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CRITICALLY APPRAISED TOPIC

Are Injuries More Common With CrossFit Training Than Other Forms of Exercise?

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Clinical Scenario: CrossFit is a form of exercise that incorporates rapid and successive high-intensity ballistic movements. As CrossFit is an increasingly popular fitness option, it is important to determine how rates of injury compare to more traditional forms of exercise. This review was conducted to ascertain the incidence of injury with CrossFit relative to other forms of exercise. ***Focused Clinical Question:*** Are injuries more common with CrossFit training than other forms of exercise? ***Summary of Key Findings:*** (1) The literature was searched for studies that compared injury rates among individuals who participated in CrossFit fitness programs to participants in other exercise programs. (2) The search initially yielded >100 results, which were narrowed down to 3 level 2b retrospective cohort studies that were deemed to have met inclusion/exclusion criteria. (3) In all 3 reviewed studies, the reported incidences of injuries associated with CrossFit training programs were comparable or lower than rates of injury in Olympic weightlifting, distance running, track and field, rugby, or gymnastics. ***Clinical Bottom Line:*** Current evidence suggests that the injury risk from CrossFit training is comparable to Olympic weightlifting, distance running, track and field, rugby, football, ice hockey, soccer, or gymnastics. Injuries to the shoulder(s) appear to be somewhat common with CrossFit. However, the certitude of these conclusions is questionable given the lack of randomization, control, or uniform training in the reviewed studies. Clinicians should be aware that injury is more prevalent in cases where supervision is not always available to athletes. This is more often the case for male participants who may not actively seek supervision during CrossFit exercise. ***Strength of Recommendation:*** Level 2b evidence from 3 retrospective cohort studies indicates that the risk of injury from participation in CrossFit is comparable to or lower than some common forms of exercise or strength training.

Keywords: functional training, physical therapy, injury incidence

Search Strategy

Term Used to Guide Search Strategy

- **P**atient/Client group: *CrossFit participants*
- **I**ntervention/Assessment: *CrossFit*
- **C**omparison: *running* OR *weightlifting* OR *exercise*
- **O**utcome(s): *injury* OR *damage* OR *trauma* OR *incidence*

Sources of Evidence Searched

- PubMed
- CINAHL Plus
- SPORTDiscus
- MEDLINE
- EBSCOhost
- Cochrane Database of Systematic Reviews
- Cochrane Central Register of Controlled Trials
- Academic Search Complete
- Academic Search Premier
- Additional resources obtained via manual search of reference lists and suggested articles via searched databases

Inclusion and Exclusion Criteria

Inclusion

- Studies that compared injury rates in CrossFit training to other types of exercise
- Limited to the English language
- Limited to humans
- Limited to the last 10 years (2006–2015)

Exclusion

- Studies that did not provide data on injury incidence

Results of Search

Three studies met eligibility requirements and were selected for review. These articles are summarized in Table 1. All 3 studies were survey-based and directly compared rates of injury from participation in CrossFit programs with other fitness programs, such as Olympic weightlifting, running, and gymnastics.

Best Evidence

The studies in Table 2 were identified as the best evidence for this review. These 3 retrospective cohort studies were classified as level 2b evidence based on the Center for Evidence-Based Medicine (CEBM, 2009) criteria.[1]

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Table 1 Characteristics of Included Studies

