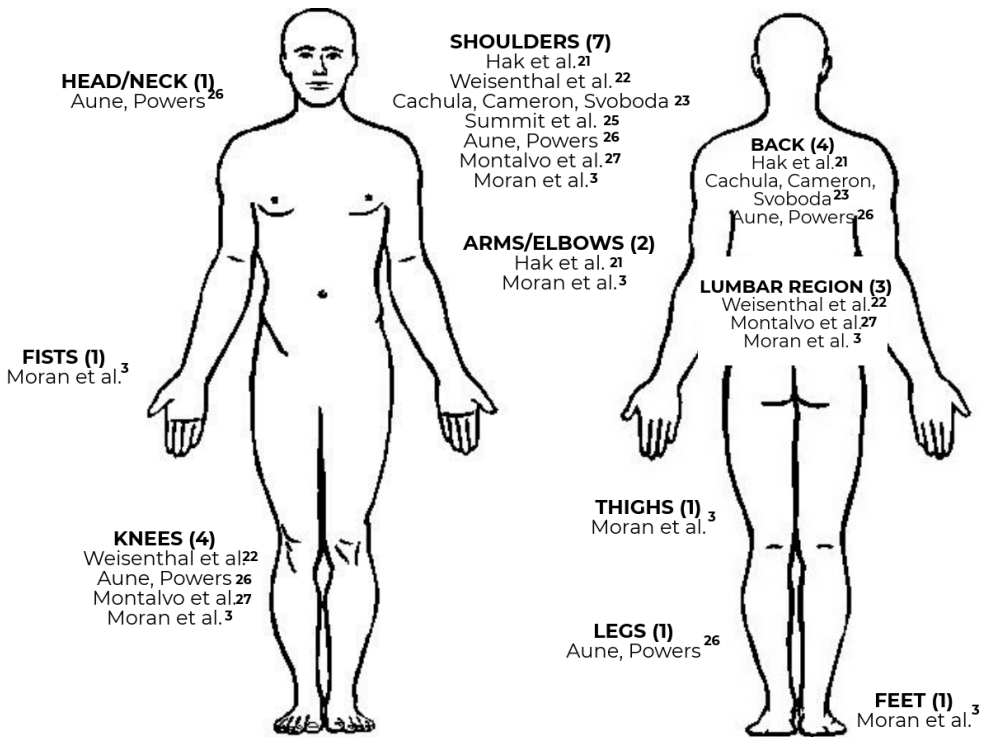


Figure 2. Body regions affected by injuries in studies on *CrossFit* (number of studies per regions)

The body region most affected by injuries in the studies selected were the shoulders (7 studies). Back and knees were injured regions in practitioners of 4 studies each, followed by the lumbar region in 3 studies, and arms/elbows in 2 studies. Body regions like head/neck, wrists, thighs, legs and feet were cited as injured regions in one study (Figure 2).

Several injury-related factors were observed in CrossFit practitioners and athletes. The most present factors within the studies were the type of exercise performed, in 5 studies[3,22-25], and the training time of CrossFit, in 3 studies[6,26,27]. In addition, sex presented relation to the prevalence of injuries, where men presented a higher number of injuries in relation to women, and the presence of prior injury was associated with new injuries. In 5 studies, age was among the factors not associated with injuries (Chart 2).

Chart 2. Results of studies on CrossFit in relation to factors associated and not associated with injuries

