

**An injury profile of musculoskeletal injuries in CrossFit athletes in KwaZulu-Natal**

By

**Nicholas Simmons**

Dissertation submitted in partial compliance with the requirements for the Master's Degree in Technology:  
Chiropractic

Durban University of Technology

I, Nicholas Simmons, do declare that this dissertation is of my own work in both conception and execution (except where acknowledgements indicate the contrary).

29-8-2024

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Nicholas Simmons

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Date

**Approved for Final Submission**

29-8-2024

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Supervisor: Julian David Pillay

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Date

## **DEDICATION**

I want to dedicate this achievement to my incredible family and my loving girlfriend Olivia. Your unwavering support, encouragement, and belief in me have been my greatest strengths throughout this journey. Thank you for your endless love and for always being there to lift me up.

## ABSTRACT

**Background-** Musculoskeletal injuries are frequently reported amongst CrossFit athletes. This study aimed to determine an injury profile of CrossFit athletes in the KwaZulu-Natal area, to identify any associated risk factors, and explore possible treatment approaches. Currently, there is a paucity of information regarding the incidence of musculoskeletal injuries in KwaZulu-Natal.

**Objectives-** The objectives of this study were to determine the prevalence of musculoskeletal injuries in CrossFit athletes and to identify and create a profile of musculoskeletal injuries among CrossFit athletes, including the location, nature, and severity of these injuries. Additionally, the study aimed to identify any associations between injury profile and selected risk factors for injury, such as age, gender, height, weight, and race. Finally, another objective was to investigate the type of care and management sought by CrossFit athletes for different types of injuries.

**Methods-** The study was a quantitative-, retrospective study utilising a descriptive questionnaire administered in the form of a survey at four selected CrossFit affiliated facilities on CrossFit athletes.

**Results-** Among the 181 participants, 29% (n=53) reported on lifetime musculoskeletal injuries. This suggests that injuries are relatively common in the sport. The most frequently reported type of injury was a strain or tear in 64.1% (n=34), with the shoulder being the most commonly affected area at 37.7% (n=20). Participants reported moderate pain levels in 49% of cases, indicating that injuries were not severe enough to result in significant discomfort, most injuries were acute (up to 3 months) and required medical attention (79.1%, n=48). The majority of injuries (73%, n=39) were caused by weightlifting, highlighting the importance of proper technique and safety measures when performing this type of exercise.

**Conclusion-** This study sheds light on the prevalence, causes, and management of musculoskeletal injuries in CrossFit athletes. The findings emphasise the need for injury prevention strategies and proper training techniques to ensure the safety and wellbeing of individuals who participate in this sport.

**Keywords:** CrossFit, CrossFit athletes, risk factors, prevalence, musculoskeletal injury, impact of injury, healthcare professionals

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# CHAPTER ONE: INTRODUCTION

## 1.1 BACKGROUND TO THE STUDY

CrossFit is a strength and conditioning program that has gained widespread popularity since its inception approximately 15 years ago (Glassman, 2007). The program is used for strength and conditioning and consists of ten fitness categories- cardiovascular/respiratory endurance, stamina, strength, flexibility, power, speed, coordination, agility, balance, and accuracy (Claudino et al., 2018). However, at present, little is known about the level of injury risk associated with this form of training (Moran et al., 2017). As CrossFit is fairly new to the sporting world, few studies have been undertaken to examine the sport (Feito, Burrows & Tabb, 2018).

According to Glassman's (2007) theory, CrossFit aims to better equip athletes for the unpredictability they will encounter in their daily lives. This is accomplished by engaging in a routine of functional exercises that change quickly and are performed at a high level of intensity (Glassman, 2007). According to Paine et al. (2010), the aim of CrossFit is to carry out a conditioning workout regimen designed to achieve a generalised and comprehensive level of fitness.

CrossFit is a form of exercise that incorporates rapid and successive high-intensity ballistic movements (Hak et al., 2013) and is becoming an increasingly popular fitness option. It is important to determine how its rates of injury compared to more traditional forms of exercise (Hopkins et al., 2019). Injury rates with CrossFit training appear to be similar to that reported in the literature for sports such as Olympic weightlifting, power-lifting, and gymnastics while remaining lower than competitive contact sports such as rugby union and rugby league (Hak et al., 2013).

