# Musculoskeletal Injuries in Competitive CrossFit Athletes

## *Lesões musculoesqueléticas em atletas de competição de* CrossFit

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## Abstract

**Objective** To identify the most frequent musculoskeletal injuries in CrossFit athletes who participated in a competition in 2017.

**Methods** A cross-sectional study conducted through the application of a questionnaire to adult competitors of both genders who participated in a competition in 2017.

**Results** Among the participants, 44% reported previous injuries, 67.3% of whom were men. The main types of lesions were inflammations, sprains and contusions. The most affected anatomic sites were the shoulder, spine and knee. Among the injured, 34.4% had a previous lesion at the site; 75.8% were undergoing follow-up with healthcare professionals; and all of them practiced CrossFit 5 times a week with a mean duration of the training sessions $68.2 \pm 12.4$ minutes and mean rest of 1.7 days a week. The duration of the training sessions was the most significant factor ($p = 0.002$) for the occurrence of injuries.

**Conclusion** The percentage of athletes injured due to the practice of CrossFit was of 44%, with a higher incidence among men. The main type of injury was inflammation, and the most exposed anatomical sites were the shoulder, spine and knee.

**Keywords**
- epidemiology
- injuries
- musculoskeletal system
- physical exercise

## Resumo

**Objetivo** Identificar as lesões musculoesqueléticas mais frequentes em atletas de *CrossFit* que participaram de uma competição em 2017.

**Métodos** Estudo transversal realizado por meio de aplicação de questionário em atletas adultos, de ambos os gêneros, participantes de uma competição em 2017.

**Resultados** Entre os participantes, 44% relataram lesões prévias, sendo 67,3% homens. Os principais tipos de lesões foram inflamação, entorse e contusão. Os locais anatômicos mais afetados foram ombro, coluna e joelho. Entre os lesionados, 34,4% apresentavam lesão prévia no local; 75,8% realizavam acompanhamento com

**Palavras-chave**
- epidemiologia
- exercício físico
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profissional da saúde; e todos relataram praticar *CrossFit* 5 vezes por semana, com duração média dos treinos de 68,2 ± 12,4 minutos e descanso médio de 1,7 dias por semana. A duração do treino foi o fator mais significativo ($p = 0{,}002$) para ocorrência de lesões.

**Conclusão** A porcentagem de atletas lesionados devido à prática de *CrossFit* foi de 44%, com maior incidência nos homens. O principal tipo de lesão foi inflamação, e os locais anatômicos mais expostos foram ombro, coluna e joelho.

## Introduction

CrossFit is a training program consisting of alternated high-intensity physical exercises. The high biomechanical and physiological demands associated with CrossFit make it paramount that healthcare professionals know its features.[1–3]

Most injuries occur due to the improper performance of movements.[3] They can be modulated by individual factors (such as anatomical abnormalities, age, and previous injuries) and the characteristics of the training sessions (including schedule and duration).[3,4] It is noteworthy that lack of supervision increases the prevalence of injuries.[5–7]

Regarding the rate of injuries, Summit et al.[4] reported 73,5% (3.1 injuries/thousand hours of practice), whereas Weisenthal et al.[8] identified a rate of 19% (2.4 injuries/thousand hours of training). Sprey et al.[1] showed no significant difference regarding gender, age, anthropometric data, the previous practice of other sports, the duration of the training sessions and their weekly frequency, rest time, and other concurrent physical activities.[1] However, Xavier and Martins[3] pointed out that men are 2.9 times more likely to be at risk, and that the chance of injury is 2.7 times higher among those who train for more than 1 hour.[3] This same study[3] identified overweight/obesity and weekly training frequency as risk factors. The most common injuries are contusion, strain, and tendinopathy; the most injured body parts include the shoulder, spine, and knee.[3,8–12]

The present study aimed to identify the epidemiological profile and factors that influence the occurrence of musculoskeletal injuries in participants of a CrossFit competition held in the city of Curitiba, Southern Brazil, in 2017.

## Materials and methods

The present is a cross-sectional study approved by the institutional ethics committee (under CAAE 68129117.6.0000.0093) involving adult, regular CrossFit athletes who participated in a competition in October 2017 and signed the informed consent form. The inclusion criteria were age > 18 years, having registered at the competition, and willingness to participate in this research project. The exclusion criteria were age <below 18 years and no registration at the competition.

The sample size was calculated based on the number of participants in the competition (634, including 446 males); the final sample consisted of 333 athletes (207 men) with a 5% error.

As the research instrument, a questionnaire (Appendix 1) consisting of descriptive and multiple-choice questions was developed, which was filled out and returned to the researcher during the competition. We obtained anthropometric data, as well as data pertaining to gender, features of the training sessions, the previous and current practice of other sports, the features of the CrossFit-related injuries, follow-up with a healthcare professional, and use of dietary supplements.

CrossFit-related injuries included physical complaints severe enough to require medical intervention for diagnosis and treatment; those requiring a change in the duration of the duration, intensity, or form of the training sessions for more than two weeks; or those leading to interruption of the training sessions or of other activity for more than one week. The investigators did not ask about the injury diagnosis, and they were available to clarify any doubts from the participants regarding what was considered a CrossFit-related injury.