| Author | Factors associated with injuries | Results | Factors not associated with injuries |
|---|---|---|---|
| Grier et al.[20] | a) Sex and body mass index<br>b) Smoking | a) Risk of injury greater for men with BMI classified as overweight or obese<br>b) Risk of injury greater in smokers compared to non-smokers. | – |
| Weisenthal et al.[22] | a) Sex<br>b) Type of exercise<br>c) Supervised by professional | a) Men presented more injuries than women (53 against 21)<br>b) The shoulder was more injured in gymnastic movements and the lumbar was more injured in powerlifting movements<br>c) The rate of injury significantly decreased with the involvement of the instructor | Age, participation time, training session time, training days per week |
| Chachula, Cameron, Svoboda[23] | a) Prior injury<br>b) Type of exercise | a) Practitioners with prior injury are 3.75 times more likely to suffer an injury related to CrossFit<br>b) Participants realize that exercises like deadlift and kettlebell swing aggravate lumbar injuries, jumps intensify knee pain, and pain in the shoulders and elbow are accentuated due to ring dips | Age<br>CrossFit experience<br>Participation in classes with professional supervision |
| Sprey et al.[6] | a) Training time | a) Practitioners of CrossFit since 6 months (35%) showed higher injury rate, with 70% compared to practitioners with less training time | Sex and age group |
| Summitt et al.[25] | a) Type of exercise | a) Practitioners considered gymnastic exercises as the main cause of injury (25 of 46 total injuries). | Age, number of resting days |
| Aune and Powers[26] | a) Training time<br>b) Type of exercise<br>c) Equipment type<br>d) Prior Injury<br>b) Excessive effort and inadequate technique | a) The incidence rate of injury among athletes with less than 6 months of experience was 2.5 times higher than that of athletes with more than 6 months of experience<br>b) Squat cleans, ring dips, overhead squats and push presses were more likely to cause injury<br>c) Exercises performed with bars resulted in more injuries<br>d) Athletes with prior shoulder injury are 8.1 times more likely to injure the shoulder compared to athletes with healthy shoulders<br>e) Athletes reported that 35% of injuries occurred due to overexertion and 20% due to improper technique in the execution of the exercises | – |
| Montalvo et al.[27] | a) Participation and training time<br>b) Physical activity aside from CrossFit<br>c) Stature | a) The injured athletes presented more participation time (in years) and weekly time of CrossFit practice compared to non injured<br>b) Athletes with physical activity practice aside from CrossFit were 2.3 more likely to injure themselves<br>c) Injured athletes presented greater stature compared to non-injured | Age, sex, size of CrossFit class, number of trainers, years of structured physical activity, and participation in competitions |
| Moran et al.[3] | a) Sex<br>b) Type of exercise | a) Highest rate of injury found in men who had injury in last 6 months<br>b) Weightlifting exercises were the most cited as cause of injury: squat, deadlift, overhead press and Snatch. | – |

Caption: (–): Not reported

Regarding to the assessment of methodological quality according to the criteria of STROBE, adherence to the criteria varied between 50% and 81.8%, the majority of studies being classified as B and only one study classified as A, having above 80% of the criteria met (Table 2).

Table 2. Assessment of methodological quality of the studies included

| STROBE criteria / Studies | Title and Abstract | Introduction | Methods | Results | Discussion | Other information | Total Score (%) | Classification |
|---|---|---|---|---|---|---|---|---|
| Grier[20] | 0/1 | 1/2 | 4/9 | 4/5 | 3/4 | 0/1 | 12 (54.5%) | B |
| Hak et al.[21] | 1/1 | 1/2 | 4/9 | 5/5 | 4/4 | 0/1 | 15 (68.1) | B |
| Weisenthal et al.[22] | 1/1 | 2/2 | 7/9 | 4/5 | 4/4 | 0/1 | 18 (81.8) | A |
| Chachula, Cameron, Svoboda[23] | 0/1 | 2/2 | 6/9 | 3.5/5 | 4/4 | 0/1 | 15.5 (70.4) | B |
| Huynh et al.[24] | 1/1 | 1/2 | 3/9 | 3/5 | 3/4 | 0/1 | 11(50) | B |
| Sprey et al.[6] | 1/1 | 2/2 | 6/9 | 4/5 | 4/4 | 0/1 | 17 (77.2) | B |
| Summitt et al.[25] | 1/1 | 1/2 | 3/9 | 3/5 | 3/4 | 0/1 | 11 (50) | B |
| Aune, Powers[26] | 1/1 | 1.5/2 | 6.5/9 | 4.5/5 | 2/4 | 0/1 | 15.5 (70.4) | B |
| Montalvo et al.[27] | 0/1 | 2/2 | 6/9 | 4/5 | 3/4 | 0/1 | 13 (59) | B |
| Moran et al.[3] | 0/1 | 1/2 | 8/9 | 2/5 | 3/4 | 0/1 | 14 (63.6) | B |

## DISCUSSION

This study aimed to analyze the injury profile of CrossFit practitioners through a systematic review of the literature. For determining injury profile in CrossFit, data such as prevalence and type of injury, body region affected, injury rate by training time, and whether factors were related to injuries or not like sex, age and type of exercise were analyzed and will be further discussed in the following sections.