While CrossFit has many advantages, such as increased flexibility, strength, and cardiovascular fitness, concerns have been raised about its resulting in musculoskeletal injuries (Hak et al., 2013). These injuries have clouded the CrossFit movement, leading to investigations into their nature, prevalence, and contributing factors (Weisenthal et al., 2014). Investigating the injury profile of CrossFit athletes in KwaZulu-Natal is crucial to fully comprehend the difficulties and opportunities related to this fitness regimen, given the lack of region-specific research on this topic.

Sports medicine and exercise science literature has begun to examine the injury landscape in relation to CrossFit training. Montalvo et al. (2017) stated that sprains, strains, and overuse injuries are prevalent and frequently impact the shoulders, knees, and lower back. Studies have emphasised the crucial role of utilising proper technique, suitable programming, and progressive advancement to reduce the risk of injury (Montalvo et al., 2017, Weisenthal et al., 2014). Few studies, however, have concentrated on the injury patterns unique to the KwaZulu-Natal region among CrossFit athletes (Da Silva, 2015). The lack of locally focused research calls for an inquiry that takes into account the demographic, environmental, and training aspects of this area (Weisenthal et al., 2014).

The proposed study has the potential to fill the knowledge gap that currently exists regarding the injury profile of CrossFit athletes in KwaZulu-Natal. This study aims to provide insights that can guide injury prevention efforts, training protocols, and athlete education, by methodically examining the types, prevalence, and potential contributing factors of musculoskeletal injuries within this local context.

The conclusions of the study will have effects on many different stakeholders. A greater awareness of injury risks will aid CrossFit athletes in making more intelligent choices about their training regimens. The insights can be used by CrossFit trainers and coaches to improve exercise programming and highlight correct technique, and therefore create a safer training environment. Healthcare professionals will gain a deeper understanding of the specific injury challenges posed by CrossFit, facilitating more targeted treatment approaches. Furthermore, the findings of the study will contribute to the broader field of sports medicine and exercise science. By shedding light on region-specific injury trends, this research can inform local discussions on injury prevention strategies within the regional CrossFit community. Ultimately, this study aligns with the goal of promoting safe and effective fitness practices, ensuring that individuals can reap the benefits of CrossFit while minimising the risk of musculoskeletal injuries.

## **1.2 RESEARCH PROBLEM**

CrossFit is a fairly new sport and consequently, there is limited literature on the types of injuries and injury profiles associated with the sport. This study will expand on the available literature and knowledge regarding injuries in CrossFit and will provide information to support the development of guidelines and recommendations to improve the management and prevention of musculoskeletal injuries.

## **1.3 AIM AND OBJECTIVES**

### **1.3.1 Aim**

This study aimed to determine the injury profile of CrossFit athletes, selected risk factors, and treatment approaches associated with this sport in the KwaZulu-Natal area.

### **1.3.2 Objectives**

1. To determine the prevalence of musculoskeletal injuries in CrossFit athletes;
2. To profile musculoskeletal injuries in CrossFit athletes in terms of their location, nature, and severity;
3. To determine the associations, if any, between injury profile and selected risk factors (age, gender, height, weight, and race) for injury; and
4. To determine the type of care and management sought by CrossFit athletes for different types of injuries.

## **1.4 HYPOTHESIS**

**1.4.1 Hypothesis-** There is a correlation between musculoskeletal injuries and demographic factors in CrossFit athletes.

**1.4.2 Null hypothesis-** There is no correlation between musculoskeletal injuries and demographics in CrossFit athletes.

## **1.5 RATIONALE**

As musculoskeletal injuries are common in CrossFit, there is speculation regarding how safely the competitors perform some of the activities. The technique may be hampered by the hurried nature of the high-intensity workouts (Weisenthal et al., 2014). More understanding of the causes of injury may be obtained by learning more about the frequency, distribution, and type of injuries linked to CrossFit (Sanders, 2013).