	Weisenthal et al[2] (2014)	Grier et al[3] (2013)	Hak et al[4] (2013)
Study design	Retrospective cohort	Retrospective cohort	Retrospective cohort
CEBM level of evidence	2b	2b	2b
Purpose	To establish injury rates among CrossFit athletes and identify associations between different demographics, gym utilization, and CrossFit injury.	To examine PT, fitness, and injury rate and to identify injury risk factors in a light infantry brigade beginning a new PT program that incorporated elements of ECPs, including CrossFit training.	To define the risk of injury during CrossFit workout participation and define pattern of injuries sustained using a cross-sectional observational experimental design.
Participants	381 individuals (males = 231 and females = 150) who participated in CrossFit training at a CrossFit gym within the United States. Length of participation in CrossFit training ranged from 0 to 6 mo. In total, 325 of the subjects trained at gyms who required a period of training for beginners and included access to trainers to correct their form and provide feedback during their exercises.	Soldiers in a US army light infantry brigade combat team (N = 1393). A total of 1032 soldiers participated in the ATAC program and/or an ECP, which consisted of either the RAW or CrossFit programs, whereas 340 soldiers performed traditional military PT or their own exercises.	A total of 132 individuals responded to a questionnaire, 93 males and 39 females with a mean age of 32.3 y. Responders had a mean total CrossFit training period of 18.6 mo and a mean weekly training participation of 5.3 h/wk.
Activity investigated	Subjects participated in CrossFit training for 4–5 d/wk with 30- to 60-min sessions. CrossFit exercises were performed in a CrossFit gym using successive and rapid ballistic movements with minimal to no recovery time between movements. A wide variety of high-intensity exercises that include running, rowing, Olympic lifting, powerlifting, and gymnastic exercises were included in the CrossFit training.	A physical fitness training program included components of the ATAC, CrossFit, and RAW programs. ATAC consists of plyometrics, kettlebells/medicine balls, high-intensity water exercises, wrestling, ladder and cone agility drills, tire flipping, speed interval training, and cinderblock throwing. CrossFit consists of continuously varied, high-intensity functional movements that fall into 3 categories: gymnastics, Olympic weightlifting, and cardiovascular training. The RAW program consists of 4 components: functional fitness, performance nutrition, sports medicine, and mental toughness.	Respondents were actively involved or had been involved in CrossFit training and sustained an injury while training. Training was performed in accordance with CrossFit specific principles including the "Workout Of the Day," which typically lasts around 20 min and includes bodyweight exercises, gymnastics, Olympic-style weightlifting, running, rowing, skipping, and the use of barbells, kettlebells, and other objects.
Outcome measure(s)	A survey, developed by the authors using 3 criteria to assess injury rate, was given to the athletes to complete. The 3 criteria assessed were (1) injury that caused cessation of participation in CrossFit or other fitness routines for >1 wk; (2) any modifications in duration, intensity, or mode of normal training technique for >2 wk due to injury; or (3) any visit to a health care professional due to injury.	A survey was used to collect information from soldiers about army physical fitness test results and injuries. The survey was administered approximately 4 mo after the new physical fitness and conditioning programs began. The DMSS was used to obtain the number of injuries treated in military treatment facilities or paid for by the Military Health System. Injuries were classified into 3 groups (based on ICD-9 diagnosis codes): overall injury, overuse injury, and traumatic injuries. The McNemar test was used to compare injury incidence in the 6 mo prior to and 6 mo after implementation of the ATAC program.	A survey was used to investigate injury rates (number and nature) specifically during CrossFit training participation. An anonymous questionnaire was supplied to individuals on CrossFit forums. Data collected included patient age, sex, smoking status and alcohol consumption, performance-enhancing drug use, and training behaviors. Injury was defined as any injury that prevented a participant from training, working, or competing in any way for any period of time or injuries that required surgery. An injury rate per 1000 h trained was calculated.

(continued)

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Table 1 *(continued)*

	Weisenthal et al[2] (2014)	Grier et al[3] (2013)	Hak et al[4] (2013)
Main findings	Over a 6-mo retrospective survey period, 75 (19.4%) participants reported an injury. There were no differences in injury rates based on age, length of time participating in CrossFit, length of training session, or days trained per week. Males were more likely to experience injuries than females. The overall injury rate was 20%. The shoulder joint was the most often injured joint across all exercises. Shoulder injuries accounted for 25% (21/84) of the total injuries.	Injury incidence increased by 12% overall and 16% for overuse injuries in the ATAC group. In the non-ATAC group, injury incidence increased 14% overall and 10% for overuse injuries. The absolute change in injury incidence was 5% for the ATAC group and 7% for the non-ATAC group.	Participants reported specific injuries in response to the supplied questionnaire. Total injury rates (73.5%) were similar to those reported in weightlifting, powerlifting, and gymnastics, as well as in adult fitness activities including running and triathlon training. The most commonly injured areas with CrossFit were the shoulder and spine. Shoulder injuries in CrossFit accounted for 25.8% of total injuries, which was higher than Olympic weightlifting. The prevalence of low back injuries approximately 19.9% was similar to powerlifting and weightlifting.
Conclusion	Injury rate from CrossFit training was 22.8% lower than injury rates reported in track and field athletes.	Injury rates were similar between groups of soldiers who participated in the ATAC ECPs and groups of soldiers who participated in traditional army PT.	CrossFit injury rates were similar to those in other recreational fitness activities.

