

## [ Physical Therapy ]

# Shoulder Injuries in Individuals Who Participate in CrossFit Training

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**Background:** CrossFit, a sport and fitness program, has become increasingly popular both nationally and internationally. Researchers have recently identified significant improvements in health and wellness due to CrossFit. However, some individuals assert that CrossFit poses an inherent risk of injury, specifically to the shoulder, due to the intensity of training. Currently, there is limited evidence to support this assertion.

**Hypothesis:** Exercises performed during CrossFit do not place the shoulder at greater risk for injury. Injury rates are comparable to other sports of similar intensity.

**Study Design:** Descriptive survey study.

**Level of Evidence:** Level 5.

**Methods:** An electronic survey was developed and dispersed to approximately 980 individuals who trained in CrossFit gyms. The survey identified demographic data, training characteristics, and the prevalence of injury over a 6-month period in individuals who participated in CrossFit training.

**Results:** A total of 187 (19.1%) individuals completed the survey. Forty-four (23.5%) indicated that they had experienced a shoulder injury during CrossFit training over the previous 6 months. Of those who reported injury, 17 (38.6%) stated that this injury was an exacerbation of a previous injury sustained prior to starting CrossFit. There was no significant relationship between several demographic and training variables and shoulder injury. All shoulder injuries occurred at a rate of 1.94 per 1000 hours training, while “new” shoulder injuries occurred at a rate of 1.18 per 1000 hours training. The most commonly attributed causes of injury were improper form (33.3%) and exacerbation of a previous injury (33.3%). Twenty-five (64.1%) of those who experienced injury reported 1 month or less of training reduction due to the injury.

**Conclusion:** Shoulder injury rates during CrossFit training are comparable to other methods of recreational exercise.

**Clinical Relevance:** Clinicians should be aware of training demands of exercises in CrossFit and modifications for these exercises to safely progress their patients back to participation.

**Keywords:** CrossFit; shoulder; injury rate; weightlifting; gymnastics

Founded in 2000, CrossFit has grown from a small group of gyms on the West Coast of the United States to over 10,000 affiliates worldwide.<sup>19</sup> CrossFit incorporates ballistic gymnastics and Olympic weightlifting with traditional exercise. These exercises are performed in rapid succession, typically with an emphasis on maximum repetitions in a certain amount of time or finishing a certain number of repetitions in the shortest time possible. In recent studies, Smith et al<sup>20</sup> and Paine et al<sup>16</sup> reported significant improvements in participants' fitness by following CrossFit programming.

Several research studies have shown high-intensity interval or intermittent exercise are effective with a small time investment.<sup>3,9,12,16,20,21</sup> Significant improvements in both maximal aerobic capacity (VO<sub>2</sub>max) and body composition have been accomplished after a CrossFit-based 10-week program,<sup>20</sup> and an Army-based study<sup>16</sup> found significant improvements in work capacity after 6 weeks of a CrossFit training program. However, a consensus paper by the Consortium for Health and Military Performance reported that although extreme conditioning programs such as CrossFit, Insanity, Gym Jones, and others have

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Table 1. Injury rate comparison to other sport/activity

Sport/Activity	Study	Injury Rate (per 1000 hours)
Elite weightlifting	Raske and Norlin <sup>18</sup>	0.42-0.53 (shoulders only)
Swimming	Parkkari et al <sup>17</sup>	1
Walking	Parkkari et al <sup>17</sup>	1.2
Cycling	Parkkari et al <sup>17</sup>	2
CrossFit	Giordano and Weisenthal <sup>8</sup> Hak et al <sup>11</sup>	2.4 3.1
Triathlon (preseason)	Burns et al <sup>4</sup>	2.5
Running (long distance)	van Gent et al <sup>22</sup>	2.5
Elite weightlifting	Raske and Norlin <sup>18</sup> Calhoon and Fry <sup>6</sup>	2.6-3.3
Gym training	Parkkari et al <sup>17</sup>	3.1
Gymnastics	Parkkari et al <sup>17</sup>	3.1
Running (overall)	Parkkari et al <sup>17</sup>	3.6
Triathlon (competitive season)	Burns et al <sup>4</sup>	4.6
Tennis	Parkkari et al <sup>17</sup>	4.7
Women's soccer (practice)	Hootman et al <sup>13</sup>	5.2
Soccer	Parkkari et al <sup>17</sup>	7.8
Basketball	Parkkari et al <sup>17</sup>	9.1
Men's spring football (practice)	Hootman et al <sup>13</sup>	9.6

positive aspects, “There is an apparent disproportionate musculoskeletal injury risk from these demanding programs, particularly for novice participants.”<sup>2</sup> Despite these conclusions by the Consortium for Health and Military Performance, the data supporting injury prevalence and rate in CrossFit are relatively limited.<sup>11,23</sup>