## **1.6 BENEFITS**

Comparing each CrossFit athlete's degree of functional movement to that of other CrossFit athletes may aid in determining whether they are at risk for injuries based on their performance compared to normative values (Teyhen, 2012). CrossFit instructors can utilise this knowledge to help athletes who are interested in joining a CrossFit facility, known as a CrossFit box, to identify potential injury risks before commencing training. If these risks are identified and addressed in advance, the likelihood that an injury will occur is reduced. These actions may lower the number of injuries suffered by CrossFit athletes (Peate et al., 2007). In so doing, the health advantages of CrossFit may outweigh the risk of injury for athletes.

## **1.7 LIMITATIONS**

The study is limited by the commitment of a CrossFit athlete (participant) to report any injuries sustained to the researcher. Thus, this study has an inherent bias as it depends on the honesty and dependability of the athletes in the study (Mounton, 2006). This study has a geographical limitation, only focusing on CrossFit athletes in KwaZulu-Natal.

## **1.8 SUMMARY**

There is still a need to identify the risk factors for these injuries based on the body of research on CrossFit injury rates from prior studies (Hak 2013; Mehrab et al. 2017; Montalvo et al. 2017; Sprey et al. 2016; Weisenthal et al. 2014).

In conclusion, injuries resulting from CrossFit involvement are known to occur. However, information on their prevalence, risk factors, and types of injury as well as treatment approaches is limited. Furthermore, Chiropractors and other healthcare professionals may help guide athletes in avoiding injury. The consequent assessment of musculoskeletal imbalances, recommendations for injury prevention measures and treatment for injuries sustained while participating in CrossFit, particularly from a chiropractic and integrated healthcare perspective may be useful.

# **CHAPTER TWO: LITERATURE REVIEW**

## **2.1 INTRODUCTION**

To help the reader better understand the justification for looking at the injury profile of CrossFit athletes, this chapter provides a summary of the most recent literature pertaining to the topic. The reader will also receive a brief overview of the frequency and nature of typical injuries suffered by CrossFit athletes. The chapter also reviews the various types of injury specific to each CrossFit discipline, as well as risk factors, such as age, gender and skill level, which have been identified in the literature as predisposing CrossFit athletes to injury.

## **2.2 CROSSFIT PRINCIPLES**

This sport named CrossFit was founded in the year 2000 (Glassman, 2010). Due to the program incorporating rapid and successive high intensity ballistic movements, it takes a different approach to fitness (Hak, Hodzovic and Hickey, 2013). To achieve generalised aerobic fitness, it combines a variety of functional movements performed with high frequency and intensity. By doing this, the body is optimised for all daily activities (Glassman, 2007). The program emphasises core strength and conditioning training to prepare athletes for physical contingencies. CrossFit involves performing a wide range of diverse exercises, such as weightlifting, powerlifting, and gymnastics.

## **2.3 CROSSFIT WORKOUTS**

CrossFit workouts, referred to as workouts of the day (WOD) , are comprised of circuit training, based on three different categories of exercises: Gymnastics (pull-ups, push-ups, burpees, etc); Metabolic exercises (running, jumping, rowing, etc) and Weightlifting (squat, deadlift, etc) (Glassman, 2007) (Table 2.1). CrossFit workouts can vary greatly due to the mixing of different types of workouts with different movement patterns (Hak, Hodzovic and Hickey, 2013). Manipulating effort/rest ratios can have a significant impact on the 'structure' of the workout and

can affect the metabolic behaviour as well as the physiological responses to the exercise (Hak et al., 2013). There are two main types of training that are commonly used in CrossFit workouts: "As many reps as possible" or "as many rounds as possible" (AMRAP) which refers to the maximum repetition of a series of rounds within a set time; and "rounds for time" (RFT), which is a set number of rounds done in the shortest possible time, within a set time (Forte, Freire, Júnior, Melo, Meireles, 2022).

Table 2.1 Examples of common CrossFit exercises:

Exercise category	Description
Name of movement	
Weightlifting movements	
Deadlift	Elevating a weighted object, such as a barbell, from the ground to a standing position (O'Reilly, Whelan, Ward, Delahunt, Caulfield, 2017).
Clean-and-jerk	Cleanly lifting a barbell to the shoulders and then pushing or jerking it overhead (Ulareanu, Potop, Timnea, Cheran, 2014).
Snatch	Lifting a barbell continuously in one motion from the ground to overhead (Ho, Lorenzen, Wilson, Saunders, Williams, 2014).

