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Title Page

The nature and prevalence of injury during CrossFit training

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ABSTRACT

CrossFit is a constantly varied, high intensity, functional movement strength and conditioning program which has seen a huge growth in popularity around the world since its inception twelve years ago. There has been much criticism as to the potential injuries associated with CrossFit training including rhabdomyolysis and musculoskeletal injuries. However to date no evidence exists in the literature to the injures and rates sustained. The purpose of this study was to determine the injury rates and profiles of CrossFit athletes sustained during routine CrossFit training. An online questionnaire was distributed amongst international CrossFit online forums. Data collected included general demographics, training programs, injury profiles and supplement use. A total of 132 responses were collected with 97 (73.5%) having sustained an injury during CrossFit training. A total of 186 injuries were reported with 9 (7.0%) requiring surgical intervention. An injury rate of 3.1 per 1000 hours trained was calculated. No incidences of rhabdomyolysis were reported. Injury rates with CrossFit training are similar to that reported in the literature for sports such as Olympic weight-lifting, power-lifting and gymnastics and lower than competitive contact sports such as rugby union and rugby league. Shoulder and spine injuries predominate with no incidences of rhabdomyolysis obtained. To our knowledge this is the first paper in the literature detailing the injury rates and profiles with CrossFit participation.

Key Words: Crossfit, Injury, weight-lifting,

INTRODUCTION

CrossFit describes itself as a "constantly varied, high intensity, functional movement" strength and conditioning program based around functional movements with the basis of "moving large loads, over long distances, and to do so quickly"(4). Over the past twelve years since its inception it has grown to include almost 3500 affiliated gyms worldwide and a recent ten-year sponsorship with Reebok.

The program takes the form of Workouts Of the Day (WODs) which typically last around twenty minutes and include a variety of bodyweight exercises, gymnastics, Olympic style weightlifting, running, rowing, skipping and using a various barbells, kettle bells and other odd shape objects. Each WOD is scalable to allow participation by a variety of different strengths and fitness levels and are typically scored and often involves a competitive element both between participators and by the individual participant themselves. This has lead to CrossFit being described as the "Sport of Fitness" and there are annual CrossFit Games which include initial qualifying WODs nationally, then regional qualifying events before the world games with the most recent games attracting a total prize purse of $1,000,000.

Described as "constantly varied", criticism has been made with regard the apparently random exercise regimes and lack of individualisation for participants of these programs. Whilst there has been widespread support of the CrossFit method for improvements in general health and fitness as an efficient exercise program that can be used safely for a variety of starting fitness and strength levels, questions have arisen with regards its safety due to the high intensity and competitive nature. Reports of rhabdomyolysis have been documented and damages were award to one participant in 2008(15,17). Concerns have

also been raised with regard the loss of good and proper form during timed workouts which may predispose to injury. A recent collaborative workshop by the Consortium for Health and Military Performance (CHAMP), other members of the Department of Defense (DoD), and representatives of the American College of Sports Medicine (ACSM), suggested potential benefits but also highlighted significant risk of injury in those involved in extreme conditioning programs such as crossfit(1). Recommendations include further research into the potential injury risk involved in these exercise programs.

Within the literature there is a lack of objective evidence to the safety and injury profiles that exist in CrossFit despite the high profile anecdotal risks that have been proposed. This study aims to define the risk of injury during CrossFit workout participation and also define the pattern of sustained injuries by using a cross sectional observational experimental design. This will enable an evidence-based approach to the understanding of the risk of injury during CrossFit participation. To our knowledge this is the first study of its kind in the published literature.

METHODS

This observational study design was based on an online questionnaire to allow collection of cross-sectional data from active participants of all levels of CrossFit training. An anonymous online questionnaire was designed and links were distributed amongst national and international CrossFit online forums. Following an Internet search using “CrossFit forums” as a search tag, the top ten ranked forums were chosen and a link to the anonymous

questionnaire was posted. All readers, including those who had not sustained any injuries, were asked to complete.

The questionnaire included patient and health demographics including age, sex, smoking status and alcohol consumption. And performance enhancing drug use. Training behaviours included total period training CrossFit as well as weekly training participation.