To date, 2 survey-based studies have been published describing injuries with CrossFit training.<sup>11,23</sup> Ninety-seven (73.5%) of 132 respondents in 1 study reported sustaining a musculoskeletal injury during CrossFit training, with an injury rate of 3.1 per 1000 hours trained.<sup>11</sup> A much lower injury prevalence was reported, with 75 (19.4%) of 386 individuals surveyed reporting injury sustained at a rate of 2.4 per 1000 hours trained.<sup>23</sup> Neither of these studies reported the effect of injury with regard to the timeframe of decreased participation, but most injuries were acute and fairly mild injuries.<sup>23</sup> The injury rates reported in these 2 studies can be compared with the injury rates for other sports and activities (Table 1).<sup>4,6,8,11,13,17,18,22</sup> The survey-based studies found the shoulder as the most frequently injured body region,<sup>11,23</sup> and previous studies on

gymnastics and Olympic weightlifting—both large components of CrossFit training—have reported similar observations.<sup>6,10</sup>

There have not been any studies to date that have identified demographic or training variables that might lead to shoulder injury for those individuals who participate in CrossFit training. Shoulder injuries often occur during resistance training, and proper technique and coaching can decrease the likelihood of injury.<sup>14,15</sup> The CrossFit Training Guide describes proper technique with movements during CrossFit workouts and identifies common faults and coaching cues to correct the faults.<sup>7</sup> A significant correlation between coaching supervision and the prevalence of CrossFit injuries was found, although this was not specific to the shoulder.<sup>23</sup> There was a fewer number of injuries in participants whose gyms required a training period for beginners, but this did not reach significance. It is unclear from the current research on CrossFit whether variables such as the requirement of a fundamental/on-ramp program for beginners or option of separate “beginners” class are linked with shoulder injury. Age, body mass index (BMI), and number of rest days during the week were additional variables of

interest. The purpose of this study was to examine participants of CrossFit to identify any characteristics of the participant or the training that could influence the occurrence of shoulder injury. Second, the injury rate in CrossFit participants was compared with injury rates in other training methods of similar intensity.

## METHODS

Study approval was granted by the Institutional Review Board at University of Indianapolis, and informed consent was obtained from all participants. For this cross-sectional study, an electronic survey was designed to determine the training characteristics and prevalence of injury in individuals participating in the CrossFit program (see Appendix at <http://sph.sagepub.com/content/suppl>). The survey took place from March 2015 to June 2015 and was available through Qualtrics (Qualtrics). The survey consisted of 35 questions relating to demographic and training data. If a participant had experienced an injury, the survey expanded by 17 questions to gather details regarding the injury. The survey contained 4 basic sections: demographic data, training data (including strength measures, general class structure, and training frequency), prevalence of injury in the last 6 months, and information regarding injury if applicable. The prevalence of injury was established based on the 3-fold criteria.<sup>23</sup> Per these criteria, “injury” encompassed any new musculoskeletal pain or feeling that resulted from a CrossFit workout and led to 1 or more of the following: total removal from CrossFit training and other outside routine physical activities for more than 1 week; modification of normal training activities in duration, intensity, or mode for more than 2 weeks; and any physical complaint severe enough to warrant a visit to a health professional.

### Survey Sample

Six CrossFit gym owners agreed to participate in the survey. Five of these gyms were located in the Midwest and 1 gym was located in the Southeast. Combined membership of the 6 gyms totaled approximately 980 members. One hundred eighty-seven individuals completed the survey (19.1% response rate).

