The Nature of Crossfit® Related Injuries and Post-Injury Management Perceptions and Behaviors

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Introduction and Clinical Mindset

CrossFit® a training methodology and competitive sport rapidly is gaining popularity since its inception in 2001 [1]. Worldwide more than 4 million participants and 15,000 affiliated gyms across 162 countries exist [2]. CrossFit integrates training principles from weightlifting, gymnastics, running, strongman, and body weight programs into “constantly varied, functional movements, performed at high intensity” [3]. CrossFit® work outs reportedly improve fitness, athletic, and functional performance through multifarious workouts purposely designed to increase work capacity over time. The methodology relies on measurable and repeatable performance standards and scoring with performance results tracked and shared with other athletes both at local affiliates and/or online through social media outlets. CrossFit® workouts are typically 60-minute group exercise sessions programmed uniquely by each CrossFit® affiliate and supervised by a CrossFit® certified trainer.

Numerous investigations report an association between CrossFit® style training and improvements in health and wellbeing [4-6] as well as an increase in exercise enjoyment and adherence [7]. Despite the widespread popularity of CrossFit® and reported physical and mental health evidenced based realizations, CrossFit® programs may be implicated in high injury rates associated with high exercise intensity, volume and repetition including muscle, tendon, ligament injury. Additionally, Exertional Rhabdomyolysis (ERM), a rapid deterioration of skeletal muscle, potentially leading to electrolyte imbalances, mental status changes, compartment syndrome, kidney impairment, cardiac arrhythmias and even arrest may occur during CrossFit® training [8-10].

Why is it important for rehabilitation practitioners to understand the basic CrossFit® training principles as we certainly cannot understand the biomechanics and training regimes of all client fitness training activities? This survey with 610 responses provides client reported data regarding CrossFit® training: patterns, experience level, incidence (per 1000 hours), injury locations, age, sex, return to activity, and perceptions of practitioner knowledge of exercise rigor demand. Our anticipated outcome is to assist practitioners establish an optimal plan for both preventive and rehabilitation of associated CrossFit® training injuries. One study purpose was to better understand CrossFit® related injuries, specifically, factors impacting athletes’ injury rates (e.g., training volume and fitness level) and to assess potential associations between injury risk and athlete demographics and training behaviors. An additional objective sought insight into self-reported injury management choices including medical professionals consulted after injury, athletes’ return to sport decisions, and perceptions regarding healthcare providers’ knowledge of CrossFit® training demands. This information is potentially valuable to clinicians interested in optimizing injured CrossFit® athlete management.

Methods

We conducted a retrospective cross-sectional study providing level 4 evidence on risk factors associated with injury and post injury behaviors and choices reported by individuals participating in CrossFit® training programs. We developed an anonymous online (SurveyMonkey®, Palo Alto, CA, USA) survey and posted on CrossFit® affiliates websites and CrossFit® forums. (Appendix A) Survey participants were encouraged to share the survey with their personal social media forums to further dissemination. The survey gathered self-reported CrossFit® participant demographic data, training characteristics, sustained injury and post injury behaviors. The University of Maryland Institutional Review Board considered this study exempt.

Statistical Analysis

All descriptive statistical procedures were performed using SPSS software, version 25.

Frequency counts were calculated to obtain the demographic profile of survey respondents (Figure 1) and injury incidence. Chi square analysis was performed to evaluate response differences for each survey question using a p-value of 0.05 to determine statistical significance.
Results

Demographic Data

610 individuals responded to the online survey from July 2017 through October 2017. Survey respondents were mainly female (65.6%), ages 30-59 (80%) who participated in CrossFit® for 4 or more years (56%). Thirty-seven percent of respondents identified CrossFit® training volumes of 4-6 hours per week with most (87%) reporting training at a CrossFit® affiliate (Table 1).