Participants were asked if they had sustained an injury during training CrossFit and to list the number and nature of all these injuries from their starting CrossFit. Specifically only injuries sustained during CrossFit training were included. Injury was defined as any injury sustained during training which prevented the participant training, working or competing in any way and for any period of time. Injuries requiring surgery were also recorded.

Data was collected anonymously between February to May 2012. Data was collected and compiled using Microsoft Excel and injuries were grouped according to body part injured and analysed.

Our study does include certain limitations. The retrospective nature of the study has inherent limitations in terms of respondent recall and medical personnel did not document injuries. Also due to the nature of self-selection of respondent's bias may have been introduced, with athletes who have had an injury being more likely to participate. However, we did note a number of respondents who did participate but had no injuries to document and these athletes were encouraged to respond. Despite these limitation we believe this study provides valuable insight into this extremely popular and fast expanding training method and provides the first objective evidence into the risks and nature of injuries sustained.

RESULTS

Over the collection period there were 132 responses with no responses discarded due to incomplete completion of the questionnaire. 93 (70.5%) respondents were male and 39 (29.5%) were female with a mean age of 32.3 years (range 19 – 57 years). There was a smoking prevalence of 3.8% and 126 respondents (95.5%) consumed fourteen or less units of alcohol per week (figure 1). Three respondents admitted to use of performance enhancing drug use with a prevalence of 2.2%. Mean total period of training CrossFit was 18.6 months. Mean weekly participation in CrossFit training was 5.3 hours per week.

Within the group 97 (73.5%) participants had sustained an injury that had prevented them from working, training or competing. A total of 186 injuries were reported in our cohort. Nine participants (7.0%) had sustained an injury that required surgical intervention. No reports of rhabdomyolysis were reported. The most common injury locations (Figure 2) were shoulder, spine followed by arm/elbow.

The total duration of training and weekly participation were used to identify the at risk period for those participating in CrossFit training. Using this data and the total injuries sustained an injury rate per 1000 hours trained was calculated. This would allow comparisons with other sports injury rates already published. In our sample an injury rate was 3.1 injuries per 1000 hours trained.

DISCUSSION

Our study is the first to report the type and incidence of injury in CrossFit athletes. The most commonly injured area was the shoulder followed by spine. Overall rate of injuries

sustained during training are broadly similar to that reported in the literature for sports including weightlifting, powerlifting(2,5,7,19,20) and gymnastics(11) and lower than that reported in competitive contact sports such as Rugby League(8) and Rugby Union(10). However all these sports could be classed as pushing the envelop of physical exertion or competitiveness. Comparing adult fitness activities(21), including general gym/fitness club training; and long, middle and sprint distance running(14) and triathlon training (12) The injury rates are also broadly similar to CrossFit training.

The high prevalence of shoulder injuries (31.8%) accounting for 25.8% of total injuries is higher than those previously reported for elite and competitive Olympic weightlifters(2). In Olympic weight lifting the placement of the shoulder in an at-risk position of extreme flexion, abduction and internal rotation place the tissues of the shoulder at risk of injury(6,18). During CrossFit workouts Olympic style overhead movements are performed at high repetition range and at high intensity often with heavy weights. This may lead to poor form and placing the shoulder at extremes of motion in the at risk position and predispose to injury. An example of this is the technical low squat snatch position (figure 3). With good form (figure 3) flexion at the shoulder is noted and no abnormal forces are generated. However with the poor form (figure 4) the shoulder can be seen to be placed in a position of hyperflexion, internal rotation and abduction, the at risk position.

Also the addition of a “kipping” motion, using body momentum and the lower body to generate explosive force to complete the repetition, on exercises such as pull up also places the shoulder in extremes of hyperflexion and internal rotation and the soft tissue structures at risk of injury. At the bottom position of a traditional pull up (figure 5) the shoulders remain in a comfortable range of forward flexion and no abnormal force is loaded through

the shoulder. Conversely at the bottom of a 'kipping' pull up (figure 6) the shoulder is placed in an extreme position of hyperflexion, internal rotation and abduction with significant force being generated at the bottom of the movement to spring the athlete back up into the next repetition.

Both these movements are particularly prevalent in WOD programming with nine out of the fifteen benchmark or core workouts involving pull-ups or a overhead pressing motion. This may lead to the unusually high prevalence of shoulder injury and the popularly termed injury amongst participants of "CrossFit shoulder".