Thruster	Combining a push press and a front squat to raise a barbell overhead in a single, smooth motion (Eckert, Snarr, 2014).
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Movements in gymnastics	
Pull-up exercises	Pulling up on a bar to raise the body until the chin is above the bar (Urbanczyk, Prinold, Reilly, Bull, 2020).
Toes-to-bar	Raising the feet until they make contact with the bar while hanging from a bar (Aydın, Gündoğan, Demirkan, 2023).
Push-up in a handstand	Push-ups done while doing a handstand.

Cardiovascular conditioning	
Rowing	Modelling the action of rowing a boat with a rowing machine (Johnson, Meador, Bodamer, Langford, Snarr, 2019).
Running	Sprints or longer runs.
Swimming	Sprints or longer swims.

Bodyweight exercises	
Burpees	A full-body exercise that combines the push-up, jump, and squat (Saputra, 2019).
Box jumps	Traversing a box by jumping on and off of it (Saputra, 2019).
Russian twist	Twisting the torso to touch each side of the ground while seated on the ground (Swanson, 2006).
Plank	Maintaining an upright posture while performing push-ups (Byrne, Bishop, Caines, Crane, Feaver, Pearcey, 2014).

Miscellaneous movements	
Wall ball shots	From a squat position, toss a medicine ball towards a target on the wall (Glassman, 2006).
Double-unders	Double-footed jumps with the rope going under the feet twice while skipping (Bruce, Fischer, 2017).
Air squats	Properly executed bodyweight squats (Nairn, Sutherland, Drake, 2017).
Lunges	Making a lunge by stepping forward or backward (O'Reilly, Whelan, Ward, Delahunt, Caulfield, 2017).

## 2.4 ANATOMY

Anatomy of commonly affected joints in CrossFit athletes

### 2.4.1 Anatomy of the shoulder

The shoulder is a remarkably intricate and highly mobile joint that serves as the crucial connection between the upper arm and the body's trunk (Terry & Chopp, 2000). Comprising of bones, muscles, ligaments, and tendons, the shoulder facilitates an extensive range of motion (ROM) while maintaining stability (Terry & Chopp, 2000).

In the upper arm, four essential bones contribute to the shoulder's structure: the humerus, scapula, clavicle, and sternum (Terry & Chopp, 2000). The humerus forms the ball-and-socket joint, with the rotator cuff linking it to the scapula. The clavicle connects to the sternum, providing essential support to the shoulder (Terry & Chopp, 2000).

At the core of shoulder functionality is the glenohumeral joint (GH), where the humerus's head (the "ball") articulates with the scapula's glenoid (the "socket"). While this joint permits extensive movement, it also ensures a degree of stability for functional mobility (Halder, Itoi, An, 2000). Additional joints, such as the acromioclavicular (AC) and the sternoclavicular joint (SC), contribute further to the intricate network of shoulder connections (Halder et al., 2000).

Four key muscles play pivotal roles in maintaining shoulder stability and facilitating arm movement: the rotator cuff, deltoid, trapezius, and pectoralis major. The rotator cuff, consisting of four muscles and their tendons, plays a crucial role, while the deltoid lifts the arm, the trapezius aids in shoulder movement, and the pectoralis major helps stabilise the shoulder (Culham & Peat, 1993).

In addition to muscles, the shoulder's ligaments, including the GH, coracoclavicular, and coracoacromial ligaments, contribute to the stability of the AC joint. Bursae,

fluid-filled sacs, work to minimise friction between bones and muscles (Culham et al., 1993).

The shoulder's anatomical framework is further supported by a network of blood vessels and nerves, with the brachial plexus playing a crucial role. This complex network of nerves regulates shoulder muscles and those in the upper extremity (Terry et al., 2000).

The shoulder's unique design allows for a broad spectrum of motion, encompassing flexion, extension, abduction, adduction, rotation, and circumduction (Terry et al., 2000). However, this remarkable mobility also exposes the shoulder to a range of potential injuries and conditions, including rotator cuff tears, shoulder impingement, dislocations, and arthritis.

