Epidemiology

Injuries in CrossFit practioner: a cross-sectional study

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Abstract - Aim: The present study aimed to investigate epidemiological parameters associated with the onset of injuries in CrossFit practitioners. **Methods:** Cross-sectional study, with fifty-two subjects (28 $\pm$ 7 years, 70 $\pm$13 kg), regular practitioners of CrossFit, of intermediate level. The Rombaldi questionnaire was applied, related to the occurrence of injuries during physical activity. The Shapiro-Wilk normality test, Pearson's chi-square, and Fisher's exact test were used, using $p < 0.05$. **Results:** Our findings show that the prevalence of injury in cross-fitters is 38%, having an incidence rate of 3.7 per 1000 h of training. The most recurrent injury was stretching (41%). The most affected regions were the shoulder and lumbar (34%). The exercise model with the highest association with injury development was Olympic weightlifting ($p = 0.004$). **Conclusion:** The CrossFit practice showed a moderate prevalence of injuries, stretching the main type. The most affected regions were the shoulders and the lumbar. In relation to the most dangerous exercise model for the appearance of injuries, the Olympic weightlifting exercises stand out.

Keywords: crossfit, injuries, injury incidence, injury prevalence.

Introduction

CrossFit is one of the fastest growing training methods for physical conditioning in the world, with great popularity and adherence[1]. Its creation dates from 1995 when it was created by former gymnast Greg Glassman[2]. Such a method is characterized as High-Intensity Functional Training (HIFT) and aims at developing general physical conditioning using increases in physical components such as aerobic fitness, motor coordination, agility, balance, speed, strength, and muscle resistance[3]. Based on this, it is suggested that CrossFit promotes broad and global physical conditioning, preparing practitioners for any physical demands of daily life[2]. Crossfit characteristically employs constant variations between gymnastic movements, Olympic Weightlifting (OWL), and cyclical exercises for aerobic capacities, alternated amongst themselves. A Crossfit workout is typically carried out in 60 min classes, subdivided into the warm-up, technique or strength development, and the main part which is properly destined for high-intensity exercises lasting between 5-20 min[3]. The knowledge of the occurrence of musculoskeletal injuries in modalities that become more popular every day, like CrossFit, is of great importance so that possible preventive measures can be taken with greater effectiveness[5]. Paluska[6] states that any practitioner of regular physical activity is subject to musculoskeletal injuries associated with the practice of the sport or modality. These injuries are potentiated by factors such as poor execution of exercises, improper load progression, and imbalances in training planning. However, although the American College of Sports Medicine recognizes the several beneficial effects of programs of extreme conditioning such as CrossFit, it still stands out as a concern concerning the rate of injuries in practitioners of this modality. Thus, the study aimed to quantify epidemiological parameters of prevalence, rate, CrossFit practitioner injuries incidence, most affected body regions, and exercise models associated with the appearance of injuries in CrossFit practitioners.

Methods

Study design

This research is characterized as a quantitative cross-sectional study. Such procedures were performed in accordance with the law 11.794/08 resolution 196/96 with the use of human beings and approved by the local Ethics Committee (00918918.3.0000.0119). Prior to the beginning of the study, all participants were informed about the purpose of the study and signed the Informed Consent Form (ICF).

As per the flow chart (Figure 1), 150 questionnaires were delivered in three 97 CrossFit boxes in the local city. Then after the predetermined period for completion and delivery of the questionnaires by the participants, 62 completed questionnaires were returned. After evaluation, 10 questionnaires were excluded for being filled out incorrectly. Thus, 52 CrossFit practitioners from Criciúma - SC of both genders participated in the study.

The participants were selected by the non-probabilistic convenience method[7], according to the following inclusion criteria: a) being an active practitioner of the sport b) submitting the questionnaire within the established period; d) having at least three months of practice.

And exclusion criteria: a) present some type of chronic nontransmissible disease chronic injury or be a carrier of some physical limitation/disease that interfere in its practice b) have visual or cognitive alterations that may interfere in the understanding of the questionnaire.