The incidence of low back pain and injuries are well documented in the athletic as well as general population(9,13). The high prevalence of spinal injuries, in particular low back injuries, mirrors that seen in powerlifting and weight lifting(2,20). Again the use of high intensity, high repetition and heavy weight in exercises requiring strict form may explain the high number of low back injuries in our sample. Loss of form at extremes of fatigue during exercises including variations of weighted squat, deadlift, clean and snatch, place abnormal forces and stresses throughout the thoracic and lumbar spine leading to injury. During Olympic style weightlifting the focus is placed on performing only one repetition of the movement, however during CrossFit workouts these movements are often performed with high number of repetitions with an emphasis on speed and this may lead to poor form and injury. The dead lift progression with strict form (figure 7) emphasises holding the lumbar and thoracic spine inline and in neutral to prevent injury. With fatigue this can be lost with forward flexion of the thoracic and lumbar spine (figure 8). This may contribute to the high prevalence of injury.

Although previously cited as a risk during CrossFit participation(15,17), rhabdomyolysis was not reported in our sample. This may be due to the inclusion of all levels of fitness and participation, as rhabdomyolysis would be expected in those participating at the very extreme level of intensity. Although due to the nature of CrossFit WODs rhabdomyolysis remains a risk we believe this risk to remain remote and likely to be similar to that experienced in other high intensity and competitive sports(6,16).

PRACTICAL APPLICATIONS

The injury patterns seen in our sample of CrossFit athletes are the first to be published in the sporting and scientific literature. They are similar to those seen in other high intensity and technically demanding sports such as Olympic weight lifting and power lifting as well as general fitness training. The rates of injury are also lower than those seen in competitive contact sports. The high prevalence of shoulder and low back injuries however, due to the high intensity, high repetition and heavy weight movements, needs to be considered and taken into account when programming WODs to reduce these injuries and change the perception of injury in CrossFit.

We believe an increased focus, especially during the initial introduction to training, of proper lifting technique and focus upon maintaining this throughout workouts rather than the speed and total number of repetitions performed is needed. Also a more balanced programing of workouts should be borne in mind, specifically reducing the rate certain movements such as pull-ups and overhead motions are included into weekly workouts. We believe these measures would not impact on the overall health and fitness benefits of

participation but would lead to a reduction to the number and rate of injuries sustained during training.

The large focus upon metabolic conditioning and apparently random workouts, with a lack of focus upon strength workouts may have a bearing on injury rates and patterns. Certainly taking the workouts form the central CrossFit HQ website for the month of April in the past three years only three, five and three days over the month were allocated to strength with nineteen, sixteen and nineteen to metabolic conditioning. Without a firm strength basis we believe performing the heavy weight, high rep metabolic conditioning workouts so regularly risks injury.

A lack of individualisation has also been proposed as a potential negative aspect of CrossFit. Indeed those following the main CrossFit HQ website programming with have no tailored programming performed. However a majority of CrossFit participants do so in an affiliated gym where coaches are available to tailor workouts and also provide individualised programing. The ethos of CrossFit believes in training to be prepared for the unknown and unknowable and therefore individualisation is not necessary. While this may be true in certain circumstances, a degree of individualisation may help define more achievable goals and reduce injury rates. We believe participation under the supervision of a dedicated CrossFit gym and coach provides this compromise.

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FIGURE LEGENDS

Figure 1 Alcohol consumption

Figure 2 Number of Injuries and location

Figure 3 Squat snatch low position with good form. Shoulders show no hyperflexion with good thoracic mobility allowing overhead position

Figure 4 Squat Snatch low position poor form. Hyperflexion of shoulders to allow weight to be loaded overhead, placing shoulders in the "at risk" position.)

Figure 5 Bottom position traditional pull-up. Shoulders comfortably at range of forward flexion overhead with no stress being placed on joint

Figure 6 Bottom of 'kipping' pull-up. Forced hyperflexion of shoulders to gain momentum to spring athlete back to top of movement to get chin over bar

Figure 7 Dead lift progression with good form. Lumbar and thoracic spine kept in neutral alignment throughout range of motion

Figure 8 Dead lift progression with poor form. Forward flexion of the lumbar and thoracic spine