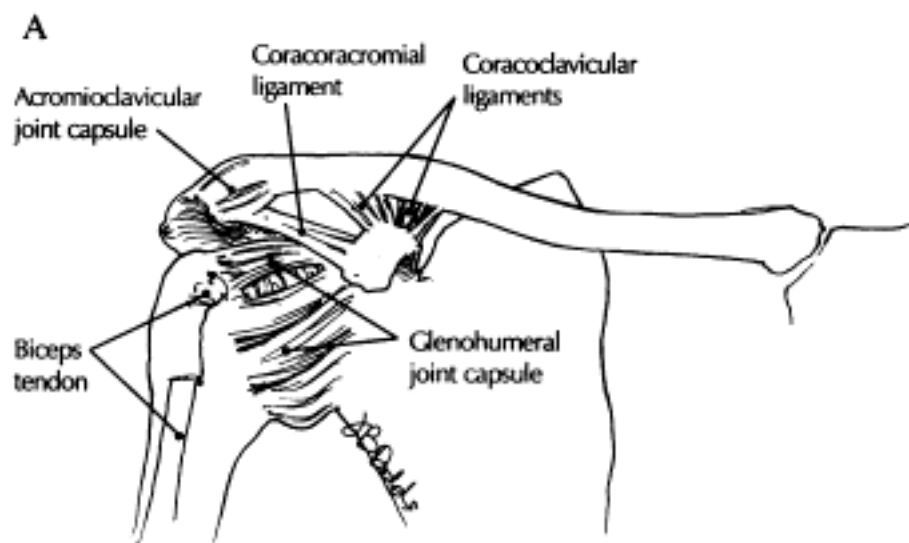


Figure 2.1: Anatomy of the shoulder (Terry & Chopp, 2000)

## 2.4.2 Anatomy of the elbow

The elbow joint complex has a distinctive functional anatomy. It consists of three bones, namely the ulna, radius, and humerus, which come together to form four articulations: the humeroulnar, humeroradial, superior radioulnar, and inferior radioulnar joints (Stroyan, Wilk, 1993). This unique bony structure offers exceptional static stabilization to the elbow, which is further reinforced by the elbow joint capsule, ulnar collateral ligament, and lateral collateral ligament. Additionally, the elbow joint is supported by 23 muscles, which can be broadly categorised into four main groups: the elbow flexors, extensors, flexor-pronator, and extensor-supinator groups. The elbow joint is an intricate structure that plays a vital role as a mechanical connector in the upper extremity, linking the hand, wrist, and shoulder. Its functions are diverse, ranging from fine movements to powerful grasping and serving as a fulcrum for the forearm (Fornalski, Gupta, Lee, 2003).

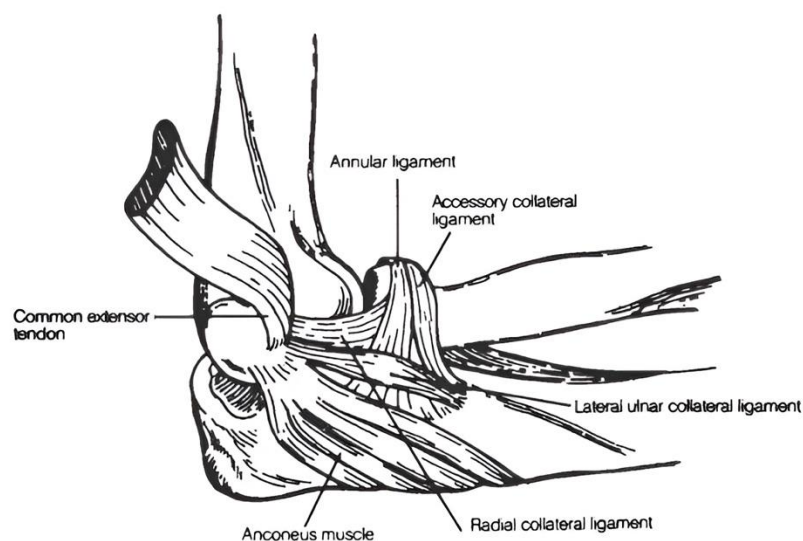


Figure 2.2: Ligaments of the elbow  
(Stroyan, Wilk, 1993)