### Data Collection

Prior to distribution of the survey, gym owners were contacted and given information regarding the survey. Gym owners signed a letter of cooperation stating their agreement to distribute the survey to their members. Electronic surveys were distributed via personal email or as a post on a gym’s Internet blog. For both distribution methods, a description was included with the survey link that outlined the purpose of the study and encouraged both those who had and had not experienced an injury to participate. After clicking on the active link, individual participants were directed to a page outlining the consent statement. Only after consenting to participate was access to the survey available to participants.

## Data Analysis

Survey responses were obtained from the Qualtrics database and analyzed using SPSS Statistics for Windows, version 22.0 (IBM Corp). Descriptive statistics for nominal data are presented as frequency and percentage, ordinal data as median and 25th to 75th percentile, and interval and ratio data as median and 25th to 75th percentile due to the nonparametric nature of the data. Normality was determined using the Shapiro-Wilk test. To determine whether there were significant differences in participant characteristics between participants who reported and did not report a shoulder injury, comparisons were completed. Nominal and ordinal data (age, number of rest days, completion of a beginner class or not, and completion of a ramp-up class) were analyzed using the Pearson chi-square test, while ratio data (body mass index [BMI]) were analyzed using the Mann-Whitney *U* test. The alpha level was set at 0.05 for statistical significance, and all tests were 2-tailed. In addition, effect sizes were calculated for selected comparisons.

## RESULTS

Of the 187 survey respondents, 156 (83%) had been participating in CrossFit for longer than 1 year, 16 (9%) had been participating less than 1 year but more than 6 months, and 15 (8%) had been participating for 6 months or less. The median BMI of all survey respondents was 25.1 kg/m<sup>2</sup> (25%, 20.7 kg/m<sup>2</sup>; 75%, 29.5 kg/m<sup>2</sup>).

Forty-four (23.5%) of the 187 individuals who completed the survey reported a shoulder injury per the criteria for this study. Of those who reported injury, 17 (38.6%) stated that this injury was an exacerbation of a previous injury sustained prior to starting CrossFit, and 27 (14.4%) sustained a new shoulder injury per the criteria used for this study. There was not a significant difference in demographics between participants who did and did not report a shoulder injury (Table 2). There was a medium effect size for rest days and a small effect size for all other variables.

### Injury Rate

Of the 187 participants, 172 reported participating in CrossFit for at least 6 months. The 15 other participants had a combined total of 172 weeks of CrossFit training. Participants trained anywhere from 1 to 20 hours per week, with a mean training time per week of 5.48 hours per week over the 6 months in which injury data were reported. Forty-six injuries were reported, with 2 individuals stating that they had 2 injuries during the 6-month timeframe (Table 3).

### Perceived Cause of Injury

Participants attributed gymnastics exercises as the primary cause of injury for 25 of 46 injuries. Weightlifting movements included both traditional power and the more ballistic Olympic lifting motions. The 3 weightlifting motions (bench press, snatch, and press) include multiple variations of the lift and were attributed as the primary cause of injury for 26 of 46 injuries (Table 4).

Table 2. Demographic data<sup>a</sup>

	Injured, n (%)	Noninjured, n (%)	P Value	Effect Size
Age, y				
18-25	6 (3)	40 (21)	0.154	0.29
26-30	32 (17)	86 (46)		
≥31	6 (3)	17 (9)		
Number of rest days				
1	1 (0.5)	2 (1)	0.137	0.43
2	7 (4)	49 (26)		
3	21 (11)	62 (33)		
4	12 (6)	20 (11)		
5	3 (2)	7 (4)		
6	0 (0)	2 (1)		
Requirement for fundamentals program				
Yes	30 (16)	103 (55)	0.818	0.09
No	8 (4)	24 (13)		
Not sure	6 (3)	15 (8)		
Beginners class offered				
Yes	17 (9)	75 (40)	0.114	0.31
No	20 (11)	60 (32)		
Not sure	6 (3)	8 (4)		

<sup>a</sup>Data presented as frequency (percentage).

Table 3. Shoulder injury rate calculations

	Nonadjusted Rate	Injuries/1000 Hours
All shoulder injuries	46/23,701.05 hours	1.94
New shoulder injuries	28/23,701.05 hours	1.18

Only 1 individual reported that his/her shoulder injury required surgery. Thirty-three of 44 injured individuals attributed their injuries to a certain cause, including improper form (n = 11, 33.3%), too heavy a weight (n = 4, 12.1%), fatigue (n = 6, 18.2%), lack of guidance (n = 1, 3%), and exacerbation of previous injury (n = 11, 33.3%). Eleven individuals chose the option “I don’t know” when asked what they think caused the injury.