Instruments

To measure the prevalence, incidence, type, and body segment most injured during the practice of Cross-Fit, a modified Rombaldi[8] questionnaire was used. The questionnaire was composed of 16 questions, 4 open and 12 closed, described as follows: 1) Anthropometric and sociodemographic characterization; 2) Time practicing of
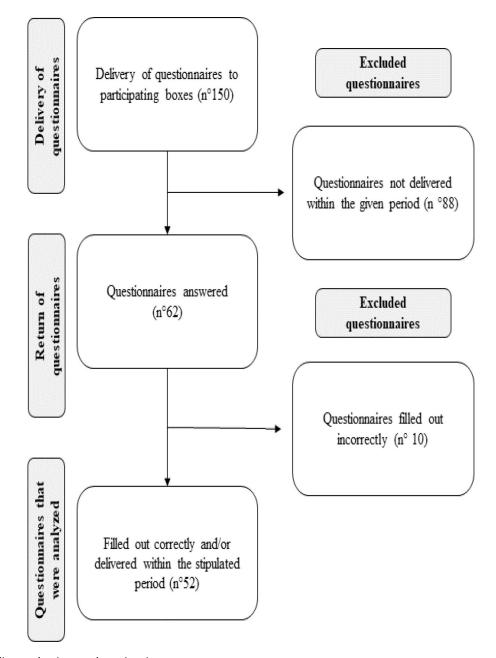

Figure 1 - Flow diagram showing attendee registration.

the sport; 3) Weekly training frequency; 4) Hourly load per training; 5) Training objective; 6) Performing or not a physical assessment before starting the sport; 7) During training have you ever felt any pain; 8) Subjective perception of pain 0-10 after training; 9) After training do you feel any pain; 10) How often do you feel pain in relation to training during the week; 11) How many times have you been injured during the practice (muscle or joint injuries); 12) According to the previous question, classification of the injuries was perfomerd, from 1 to 5, being 1 the lightest and 5 the most intense; 13) What type of injury has affected you during the period of CrossFit practice (muscle or bone/joint injuries); 14) What body segment has been the most injured during the practice; 15) What exercise model have you been injured in; 16) Do you practice another activity, which one? Subsequently, the criteria for injury characterization were established, according to the Weisenthal et al.[20], which uses the triple injury criterion covering a wide variety of injuries that can occur in CrossFit, being described as 1) Total removal from CrossFit training and other activities non-routine physical activities for > 1 week; 2) Modification of normal training activities in duration, intensity or mode for >2 weeks; 3) Any physical complaint serious enough to warrant a visit to a healthcare professional.

Crossfit injury rate

The injury rates were calculated by estimating the training volume of practitioners in the retroactive period of practice of the modality, obtained in the inventory. The total weekly volume of training was multiplied by the number of weeks corresponding to the period of practice. The rate was then converted into the number of injuries/ 1000 h of training[9].

Statistical analysis

For the statistical analysis, a spreadsheet was assembled for the elaboration of the database, based on the data collection performed. Quantitative variables were presented as mean ± standard deviation and qualitative variables as frequency and percentage. For all statistical analyses, a value of $p < 0.05$ was adopted to indicate a statistically significant difference or association between groups. Quantitative variables were assessed for normality by applying the Shapiro-Wilk test. Verification of the existence of an association between qualitative variables was performed by applying Pearson's chi-square test and Fisher's exact test, followed by residue analysis when statistical significance was observed. The analyses were performed in the statistical package SPSS (Statistical Package for the Social Sciences) version 20.0.

Result

Characterization of the sample

As shown in Table 1, 52 participants took part in the study, approximately 57% (30 participants) were male and 43% (22) female, with a mean age of 28 ± 7 years, a weight of 70 ± 13 kg, and a mean practice time for 14 months. Thirty-two practitioners, representing 64% of the sample, train for over 12 months, indicating intermediate-level subjects. Most of the practitioners (65%; n = 34) present a high frequency (5 times/week).

Prevalence and injury rates of CrossFit practitioners

The prevalence of injuries was 38% (n = 20) of the total sample (n = 52). Regarding injury rate per 1,000 hours of training, a rate of 3.7/1000 h of training was observed (Table 2).

Incidence and anatomical regions of injuries of CrossFit practitioners

The type of injury with the highest incidence (Figure 2) was stretching (41%), followed by dislocation (20%) and distension (20%). Regarding the most injured

Table 1 - Characterization of the sample and profile of practitioners.