### 2.4.3 Anatomy of the wrist and hand

The wrist joint is one of the most complex joints in the human body, known as a diarthrodial joint. This joint is made up of a group of eight unique carpal bones that are positioned between the forearm bones (radius and ulna) and the five metacarpal bones. The wrist is made up of two rows of carpal bones, each with its distinct structure and function (Eschweiler et al., 2022). The proximal carpal row is located closer to the forearm and includes the scaphoid, lunate, triquetrum, and pisiform bones from radial to ulnar. The distal carpal row is positioned closer to the hand and includes the trapezium, trapezoid, capitate, and hamate bones from radial to ulnar. Each of these eight carpal bones contributes to the complex ROM of the wrist joint and plays a crucial role in stabilizing the joint during movement (Eschweiler et al., 2022).

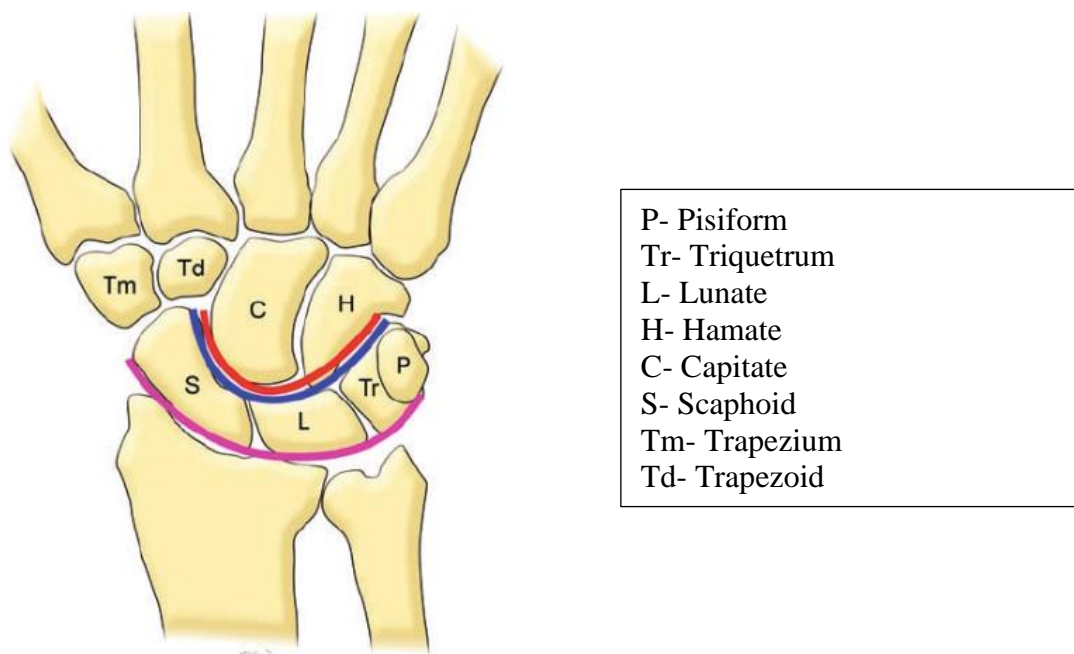


Figure 2.3: Wrist bones  
(Kaewlai et al., 2008)

#### **2.4.4 Anatomy of the lumbar spine**

The lumbar spine consists of five vertebrae, designed to bear significant weight as well as add stability to the lower back, ranging from L1 (largest) to L5 (smallest) (Higuchi & Sato, 2002).

The vertebrae in the lumbar region are renowned for their large size and robust bodies, which are designed to support and stabilise weight. The anterior part of the vertebrae is wider than the posterior part, resulting in a kidney shape (Higuchi & Sato, 2002). These vertebrae are responsible for the transmission of weight from the upper body to the lower extremities and are essential for maintaining upright posture. Additionally, the spinous process of each vertebra is relatively short and robust compared to the thoracic vertebrae (Bogduk, 2005).