The categorical variables were expressed as relative frequencies followed by their respective 95% confidence intervals (95%CIs), and the continuous variables, as mean and standard deviation values. The Fisher exact test for qualitative variables identified differences between strata. The quantitative variables deemed non-normal by the Shapiro-Wilk test were evaluated using the Mann-Whitney test, and the statistical analyses were performed using the Prism statistical package (GraphPad Software, San Diego, CA, United States), version 6.0.

## Results

A total of 346 athletes were willing to participate in the research; their mean age was of 28.6 ± 7.49 years. ►**Table 1** shows the anthropometric data. Most participants (33%) had been practicing CrossFit for more than 24 months, predominantly (65%) for 60 minutes per session (►**Table 2**).

**Table 1** Anthropometric data regarding CrossFit athletes (N = 346)

| | Male | Female |
|---|---|---|
| **Gender (%/absolute number)** | 61.9%/214 | 38.1%/132 |
| **Weight (average)** | 81.44 kg | 61.90 kg |
| **Height (average)** | 1.77 meters | 1.64 meters |

**Table 2** Characteristics if the training sessions, rest days, and motivation to start practicing CrossFit

| | Male (n = 214) | Female (n = 132) |
|---|---|---|
| *Time of practice (months)* | | |
| 3–6 | 9.8% | 7.6% |
| 7–12 | 20.1% | 18.9% |
| 13–18 | 16.4% | 28% |
| 19–24 | 20.6% | 12.9% |
| > 24 | 33.2% | 32.6% |
| *Number of training days per week* | | |
| 2–3 | 10.8% | 15.9% |
| 4–5 | 52.8% | 47% |
| 6–7 | 36.4% | 36.4% |
| *Duration of the training sessions (minutes)* | | |
| 30 | 0.5% | 0% |
| 45 | 3.7% | 1.5% |
| 60 | 56.5% | 79.5% |
| 75 | 22.9% | 11.4% |
| > 90 | 16.4% | 7.6% |
| *Rest days* | | |
| 0–1 | 41.6% | 48.5% |
| 2–3 | 57% | 47% |
| 4–5 | 1.4% | 3% |

We observed 153 lesions (44%), 67.3% of them in males. Among the injured athletes, 33% had had previous lesions at the site. The most common injury was inflammation, and the most affected anatomical sites were the shoulder, the spine, and the knee (►**Table 3**).

►**Table 4** shows the comparison between the injured and non-injured groups.

A total of 75.8% of athletes was followed-up regularly by healthcare professionals, mainly dieticians. Dietary supplementation was frequent, reported by 79.8% of athletes, especially women (►**Table 5**).

## Discussion

Studies[8] report high injury rates in CrossFit due to the repetitiveness and intensity of the exercises; however, other studies[9] deny this hypothesis because of the high level of supervision and instruction during training. The present study showed an injury rate of 44%, higher than the 31% reported by Sprey et al.[1] The fact that the sample of the present study consisted only of competitive athletes explains this difference. The rates are similar to those of other sports with analogous movements (such as weightlifting and gymnastics).[2,9] In comparison to team sports, such as soccer, the percentages are lower (57% to 61.8%).[1,10–13]

**Table 3** Frequency and distribution per age group, gender, injury type, anatomical region, and postlesion management among the injured group

| *CrossFit-related injury* | | |
|---|---|---|
| Total | 153/346 | |
| *Injuries per age group* | | |
| 18–29 years | 46.8% | |
| 30–40 years | 40.5% | |
| 41–50 years | 35.4% | |
| *Injuries per gender* | Male | Female |
| | 48.1% | 37.9% |
| *Type of CrossFit-related injury** | | |
| Fracture | 7.8% | 6% |
| Contusion | 19.4% | 12% |
| Sprain | 22.3% | 18% |
| Inflammation | 68.9% | 78% |
| Dislocation | 9.7% | 2% |
| Rupture | 5.8% | 4% |
| Other | 1.9% | 0% |
| *Postlesion management** | | |
| Seeking medical assistance | 70.9% | 72% |
| Changes in training (duration, intensity, or characteristics for more than 2 weeks) | 47.6% | 50% |
| Stopping CrossFit or any other activity for more than a week | 14.6% | 6% |
| None of the above | 3.9% | 4% |
| Other | 0% | 2% |
| *Number of CrossFit-related injuries* | | |
| 1 | 56.3% | 56% |
| 2 | 29.1% | 34% |
| 3 | 5.8% | 8% |
| > 3 | 6.8% | 2% |
| *Injured body part** | | |
| Shoulder | 56.3% | 48% |
| Spine | 25.2% | 26% |
| Knee | 19.4% | 32% |
| Wrist | 15.5% | 12% |
| Elbow | 4.9% | 6% |
| Abdomen | 3.9% | 0% |
| Neck | 2.9% | 6% |
| Leg | 2.9% | 2% |
| Ankle | 2.9% | 2% |
| Thorax | 2.9% | 0% |
| Calf | 1.9% | 8% |

**Table 3** (*Continued*)

| | | |
|---|---|---|
| Pelvis | 1.9% | 2% |
| Thigh | 1.9% | 0% |
| Foot | 1% | 0% |
| Hand | 0%% | 2% |
| Hip | 0%% | 2% |
| Other | 2.9% | 4% |
| *Existence of a previous lesion at the same injured site* | 35% | 30% |

Note: *More than one alternative could be selected.