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>210</td>
<td>34.4%</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>400</td>
<td>65.6%</td>
<td>0.01</td>
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<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
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</thead>
<tbody>
<tr>
<td>&lt;18</td>
<td>3</td>
<td>0.5%</td>
</tr>
<tr>
<td>18-29</td>
<td>89</td>
<td>14.6%</td>
</tr>
<tr>
<td>30-39</td>
<td>163</td>
<td>26.7%</td>
</tr>
<tr>
<td>40-49</td>
<td>178</td>
<td>29.2%</td>
</tr>
<tr>
<td>50-59</td>
<td>143</td>
<td>23.4%</td>
</tr>
<tr>
<td>60+</td>
<td>34</td>
<td>5.6%</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>CrossFit Years</th>
<th>Frequency</th>
<th>Percent</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 months</td>
<td>34</td>
<td>5.6%</td>
<td></td>
</tr>
<tr>
<td>6-months-1 year</td>
<td>62</td>
<td>10.2%</td>
<td></td>
</tr>
<tr>
<td>1-2 years</td>
<td>183</td>
<td>30.0%</td>
<td>0.01</td>
</tr>
<tr>
<td>2-4 years</td>
<td>228</td>
<td>37.4%</td>
<td></td>
</tr>
<tr>
<td>&gt;4 years</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Hours per week</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 hours or less</td>
<td>343</td>
<td>56.2%</td>
</tr>
<tr>
<td>4-6 hours</td>
<td>156</td>
<td>25.6%</td>
</tr>
<tr>
<td>7-10 hours</td>
<td>52</td>
<td>8.5%</td>
</tr>
<tr>
<td>&gt;10 hours</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Training Level</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation/Beginner</td>
<td>13</td>
<td>2.1%</td>
</tr>
<tr>
<td>Scaled</td>
<td>140</td>
<td>23.0%</td>
</tr>
<tr>
<td>Intermediate</td>
<td>225</td>
<td>36.9%</td>
</tr>
<tr>
<td>Rx</td>
<td>196</td>
<td>32.1%</td>
</tr>
<tr>
<td>Rx+/Elite</td>
<td>36</td>
<td>5.9%</td>
</tr>
</tbody>
</table>

Injury Reports

This survey defined injury as any bodily harm/damage directly resulting from participation in CrossFit® workouts, excluding hand tears/rips, rope burns, cuts, sore musculature or chipped teeth. Per this definition more than half (55%) of survey respondents reportedly sustained at least one injury attributable to CrossFit® training. The rate of injury, that is, injury per 1000 training hours, was calculated from total survey responses (n=610) at 2.03 injuries per 1000 training hours. Athletes who trained 3 or less hours per week demonstrated the highest rate of injury at 3.6 injuries per 1000 training hours with the injury rate decreasing as weekly training volumes increased. Consistent with other studies the most commonly injured body parts were shoulder (28%), back (19%), and knee (13%) [11-17]. (Table 3).

Individuals reporting injuries, 57% (189) continued to train despite their injury, while 40.2% (131) reported stopping CrossFit® training temporarily, returning after the injury resolved. Overwhelmingly, athletes assumed personal responsibility for their injury, attributing injury cause to overtraining (37%) and/or their own poor choices (39%), rather than an issue with coaching, programming, or methodology. Regardless of injury, almost all survey respondents reported a higher fitness level with CrossFit® training. Fitness levels prior to starting CrossFit® training were minimal for 26% of respondents, moderate for 54%, and excellent for 12%. After participating in CrossFit® training only 3% described their fitness levels as minimal, while 45% self-reported moderate fitness and 52% described themselves in excellent fitness (Figure-2).

A significant percentage (87.4%) of CrossFit® athletes who reported injuries indicated they sought professional injury treatment ($\chi^2 = 86.113, df = 1, p < 0.01$). Physical therapists (39.9%), chiropractors (17.1%), massage therapists (14.9%), and orthopedic surgeons (12.7%) were medical providers most frequently consulted, though primary care physicians (7.6%) and athletic trainers (3.9%) were also utilized for injury diagnosis and management. Only 40% of individuals seeking professional medical care believed their healthcare provider held a high understanding of CrossFit® methodology and training approach with chiropractors reported to hold the highest knowledge. Providers in the “other” category, were considered to demonstrate the lowest knowledge of CrossFit®s training methodology (Figure-3).
## Table 2: Injury Vs. Cross Fit Years/Gender/Age/Weekly Training Hours