The vertebral discs (intervertebral discs [IVDs]) are located between pairs of vertebrae, providing cushioning and shock absorption between them (Bogduk, 2005). The discs are composed of a hard outer ring, known as the annulus fibrosus, and a soft inner core called the nucleus pulposus. Vertebral foramen joints are located on the sides of the lumbar vertebrae, allowing for movement and articulation between neighbouring vertebrae, while also helping to maintain the spine's stability (Vora, Doerr, & Wolfer, 2010). The vertebral canal is the main structure of the spine, forming the central canal in which the spinal cord runs.

The lumbar area of the spine is naturally curved inward, forming a lordosis, which is responsible for the distribution of body weight and the absorption of shock during activities such as walking and running (Vora et al., 2010). The spinal cord roots, arising from the spinal cord and branching out from the lumbar canal, provide motor and sensory connections to the lower back and pelvis, as well as to the legs and feet.

In summary, the lumbar vertebrae are crucial for providing support, stability, and mobility to the lumbar spine and the entire body. Their unique structure allows them to bear significant loads and accommodate the stresses associated with various movements and activities.

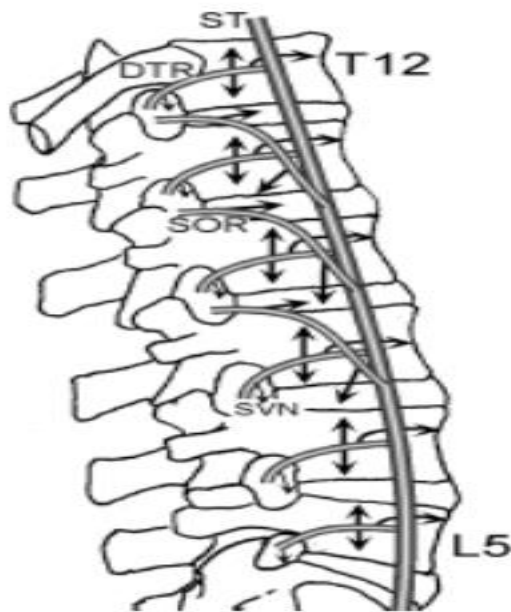


Figure 2.4: Anatomy of the lumbar spine (Higuchi & Sato, 2002)

### 2.4.5 Anatomy of the knee

The knee joint is a complex and pivotal joint in the human body, connecting the femur (thigh bone) to the tibia (shin bone) and the fibula (shin bone). It functions as a hinge joint, enabling movements like flexion (bending), extension (straightening), and a limited degree of rotation (Flandry & Hommel, 2011).

The knee joint is composed of three bones: the femur, the tibia, and the fibula. The lower end of the femur is composed of two rounded condyles, the medial and lateral condyles, which articulate with the condyles on the tibia (Flandry & Hommel, 2011). Although the fibula is not directly connected to the knee joint, it is nearby and provides support. Articular cartilage is also present at the opposing ends of the knee joint, reducing friction and allowing for smooth and pain-free movement (Abulhasan, Grey, 2017). The medial and lateral meniscus, which are crescent-shaped, serve as shock absorbers and support the joint (Watanabe, Moriya, Takahashi, Yamagata, Sonoda, Shimada, Tamaki, 1993).

Ligaments are bundles of connective tissue which are essential for the stability of the knee joint and the prevention of excessive movement (Watanabe et al.,1993). These ligaments are responsible for a variety of functions. The patellar tendon is a key structure, providing a connection between the patella and the tibia. The synovial membrane, which produces synovial fluid, works with the bursae to both lubricate and nourish the joint (Abulhasan & Grey, 2017).