Abbreviations: ATAC, Advanced Tactical Athlete Conditioning; CEBM, Centre for Evidence-Based Medicine; DMSS, Defense Medical Surveillance System; ECP, extreme conditioning program; PT, physical training; RAW, Ranger Athlete Warrior.

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Table 2 Summary of Study Designs of Retrieved Articles

Level of evidence	Study design/ methodology	Number located	Author (year)
2b	Retrospective cohort study	3	Grier et al[3] (2013)
			Hak et al[4] (2013)
			Weisenthal et al[2] (2014)

Implications for Practice, Education, and Future Research

Although high-intensity interval exercise is not a new concept, the CrossFit model of combining various high-intensity functional movements is a relatively recent fad. CrossFit is an exercise program that utilizes high-intensity functional movements with limited amounts of rest to build strength and endurance using a combination of cardiovascular, weightlifting (Olympic and power), and gymnastic-type exercises.[2–4] Given the novelty of CrossFit training, there is limited research currently available on injury rates. However, the 3 articles retrieved for this review found that the injury rate with CrossFit was comparable to or lower than injury rates with Olympic weightlifting, distance running, military conditioning, track and field, rugby, or gymnastics.[2–4] Each article defines injury differently, with Weisenthal et al[2] describing it as "musculoskeletal pain, feeling or injury as a result of a CrossFit workout that led to at least one of the following situations: total removal from CrossFit or other physical activity for >1 week, modification of normal training duration, intensity or mode for >2 weeks or a physical complaint severe enough to require a visit to a health care professional." Grier et al[3] concluded that injuries ranged from overuse injuries, traumatic injuries, and overall injury. Overall injuries were defined as the total number of injuries from International Classification of Diseases, Ninth Revision (ICD-9) codes 800–999 and 710–739.[3] Overuse injuries from repetitive microtraumas (ICD codes 710–739) included injuries, such as stress fractures and reactions, tendinitis, shin splints, and general musculoskeletal pain.[3] Traumatic injuries were defined as those that resulted from sudden force or forces applied to the body (ICD 800–999).[3] Finally, Hak et al[4] proposed that injury was anything that prevented the individual from training, working, or competing in any way and for any period of time.

Weisenthal et al[2] found that the injury rate from CrossFit training was 19.4% over a 6-month survey period. This injury incidence is no higher than that found for long-distance runners in a systematic review by van Gent et al.[5] Those authors found that injury incidence in distance and track and field runners ranged from 19.4% to 79.3%. The most commonly injured areas reported by Weisenthal et al[2] were the shoulder, accounting for 25% of reported injuries, and the lower back and knee, which were involved in 14.3% and 13.1% of injuries, respectively. In contrast to the other 2 main articles reviewed, Weisenthal et al[2] surveyed only "athlete-level" CrossFit participants, which the article defined as those individuals actively training in CrossFit-affiliated gyms and having some sort of coaching or supervision available. Athletes who performed "CrossFit" workouts in unsanctioned gyms were not included in the study. Hak et al[4] allowed respondents to be considered for data review if they had been involved in CrossFit training for any length of time.