### Injury prevalence

The prevalence of injuries was distributed unevenly among studies, which can be explained by the large amplitude in sample sizes, aside from differences between the populations analyzed and training characteristics.

Although one of the studies showed high prevalence of injuries with 73.5%[21], this one was conducted through questionnaire available in online forums, which is a methodological limitation, as it is not known how many individuals have seen the research and opted not to respond. In addition, Hak et al.[21] conducted the study with practitioners of all CrossFit participation levels; on the other hand, the prior training experience, that is, the previous practice of the participants of the research by Weisenthal et al.[22] and Grier et al.[20] may have contributed to the lower prevalence of injuries when compared to the study by Hak et al.[21], but this relationship is not clear in the literature yet.

### Injury rate

When compared to other modalities of physical exercise or sport, the injury rate of CrossFit is not considered high. A rate of 3.1 injuries every 1,000 hours of training as a maximum value found in the studies was observed[21]. In sports, rates from 2.3 to 33 injuries in running, 2.5 in handball, 5.4 in triathlon, 5.45 in gymnastics, 9.6 in soccer and 26.7 in rugby, every 1,000 hours of training, were found[28-33].

It is inferred that this result may occur due to the absence of determinants such as physical contact and practice of exercise on irregular soils, which were already shown to be associated with injuries in sports[34-36].

### Associated factors

A higher injury rate was observed in males, a result that may be related to the lower demand of men for trainers compared to women with the aim of being supervised. Evidence shows that women consult their trainers for doubts and supervision more when compared to men[22]. Publications on injuries comparing men and women have also shown a higher prevalence in males, in sports such as basketball, judo and running[37-39].

Several populations have sought to practice *CrossFit*, many already practicing other forms of physical exercise or sport and, in some cases, this population is composed of people with prior injuries. It was observed that this is an important related factor, because individuals with previous injuries are 3.75 times more likely to acquire them again in *CrossFit*[23], specifically with regard to the shoulder, where it was shown that athletes with prior injury are eight times more likely to injure the shoulder compared to athletes with healthy shoulders[26]. Therefore, the need for attention to the anamnesis of new practitioners in sites that offer CrossFit practice is highlighted, in order to know prior injuries and prevent the recurrence of these injuries.

The association between injury and training time was shown to be not clear, as some studies have shown that practitioners with longer training time suffer more injuries in relation to those with less time[6,27]. On the other hand, a study found an incidence rate of injury among athletes with less than six months of experience to be 2.5 times greater than that of athletes with more than six months of experience, which can be explained by the lack of execution of the correct movements technique[26]. Despite the training time and weekly frequency being associated with greater experience in the exercises, there is the increase in exposure of the practitioner to repetitive movement, which increases the chances of injury[27]. Furthermore, one of the features present in the practice inside CrossFit gyms is the establishment of personal records, especially in exercises related to weightlifting, in which the individual seeks to execute the movement with the greatest possible load. This encourages practitioners to raise the load as they increase their practice time, aiming to improve their records, but also increasing the risk of injury. Hak et al.[21] suggest a focus on the proper execution technique, being a more important feature than speed and number of repetitions performed.

The fact that most studies found no association between the presence of injuries and age/age group reinforces what is proposed by Weisenthal et al.[22], who claim that CrossFit is a fitness training program that can be practiced safely by individuals of a wide age range – from 18 to 69 years, but only if carried out in a safe environment.

## Body regions affected and type of exercise

The shoulder was the joint most affected by injuries due to CrossFit training. According to studies, this result is related to the execution of some exercises that have been considered harmful – such as overhead squat, push press, kettlebell swing and snatch[26] – because they have a high range of motion of the shoulder complex, a characteristic that can increase the risk of injury, since movements above the shoulder joint lead to injury due to the reduction of the subacromial space[40].