Variables	Mean ± standard deboatons or n (%) N = 52
Age (years old)	28.90 ± 7.48
< 25 years old	19 (36.5)
25 a 35 years old	25 (48.1)
>35 years old	8 (15.4)
Weight (kg)	70.52 ± 13.21
Height (m)	1.71± 0.09
Sex	
Man	30 (57.7)
Woman	22 (42.3)
Practice time	
3 a 6 months	6 (11.5)
7 a 12 months	11 (21.2)
13 a 24 months	12 (25.1)
>24 months	20 (39.2)
Training frequency	
Two times a week	2 (3.8)
Three times a week	10 (19.2)
Four times a week	6 (11.5)
Five times a week	34 (65.4)
Pre-participatory assesment	
No	33 (63.5)
Yes	19 (36.5)

Values presented as mean (standar deviation) for qualitative variables and n (%), for quatitative 354 variables.

Table 2 - Prevalence and injury rate of crossfit practitioners.

Variables	N (%)
Never injured	32 (62%)
Got injured at least once	20 (38%)
Injury rate	3.7/1000h
Total	52 (100%)

Values presented in n and (%), in the quantitative variables.

anatomical regions (Figure 3), shoulder (34%) and lumbar (34%), followed by the knee (13%), pectoral (3.8%), and elbow (1.9%) were the most frequent.

Exercise models associated with the appearance of injuries

Of the CrossFit practitioners (Table 3) who injured their shoulder, 55% stated that they were injured while performing exercise models that involved Olympic weightlifting exercises, 25% cyclical exercise models, and 45% gymnastic exercise models. In relation to knee injuries, 71% of the practitioners were informed to have been injured during the practice of exercise models involving Olympic weightlifting, 29% during cyclic exercise models, and 17% during gymnastics. Concerning the lumbar lesions, 66% reported having suffered this lesion during the realization of models of exercises involving Olympic weightlifting, 16% in cyclic exercises, and 16% in gymnastics.

Discussion

This study investigated specifically, the prevalence, injury rate, incidence, anatomical regions, and exercise models associated with the development of injurie in CrossFit practitioners. Our findings show a prevalence of 38%, an injury rate of 3.7/1000 h of training, and the highest incidence (41%) of injuries, by stretching. Anatomically the most affected regions were the shoulders and lumbar. In relation to the exercise models that more cause
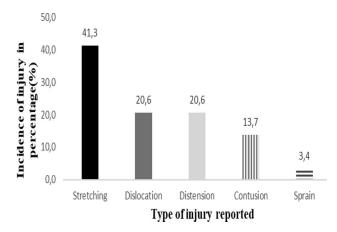
Figure 2 - Incidence of injuries in crossfit practitioners.
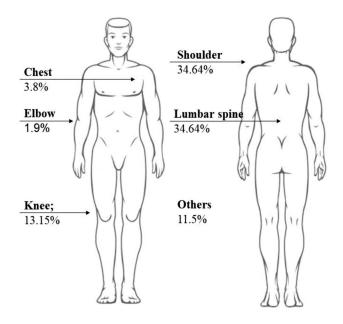
Figure 3 - Anatomical regions affected by the injuries reported by the study participants.

injuries we point out the OWL. All of them suffered some type of injury (muscular/osteoarticular) during the period of CrossFit practice. These data are similar to values that are close to the earliest studies[1,10,11], which found values between 31 and 37%. However, the injury rate among CrossFit practitioners in this study was 3.7/1000 h of training. According to Ory[12], every form of physical activity offers some risk of injury to the practitioner. Our injury rate values presented here (3.7/1000 h) are higher than those found in a recent systematic review[13], which varied from 1.94 to 3.1/1000 h of training.

Table 3 - Exercise models are associated with the appearance of injuries.