**Table 4** Comparative analysis of CrossFit-related injuries and multiple variables

| Variable | Injury | | *p*-value |
|---|---|---|---|
| | *Yes (n = 153)* | *No (n = 193)* | |
| Female gender | 32.7% | 42.5% | 0.075 |
| Male gender | 67.3% | 57.5% | |
| Practice of another sport | 41.4% | 36.8% | 0.436 |
| Previous injury | 34.4% | 0.0% | 0.548 |
| Follow-up with healthcare professionals | 75.8% | 75.5% | 1.000 |
| Use of dietary supplements | 79.7% | 79.6% | 1.000 |
| Weekly frequency of the training sessions | 5.0 ± 1.1 | 5.0 ± 1.1 | 0.963 |
| Duration of the training sessions | 68.2 ± 12.4 | 64.5 ± 10.3 | 0.002 |
| Rest days | 1.7 ± 0.7 | 1.6 ± 0.8 | 0.778 |

**Table 5** Professional follow-up and use of supplements by CrossFit athletes

| | Male | Female |
|---|---|---|
| ***Regular follow-up with healthcare professionals*** | 75.2% | 75.8% |
| Healthcare professionals (yes as previous answer)* | | |
| Dietitian | 75% | 72.5% |
| Physiologist | 11.3% | 5% |
| Personal trainer | 17.5% | 14.9% |
| General practitioner | 21.3% | 13.9% |
| Physician nutrition specialist | 16.9% | 19.8% |
| Physical therapist | 11.9% | 5.9% |
| Other | 13.1% | 12.8% |
| ***Use of dietary supplements*** | 76.2% | 85.6% |
| Supplements (yes as previous answer)* | | |
| Whey protein | 90.8% | 86.7% |
| Branched-chain amino acids (BCAAs) | 50.3% | 53.1% |
| Albumin | 5.5% | 5.3% |
| Casein | 5.5% | 5.3% |
| Creatin | 41.1% | 46.9% |
| Thermogenic compounds | 17.8% | 22.1% |
| Other | 22.1% | 18.6% |
| ***Supplement prescription by healthcare professional*** | ***76.1%*** | ***77.9%*** |
| Which healthcare professional?* | | |
| Dietitian | 50.3% | 61.1% |
| Physician, except physician nutrition specialist | 6.1% | 3.5% |
| Physician nutrition specialist | 10.4% | 8% |
| Personal trainer | 1.2% | 0% |
| Other | 0.6% | 0% |

Note: *More than one alternative could be selected.

In the present study, the most common injuries were inflammation, sprain, and contusion, contrasting with data from the study by Xavier and Martins,[3] who observed mainly contusions. Male athletes had more injuries, which agrees with the literature.[13] On the other hand, female athletes are more careful about seeking instructions from their coach, weight overload, the frequency of training sessions, and exercise performance.[8,9]

Most injuries (46.8%) occurred in the youngest athletes (18 to 29 years old), who tend to perform exercises with higher loads or repetitions due to greater impulsiveness and exhibitionism. In addition, the injury rate was indirectly proportional to age; those between 41 to 51 years old presented fewer lesions (35.7%), indicating that they may be more cautious when performing movements or they may have a better technique.

The duration of the training sessions was significant, and those who trained for longer suffered more injuries. We believe intense fatigue and lower concentration lead to erroneous movements that precipitate lesions. Consistent with the literature, 54% of the injuries affected the shoulder, 25% occurred at the spine, and 24% involved the knee.[3,8]

The greater demand for dieticians (73.9%) compared to physicians (18.4%) may reveal more attention to the intake of food and dietary supplements (aiming at achieving a body with good esthetic quality) rather than comorbidities.[14–18] Women take more supplements, probably to perform the same training pattern as men or to change their body image.[18]

These findings indicate the need to monitor, quantify and regulate the individual training load[2,16] to minimize excesses and damages to physical, psychological, and social health.[18]

Sports injuries are multifactorial, and their prevention remains the best treatment.[19,20]

The present study had limitations, since the information was obtained from a single competition and was dependent on the participant's memory and understanding of the concept of injury. In addition, factors such as physical and emotional stress may influence the correct completion of the questionnaire. Future epidemiological studies should focus on larger sample sizes and a high number of competitions, in order to obtain more heterogeneous and representative populational outcomes to identify other associated risk factors.

## Conclusion

In total, 44% of the athletes presented CrossFit-related injuries, including 48% of men and 38% of women. The most common injury was inflammation, and the most injured anatomical sites were the shoulder, spine, and knee. The only variable significantly associated with such injuries was the duration of the training sessions ($p = 0.002$).

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Conflict of Interests
The authors have no conflict of interests to declare.

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