<table>
<thead>
<tr>
<th>Cross Fit® Years</th>
<th>Injuries</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 months</td>
<td>12</td>
<td>12/34 = 35.29%</td>
</tr>
<tr>
<td>6 months-1 year</td>
<td>30</td>
<td>30/62 = 48.39%</td>
</tr>
<tr>
<td>1-2 years</td>
<td>55</td>
<td>55/103 = 53.40%</td>
</tr>
<tr>
<td>2-4 years</td>
<td>98</td>
<td>98/183 = 53.55%</td>
</tr>
<tr>
<td>&gt;4 years</td>
<td>139</td>
<td>139/228 = 60.96%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>334</td>
<td>334/610 = 54.75%</td>
</tr>
</tbody>
</table>

- Gender
  - Male: 123/210 = 58.57%
  - Female: 211/400 = 52.75%

- Age (y)
  - <18: 1/3 = 33.33%
  - 18-29: 42/89 = 47.19%
  - 30-39: 77/163 = 47.24%
  - 40-49: 114/178 = 64.04%
  - 50-59: 81/143 = 56.64%
  - 60+: 19/34 = 55.88%

- Hours Per week
  - <3: 32/59 = 54.24%
  - 4-6 hours: 191/343 = 55.69%
  - 7-10 hours: 84/156 = 53.85%
  - >10 hours: 27/52 = 51.92%

- TOTAL: 334/610 = 54.75%

\( p = 0.041 \) for cross fit years

\( p = 0.17 \) for gender

\( p = 0.026 \) for age

\( p = 0.951 \) for hours per week

### Notes
- 633 Cross Fit® injuries were documented by responders
- 334 individuals experienced a Cross Fit® related injury 334/610 = 54.75%

## Table 3: Injury Site and Occurrence

<table>
<thead>
<tr>
<th>Injury Site</th>
<th>Number of Injuries</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>26</td>
<td>4.11%</td>
</tr>
<tr>
<td>Back</td>
<td>122</td>
<td>19.27%</td>
</tr>
<tr>
<td>Shoulder</td>
<td>179</td>
<td>28.28%</td>
</tr>
<tr>
<td>Elbow</td>
<td>46</td>
<td>7.27%</td>
</tr>
<tr>
<td>Body Part</td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>--------------</td>
<td>-------</td>
<td>------------</td>
</tr>
<tr>
<td>Wrist/Hand</td>
<td>54</td>
<td>8.53%</td>
</tr>
<tr>
<td>Hip</td>
<td>31</td>
<td>4.90%</td>
</tr>
<tr>
<td>Knee</td>
<td>82</td>
<td>12.95%</td>
</tr>
<tr>
<td>Ankle/Foot</td>
<td>45</td>
<td>7.11%</td>
</tr>
<tr>
<td>Other</td>
<td>48</td>
<td>7.58%</td>
</tr>
<tr>
<td>Total Injuries</td>
<td>633</td>
<td>100%</td>
</tr>
</tbody>
</table>

P < 0.01

**Figure 2**: Pre and Post CrossFit Training Reported Fitness Levels

**Figure 3**: Practitioner of Choice to Address Injury
Discussion

CrossFit® is a relatively safe form of exercise with similar injury risk as other sports/fitness pursuits of similar intensity[11,18-20]. However, injuries do occur and with the increase in CrossFit’s® popularity the numbers of individuals seeking healthcare practitioner injury management also is growing. We investigated and provided additional insight into CrossFit® training injury patterns as well as injured athletes’ choice of medical care provider and perceptions regarding their provider’s knowledge about the CrossFit®. More than half of this survey respondents (54.75%) reported an injury from their participation in CrossFit® falling within the injury clinical incidence range of 19%-75% in similar survey studies[13-17,21]. The wide discrepancy in injury reporting among various authors is potentially attributed to injury definition variability and the injury question subjective nature. In our survey, the question was “Have you ever sustained an injury as a direct result of CrossFit® training (not including hand tears, rips, rope burns, banged/cut shins, sore joints, and/or chipped teeth)?” No other descriptor or qualifier was provided, for example, “an injury that prevented your CrossFit® participation,” or “serious injury” or “injury requiring immediate medical attention.” The time domain implied by “have you ever sustained an injury” suggests the entirety of the participants’ CrossFit® training experience, compared with others surveys that describe a specific time frame, such as “in the past 1 month, 3 months, 1 year, etc... did you sustain an injury?” When assessing injury occurrence and risk across various sports it is important to consider injury rate not just incidence. An understanding of number of injuries per athlete relative to the time spent participating in the sport provides a more precise representation of true injury risk.[22]. The overall injury rate in this study was calculated from reported weekly workout volumes multiplied by 52 to determine annual training hours, then divided by the number of reported injuries to determine injury rate. The injury rate reported in our survey study ranged from <1 to 3.6, increasing as weekly training hours decreased. Other investigators using similar calculations of CrossFit injury rate reported overall injury rates ranging from 2.0-3.6 depending on the survey. CrossFit® injury rate is comparable to other weightlifting sports and lower for recreational sports like running and aerobic dance[18,22,23]. The injury rate reported for team sports like football, basketball, soccer, and rugby is higher than CrossFit® injury rates[20,22-25](Figure-4).