Grier et al[3] examined overuse injuries, traumatic injuries, and overall injury rates among a US army brigade combat team that participated in extreme conditioning programs that included elements of CrossFit. Those authors found that injury rates were similar between soldiers who participated in extreme conditioning programs and soldiers who participated in traditional army physical training (PT).[3] The extreme conditioning programs in this article include a number of different exercise programs. Two of these programs were the Advanced Tactical Athlete Conditioning program, which includes the use of plyometrics, kettlebells, agility drills, speed interval training, and cinderblock throwing, and the Ranger Athlete Warrior program, which involves a combination of muscular endurance and heavy resistive exercises, power exercises, endurance training, movement skills training, and hybrid training exercises. Both of these programs are based upon similar principles as CrossFit, such as high-intensity repetitions, cardio, and strength. Occasionally, these programs incorporate actual CrossFit exercises into their workout programs, which make them a valuable comparison. More traditional army PT consists of warm-up and stretching exercises followed by calisthenics, push-ups, sit-ups, some sprint training, and group long-distance running.[3] Participation in the extreme conditioning program resulted in a 12% (significant at $P = .02$) increase in all types of injuries, whereas soldiers who participated in PT had a 14% (significant at $P = .05$) increase in all types of injuries.[3] Thus, soldiers who participated in the extreme conditioning programs (ie, CrossFit-like programs) had a decreased risk of injury than those participating in typical exercise programs. The increase in overuse injuries was higher in the extreme conditioning group (16%; significant at $P = .02$) versus the PT-only group (10%; nonsignificant), although the incidence of traumatic injuries was not different between the training groups. The authors did not perform between-group statistical comparisons.

Hak et al[4] found that 73.5% of 132 survey respondents sustained an injury during CrossFit training.[4] The total injury rate (3.1/1000 h trained) sustained during CrossFit training was similar to reported injury rates in Olympic weightlifting (3.3/1000 h trained),[6] gymnastics (3.1/1000 h trained),[7] and rugby (3/1000 h trained).[8] Sports with higher reported rates of injury than CrossFit include American high school football (140 per 1000 exposure hours),[9,10] ice hockey (78.4 injuries per 1000 exposure hours),[11] and men's and women's soccer competition (4.22 and 5.21 per 1000 exposure hours, respectively).[12] The injury rates with CrossFit reported by Hak et al[3] were markedly higher than those reported by Grier et al[4] and Weisenthal et al.[2] It is unclear why the injury rate was higher in the Hak et al's[4] study, although differences in sample size and/or response bias may explain some of the disparity between these studies. Differences in CrossFit experience between the reviewed studies may also explain some of the disparities in injury rates. Weisenthal et al[2] surveyed only those claiming to be "athlete-level" CrossFit participants, whereas Grier et al[3] surveyed military recruits who may have had more experience with high-intensity training. In contrast, Hak et al[4] collected data on active participants of any level of participation in CrossFit. Therefore, the high level of previous training by respondents in the Weisenthal et al[2] and Grier et al[3] studies could account for the lower injury rates when compared with the Hak et al[4] study.

Both Hak et al[4] and Weisenthal et al[2] reported a high incidence of shoulder injuries (31.8% and 25%, respectively) from CrossFit training. The Olympic-style lifts that are inherent to CrossFit require the shoulders to move beyond their usual physiologic range of motion (eg, kipping pull-up).[6] Another potential

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contributor to CrossFit-related injuries in general and shoulder injuries in particular is muscular fatigue due to high number of repetitions performed during CrossFit sessions.[4] Muscular fatigue may have particularly deleterious effects on the glenohumeral joint, as congruency of this joint is dependent on sustained muscular activation. Muscular fatigue may also contribute to loss of proper exercise technique and resultant injury.[4]

Weisenthal et al[2] found a significantly higher incidence of CrossFit-related injuries in males versus females ($P = .03$). Females, however, utilized a CrossFit coach *significantly* ($P = .02$) more often than males.[2] Thus, in this study, it is difficult to determine the influence of gender alone on CrossFit-related injuries. The other reviewed studies did not report injury incidence relative to gender. Nonetheless, it may be advisable for athletes of both genders to utilize a qualified CrossFit coach, particularly when starting out.

Additional research is needed on this topic to further the current knowledge regarding CrossFit injury rates as well as to ascertain the long-term impact of CrossFit-related injuries.[2–4] Injury surveillance should be conducted on all those who participate in CrossFit, whether it be at a certified gym or another location, to determine the impact that proper training can have on injury incidence. Performing CrossFit training under the supervision of qualified trainers may help to modulate injury risk.[2]

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