Exercise models	Shoulder	p value	Injured region knee	P value	Lumbar spine	Value-p
OWL	Yes		Yes		Yes	
	55%	0.004[*]	71%	0.034[**]	66%	0.001[**]
	No		No		No	
	45%		29%		34%	
Cyclical exercise	Yes		Yes		Yes	
	25%		29%		16%	
	No	0.009[*]	No	0.013[*]	No	0.003[*]
	75%		71%		84%	
Gymnastic exercise	Yes		Yes		Yes	
	45%		17%		16%	
	No	0.002[**]	No	0.034[**]	No	0.009[*]
	55%		84%		84%	

Values presented in percentage (%), (p < 0.05).
[*] value obtained after application of Pearson chi-square test.
[**] Value obtained after application of Fisher exact test.

However, the values presented in the present study are lower when compared with traditional sports such as football, which presents values varying from 5.2/1000 h to 7.8/1000 h of training, and field tennis with values of 4.7/1000 h of training, and similarly found in recreational running 3.6/1000 h[14,15].

According to Rahusen[18], these injuries may be related to the excessive stretching of muscle fibers that during the strength exercises used in CrossFit, the total and rapid amplitude is required, in addition to movement speed, causing the practitioner to exceed the maximum amplitude of the movement, leading to musculoskeletal injury, which may lead to a compromise of muscle and joint functionality.

As for the anatomical regions with greater involvement in injuries, our results point to a predominance of the shoulder and lumbar (34%), followed by the knee (23%). Montalvo[9], when investigating the most injured anatomical region of CrossFit practitioners, concluded that the regions with the highest incidence of injuries are the shoulder and the lumbar spine, as well as Xavier and Costa[3], who found percentages of 44% and 40%, respectively. Such evidence regarding the location of the lesion corroborates our findings. One explanation for the appearance of injuries in these locations is possibly related to the fact that the practitioners perform the movements repeatedly until concentric fatigue. Specifically in lesions of the shoulder region, when limb movements are performed in abduction/adduction and/or flexion/extension above 90°, these movements are biomechanically considered triggers for lesions due to the disproportionate adjacent angles and forces[19].

Regarding the exercises that have a greater association with the appearance of injuries in the knee follow-up, our study found a percentage of 71% for Olympic weightlifting and 29% for cyclic exercises. Weisenthal[22] point out the knee as one of the most frequently injured sites during exercise. Montalvo[9] states that Olympic weightlifting movements can facilitate the appearance of injuries when compared to other simpler movements. It is a fact that according to Tavares and oliveira[23] such movements (Olympic lifts) generate a higher risk due to the presence of a longitudinal external load. Another possible justification is linked to intrinsic anatomic factors such as discrepancy of muscular balance and biomechanics that relate to subtalar pronation or supination[22].

Conclusions

We conclude that the prevalence of injuries in CrossFit practitioners in this study is moderate when compared with other CrossFit studies. Nevertheless, it is lower when compared with traditional sports such as football and tennis. In relation to the rate of injuries, it is above average. As a practical application, we suggest

redoubled care in the Olympic weightlifting exercises, having in mind that it appears in first place in the three evaluated segments.

References

1. Costa TS, Louzada CTN, Miyashita GK, Silva PHJ, Sungaila HYF, Lara PHS, et al. Injury prevalence and main risk factors. Clinics. 2019;7(4):e1402 doi

2. Glassman G. The CrossFit training guide. CrossFit Journal. 2021;1-263.

3. Xavier AA, Lopes AMC. Lesões musculoesqueléticas em praticantes de crossfit. Rev Interdiscip Ciênc Méd. 2017;1 (1):11-27.

4. Heinrich KM, Patel PM, O'Neal JL, Heinrich BS. High-intensity compared to moderate-intensity training for exercise initiation, enjoyment, adherence, and intentions: an intervention study. BMC Public Health. 2014;14(1):1-6.

5. Souza GL, Moreira NB, Campos WC. Ocorrência e características de lesões entre praticantes de musculação. Saúde e Pesqui. 2015;8(3):469-77. doi

6. Paluska SA. An overview of hip injuries in running. Sports Med. 2005;35(11):991-1014. doi

7. Coelho BS, Souza LK, Bortoluzzi R, Roncada C, Tggermann CL, Dias CP. Comparação da força e capacidade funcional entre idosos praticante de musculação, hidroginástica e não praticantes de exercícios físicos. Rev Bras Geriatr Gerontol. 2014;17(3):497-504. doi

8. Rombaldi AJ, Silva MC, Barbosa MT, Pinto RC, Azevedo MR, Hallal PC, et al. Prevalência e fatores associados à ocorrência de lesões durante a prática de atividade física. Rev Bras Med Esporte. 2014;20(3):190-4. doi

9. Montalvo AM, Shaefer H, Rodriguez B, Li T, Epnere K, Myer GD. Retrospective injury epidemiology and risk factors for injury in CrossFit. J Sports Sci Med. 2017;16(1):53-9.