![Table: Evidence based Reported Injury Rate per Team Sport](image)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Injuries per 1000 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>14</td>
</tr>
<tr>
<td>Rugby</td>
<td>12-53</td>
</tr>
<tr>
<td>Recreational Running</td>
<td>11</td>
</tr>
<tr>
<td>Football</td>
<td>9.6</td>
</tr>
<tr>
<td>Strongman</td>
<td>4.5-6.1</td>
</tr>
<tr>
<td>Soccer</td>
<td>0.5-13.7</td>
</tr>
</tbody>
</table>

Figure 4: Evidence based Reported Injury Rate per Team Sport

Consistent throughout the reports of both competitive and recreational CrossFit® athletes, participants do not stop training once injured, rather the vast majority continue to train around their injury with or without modification of activity. This phenomenon is potentially due to the broad and varied nature of movements in CrossFit® as well as the ease of workout parameter scalability enabling an athlete to find injury “work arounds” and continue participation despite injury. Additionally, an injured athlete’s continued participation in the CrossFit® could be related to the strong social connection many feel by being part of the CrossFit® fitness community, which according to Claudino “promotes powerful feelings of wellbeing and exercise enjoyment”[26]. Whitman similarly reports CrossFit® athletes reporting “higher levels of social capital and feelings of community than members of traditional globo gyms”[27-31]. Potentially the camaraderie and social connection experienced by individuals in CrossFit® gyms outweigh the physical discomfort and loss of function associated with injury. Despite the reported injuries respondents almost universally reported improvements in perceived resultant fitness levels with CrossFit® participation. An important survey finding revealed sixty percent of participants believed their health care practitioner lacked understanding of CrossFit® methodology which is clinically significant considering the number of CrossFit® athletes seeking medical care post injury. To design appropriate rehabilitation, return to activity, and prevention programs health care practitioners must familiarize themselves with CrossFit® physical demands and training approach. Understanding the nature of CrossFit® injuries, e.g. volume of training, susceptible body regions, and foundational movement standards (e.g. Olympic and power lifts, gymnastics skills, odd object/equipment use) would enable physical therapists, physicians, chiropractors, and other medical providers to better manage recovery and injured athlete return to sport decisions. Healthcare practitioners knowledgeable about the movement demands and CrossFit® methodology may better support injured CrossFit® athlete recovery while facilitating safer return to training. Physical therapists, chiropractors, and orthopedists encompassed the medical practitioners specifically identified by survey respondents as being visited more often than other medical providers. These providers already possess the requisite anatomy, physiology, and kinesiology knowledge to rehabilitate injured CrossFit® athletes. Increased practitioner understanding of CrossFit® varied movement standards and physical demands might optimize rehabilitation and return to activity.

Study limitations

With online survey distribution, selection bias existed as an inherent potential study limitation. No accurate calculation existed regarding how many individuals viewed the survey but opted out nor to know who and why individuals chose not to provide personal data. An additional bias arose from posting the survey on CrossFit® Affiliate websites and social media forums, limiting survey exposure primarily to current CrossFit® participants.
participants, possibly excluding individuals who participated but no longer engage in the CrossFit® community. Interpretation and recall bias due to the subjective nature of survey design and questioning was a study design limitation. Another potential study limitation included “gatekeeping” by some affiliate owners and forum administrators who expressed unwillingness to disseminate the survey fearing data would be misconstrued or used to perpetuate negative CrossFit® stereotypes.

**Conclusion**

We gathered data to increase awareness of the factors associated with CrossFit® participants’ self-reported injuries, to gain insight into the athletes’ injury management behaviors and perceptions post injury. To optimally educate, prevent injury and rehabilitate this clientele more rigorous inquiry is needed: investigating healthcare practitioners regarding perceived knowledge and competence in treating CrossFit® athletes; and assessing activity completion accuracy utilizing video of original exercise prescription and periodically videoing athletes as they complete workouts.