#### Abstinence or Reduction of Training

Thirty-nine of 44 injured individuals reported a timeframe for reduced training, with 64% of individuals decreasing their frequency of training for 1 month or less. The most frequent

duration of training abstinence or reduction was 1 to 2 weeks. Forty-one individuals reported a timeframe for scaling their workouts, whereas 21 of 39 (53.8%) individuals reported abstaining/reducing training for longer than 2 weeks and 30 of 41 (73.1%) individuals reported scaling their workouts for longer than 2 weeks (Table 5). Only 1 individual reported surgical intervention for the injury, which was described as a labral tear diagnosed by a sports medicine physician.

## DISCUSSION

Despite the intense nature of CrossFit, injury rates do not vary from other similar intensity activities. No significant correlation was found between demographic data, training data, and the presence of injury. A study on CrossFit that was not specific to any single body region reported that 20% of participants sustained a musculoskeletal injury, providing an injury rate 2.4 per 1000 hours.<sup>23</sup> Another study reported 3.1 injuries per 1000 hours of CrossFit, which may have been due to a larger sample size.<sup>11</sup> These rates are still comparable to other sports or activities.<sup>1,4,6,13,17,18,22</sup> Expectedly, CrossFit injury rates remain higher than less physically demanding commuting and lifestyle activities, such as walking and cycling to work, gardening, home repair, hunting and fishing, golfing, swimming, and dancing.<sup>17</sup>

Gymnastics exercises were most often the primary cause of shoulder injuries in CrossFit.<sup>23</sup> The results from this study indicated a more equal distribution, with 49% of total injuries

Table 4. Reported primary cause of injury

Movement	Cause of Primary Injury, n <sup>a</sup>
Push-up	3
Hand stand push-up	1
Hand stand walk	2
Kipping pull-up	5
Butterfly pull-up	2
Toes-to-bar	2
Knees-to-elbow	1
Ring muscle-up	4
Bar muscle-up	2
Ring dips	3
<b>Total, gymnastics</b>	<b>25</b>
Bench press	3
Snatch (any variation: power, squat, dumbbell, etc)	10
Overhead press (any variation: strict press, push-press, push-jerk, split-jerk, etc)	13
<b>Total, weightlifting</b>	<b>26</b>
Unknown origin	14

<sup>a</sup>Participants could choose more than 1 option for each injury.

due to gymnastics movements and 51% of injuries due to weightlifting movements. The report of injury with overhead lifting motions, including both pressing and snatch variations, is important information for CrossFit coaches and participants alike. A similar risk of shoulder injuries occurred in elite weightlifters, and CrossFit training includes many traditional weightlifting movements described in these articles.<sup>6,10</sup> Since these movements have a large demand on shoulder range of motion and stability, both participants and coaches should be aware of potential risks with these movements and should ensure that proper range of motion is achieved with low resistance prior to an increase in external resistance.

There are limitations with this study that should be considered when reviewing the results presented. The response rate to the survey was low at 19%. Sampling bias probably occurred, with those who were injured being more likely to complete the survey. Injuries were also self-reported, which could introduce error for potential misdiagnosis of injury severity. Although the questioning reflects the impact of injury on gym participation, it

Table 5. Timeframe for reducing training/scaling workouts after injury

Duration	Participants Who Reduced/ Abstained From Training, n	Participants Who Scaled Workouts, n
<1 wk	2	1
1-2 wk	16	10
3-4 wk	7	11
1-2 mo	7	7
3-6 mo	7	12

does not grade severity, diagnosis, or classification per a formal evaluation and diagnosis. There is also a potential for recall bias due to the study being retrospective in nature. This study was also limited because of reduced external validity of generalizability. Five of 6 participating gyms were located in the Midwest, and the sixth gym was located in the Southeast. Participating gyms were located in different areas of their respective cities, have varying experience levels of coaching, and different class sizes.<sup>11,23</sup>

## CONCLUSION

Although CrossFit training does pose a risk for injury, these very limited data show that injury rates are comparable or even lower than other recreational and competitive forms of exercise.

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