10. Huynh A, Leong KE, Jones N, Crump N, Russell D, Anderson M, et al. Outcomes of exertional rhabdomyolysis following high-intensity resistance training. Intern Med J. 2016;46(5):602-8. doi

11. Sprey JW, Ferreira T, Lima MV, Duarte JA, Jorge PB, Santili C. An epidemiological profile of CrossFit athletes in Brazil. Orthop J Sports Med. 2016;4(8)1-8. doi

12. Ory M, Resnick B, Jordan PJ, Coday N, Riebe D, Garber CE, et al. Screening, safety and adverse events in physical activity interventions: collaborative experiences from the Behavior change consortium. Ann Behav Med. 2005;2 (9):20-8. doi

13. Dominski FH, Siqueira TC, Serafim TT, Andrade A. Perfil de lesões em praticantes de CrossFit: revisão sistemática. Fisioter Pesqui. 2018;25(2):229-39. doi

14. Hootman J, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. J Athl Train. 2007;4(2):311-9. doi

15. Parkari J, Kannus P, Natri A, Lanpinleimu I, Palvenen M, Heiskanen M, et al. Active living and injury risk. Int J Sports Med. 2004;2(5):209-16. doi

16. Dragos SD. Incidência de lesões no tendão patelar em atletas praticante do exercício agachamento total. Monografia

[Educação Física], Universidade Estácio de Sá, Rio de Janeiro; 2006.

17. Barroso GC, Thiele ES. lesão muscular em atletas. Rev Bras Ortop. 2011;46(4):354-8. doi
18. Rahusen FT, Weinhold PS, Almekinders LC. Nonsteroidal anti-inflammatory drugs and acetaminophen in the treatment of an acute muscle injury. Am J Sports Med. 2004;32 (8):1856-9. doi
19. Silva AA, Bittencourt NFN, Mendonça LM, Tirado MG, Sampaio RF, Fonseca ST. Análise do perfil, funções e habilidades do fisioterapeuta com atuação na área esportiva nas modalidades de futebol e voleibol no Brasil. Rev Bras Fisioter. 2011;15(3):219-26. doi
20. Weisenthal BM, Beck CA, Maloney MD, DeHaven KE, Giordano BD. Injury rate and patterns among CrossFit athletes. Orthop J Sports Med. 2014;2(4)1-7. doi
21. Tibana RA, Farias DL, Nascimento D, Grigoletto ME, Prestes J. Relação da força muscular com o desempenho no levantamento olímpico em praticantes de CrossFit®. Rev Andal Med Deporte. 2018;11(1):84-8. doi
22. Kolt GS, Kirkby RJ. Epidemiology of injury in elite and sub-elite female gymnasts: comparison of retrospective and prospective findings. Br J Sports Med. 1999;33(1):312-8. doi
23. Tavares LAB, Oliveira RB. Incidência de lesões em regiões corporais de atletas de levantamento de peso olímpico. Rev E Novo Enfo. 2010;10(10):86-100.
24. Souza TR, Pinto RZA, Trede RG, Araujo PA, Fonseca HL, Fonseca ST. Pronação excessiva e varismo de pé e perna: relação com o desenvolvimento de patologias músculo esqueléticas revisão da literatura. Fisioter Pesqui. 2011;18 (1):92-100. doi
25. Crockett MC, Butryn T. Chasing Rx: a spatial ethnography of the Crossfit gym. Sociol Sport J. 2018;35(2):98-107. doi
26. Claudino JG, Gabbett TJ, Bourgeois F, Souza H de S, Miranda RC, Mezêncio B, et al. CrossFit overview: systematic review and meta-analysis. Sports Med Open. 2018;4 (1):1-14. doi

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