**Appendix A**

Survey: Injury Prevalence and Management in Recreational CrossFit® Athletes

1) How long have you been participating in CrossFit® training?
   a) ___0-6 months
   b) ___6month- 1 year
   c) ___1-2 years
   d) ___2-4 years
   e) ___>4 years

2) Gender
   a) ___female
   b) ___male

3) Age
   a) ___<18
   b) ___18-29
   c) ___30-39
   d) ___40-49
   e) ___50-59
   f) ___>60

4) Height
   a) <5’
   b) 5’0”-5’2”
   c) 5’3”-5’4”
   d) 5’5”-5’6”
   e) 5’7”-5’9”
   f) 5’9”-5’10”
   g) 5’11”- 6’1”
   h) >6’2”

5) Weight
   a) <110 lbs
   b) 110 to 125 lbs
   c) 126 to 140 lbs
   d) 141 to 165 lbs
   e) 166 to 180 lbs
   f) 181> 200 lbs
   g) 201-225 lbs
   h) 225-250
   i) >250

6) How many hours per week do you train?
   a) 3 hours or less
   b) 4 to 6 hours
   c) 7-10 hours
   d) More than 10 hours

7) What is your typical training level?
   a) Foundations/beginner
   b) Scaled
   c) Intermediate
   d) RX
   e) RX +/Elite

8) Do you compete in CrossFit® and/or Functional Fitness Competitions, if so, what division? (check all that apply)
   a) Yes, scaled division in competitions
   b) Yes, Rx division in competitions
   c) Top 1000 in CrossFit®open scaled division
   d) Top 1000 in CrossFit® open Rx division
   e) Regional/games competitor
   f) I do not compete in CrossFit®

9) What was your level of fitness prior to beginning a CrossFit® training program?
   a) Did not exercise
   b) Minimal fitness
   c) Moderate fitness
d) Excellent fitness

10) Where do you do the majority of your training?
   a. CrossFit® affiliate
   b. Unaffiliated CrossFit® box
   c. Traditional fitness facility/gym
   d. Home/garage gym
   e. Other

11) What is your level of fitness now?
   a) Do not exercise
   b) Minimal fitness
   c) Moderate fitness
   d) Excellent fitness

12) Do you you do train in other sports or fitness activities concurrently with CrossFit® (e.g., running, biking, powerlifting, Olympic lifting, team sports, etc.)?
   a) Yes
   b) No

13) Have you ever sustained an injury as a direct result of CrossFit® training (not including hand tears, rips, rope burns, banged/cut shins, sore joints, and/or chipped teeth)?
   a) yes
   b) no

14) If yes, please indicate body part injured (list all injured areas)
   a) Neck
   b) Back
   c) Shoulder
   d) Elbow
   e) Wrist/hand
   f) Hip
   g) Knee
   h) Ankle/foot
   i) Other (please specify)

15) What type of injury (select any/all that apply)
   a) Tendonitis
   b) Muscle, tendon, or ligament tear or rupture
   c) Disc problems
   d) Nerve problems
   e) Bone problem (fracture)
   f) Joint problem (cartilage/meniscus)
   g) Other (please specify)

16) Was your injury a direct result of your:
   a) programming
   b) coaching
   c) overtraining
   d) Unknown
   e) Other (please specify reason for each injury if more than one injury has been sustained)

17) Did this injury require treatment?
   a) Yes
   b) No

18) What healthcare provider(s) addressed your injury (check all that apply)
   a) physical therapist
   b) orthopedic physician/surgeon
   c) chiropractor
   d) primary care physician
   e) athletic trainer/personal trainer
   f) massage therapist

19) What level of understanding do you believe your healthcare provider(s) holds regarding the physical demands of your training style?
   a) high
   b) moderate
   c) low

20) Did your injury require you to stop training?
   a) Yes, never returned
   b) Yes, temporarily but able to return
   c) No, able to continue to train around injury or with modifications
   d) No, continued to train with the injury/no change in program

21) What level of training/skill did you return to after your injury?
   a) Lower level
   b) Prior level
   c) Higher level
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References