The study by Weisenthal et al.[22] showed that, for the olympic gymnastics movements present in the modality, there was significant difference between the body regions that suffered injury, the shoulder being the most injured, corresponding to more than 41% of shoulder injuries in the practitioners analyzed. The cause of this type of injury is usually associated with a decrease in the stabilization of the scapulothoracic joint. Scapular dyskinesia affects the excursion movement of this joint, overloading the glenohumeral joint[41,42], which is usually associated to muscle imbalance, mainly due to weakness of the serratus anterior and lower trapezius fibers[43,44]. The study by Summit et al.[25] showed that, among the gymnastic movements that cause injury (25 out of 46) reported by practitioners, there are kipping pull-up, ring muscle-up, push-up and ring dips

In addition to the exercises derived from gymnastics, the exercises specific to olympic weightlifting that constitutes CrossFit, like overhead squat, require the placement of the shoulder joint in positions of extreme flexion, abduction and internal rotation, which increase the risk of injury[45]. Due to the high incidence of shoulder injuries found in the studies, greater caution is suggested regarding gymnastic exercises and olympic weightlifting on the part of practitioners and professionals who supervise the execution of these movements, with a focus on factors such as overexertion and improper technique, factors reported by athletes to cause injuries in 35 and 20% of cases, respectively[26].

Previously cited in the literature as a risk during the practice of CrossFit[10], cases of rhabdomyolysis were reported in one related study[24]. According to Hak et al.[21], this may have occurred due to the inclusion of practitioners of various fitness levels, where rhabdomyolysis is to be expected in those who exercise in extremely high levels of intensity. Rhabdomyolysis is a condition not exclusive of CrossFit, since other sports, if performed strenuously, can also cause it. It usually occurs due to poor exercise prescription or execution without adequate supervision[46], factor of which is also associated with injuries in CrossFit, as verified in the study by Weisenthal et al.[22], where the injury rate was significantly decreased with the involvement of the instructor.

Lack of proper supervision and/or bad training prescription can result in training components like volume and inadequate load for the practitioner[47], especially when it comes to extreme conditioning program. This way, the trainer must possess knowledge of the peak load of each athlete in order to prevent injuries. Halson[48] suggests some variables that can be assessed to monitor the training load. Variables such as frequency, time, training intensity, effort, repetitions, volume, perceived exertion or fatigue, technical analysis, among others, must be taken into consideration. The monitoring of these variables is important to prevent injuries, since performance should not be the only way to verify whether training load is suitable or not for the athlete[48].

The epidemiological condition of injuries in some sports and physical exercise modalities still has gaps, lacking further investigation[49]. In this case, CrossFit stands out, as it is a type of new physical training that has shown significant growth in recent years. Consequently, the scientific literature on injuries in this modality is also novel, so it is suggested that be performed research on injuries analyzing practitioners and athletes after exposure to CrossFit in the long term in future studies, featuring prospective longitudinal studies, with better methodological conditions and specific instruments.

All selected studies in the review met 50% or more of the criteria defined by STROBE. Most of items not met were related to the description of the methods, particularly with respect to bias, sample size and treatment of quantitative variables. Aside from that, no studies reported other information such as funding. Such findings suggest the need for more detail in the description present in the Methods section in future studies, for better methodological quality.

The selected studies present limitations, as they investigated the injuries of practitioners through self-report, so the accuracy of some answers may have been impaired, demonstrating the need for the use or development and validation of specific instruments for analyzing this population. In addition, most studies were characterized as retrospective, that is, based on past data, and few studies addressed the issue of the treatment used for injuries, which can be a subject of future research.

### Clinical implications

The extrapolation of the findings of this study enables professionals involved with CrossFit practitioners to identify risk factors associated with injuries, in order to act preemptively against them. Knowing the population, most affected body regions and providing proper supervision in the practice of the modality allows the practitioner to be oriented correctly, minimizing the risk of injury. Knowing that population is important for the execution of physical and functional evaluations with the modality practitioner. This can be done, for example, with assessments on the factors mobility, balance and neuromuscular control by tests such as Y balance and step down[50,51]. Poor performance in those tests shows the need for greater caution for these practitioners.

CrossFit classes with little supervision and/or with a high number of practitioners should also be avoided, as the professional control over movements performed incorrectly becomes more difficult. In addition, the work leading up to the workout of the day (WOD), such as warm ups and activities for developing a specific skill must be performed.

## CONCLUSION

It is concluded that the shoulders are the most commonly affected body region, followed by the back and knees, according to the studies analyzed. The injuries were reported more frequently in males and with previous injuries, often obtained in other modalities. In most studies, it was not possible to observe relations between age and the presence of injuries, characterizing CrossFit as a physical training program that can be practiced safely by individuals from 18 to 69 years.

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