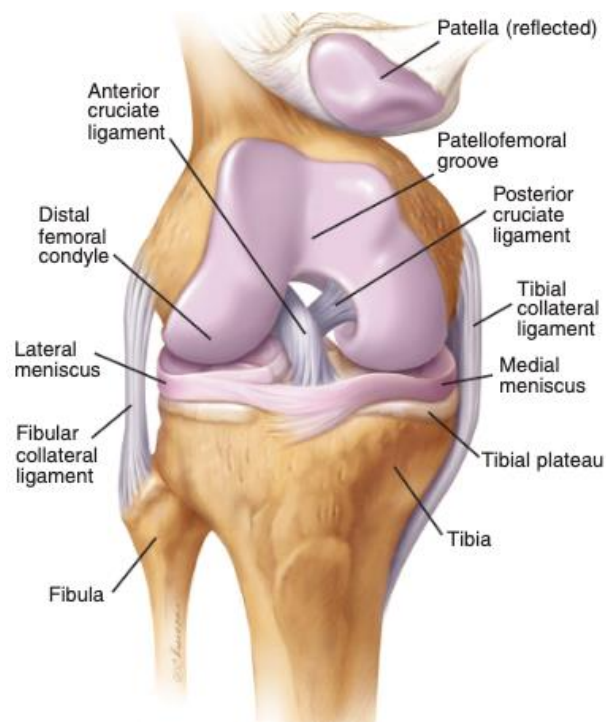


Figure 2.5: Anatomy of the knee (Smith, 2004)

## 2.4.6 Anatomy of the ankle

The foot and ankle are complex structures that consist of a network of 26 individual bones in the foot and several long bones in the lower extremity (Brockett, Chapman, 2016). Together, these bones create a total of 33 joints that work together to support a wide ROM (Brockett, Chapman, 2016). Despite being commonly referred to as the "ankle joint", there are actually many different joint articulations that facilitate the complex motions of the foot. These include the talocalcaneal (subtalar) joint, which helps with side-to-side movement, the tibiotalar (talocrural) joint that allows for up-and-down motion, and the transverse-tarsal (talocalcaneonavicular) joint that contributes to both side-to-side and up-and-down movements (Brockett, Chapman, 2016).

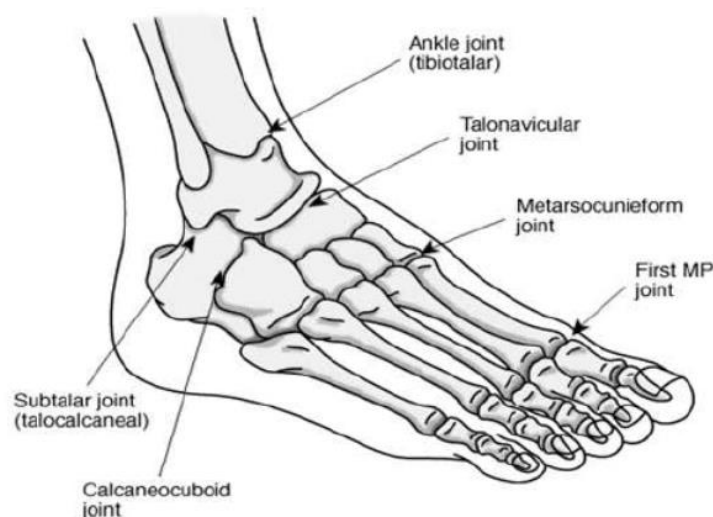


Figure 2.6: Anatomy of the ankle  
(Houghton, 2008)

## 2.5 CROSSFIT INJURY

CrossFit involves high levels of resistance and intensity which increases the risk of injury (Weisenthal et al., 2014). Injuries are traditionally defined as physical harm to a person caused by a sudden transfer of energy, such as mechanical, thermal, electrical, chemical, or radiation energy (Norton & Kobusingye, 2013). An article by Weisenthal et al. (2014) found that CrossFit has a 20% injury rate. The most common acute injuries were to the knees, shoulders, and lower back.

Athletes may be more prone to injury when performing technical exercises repeatedly at a high intensity (Bergeron et al., 2011). While a study has proven CrossFit's benefits (Meyer, Morrison and Zuniga, 2017), other studies have discovered an increased risk of musculoskeletal injury (Mehrab et al., 2017) (Weisenthal et al., 2014). Between six and 18 months following the initiation of participation in the sport, a wide range of estimated occurrence rates for CrossFit musculoskeletal injuries (CRMIs) has been reported, ranging between 19.4 to 73.5 per cent (Meyer, Morrison and Zuniga, 2017). The incidence of CRMIs has been reported as ranging from 2.1 to 3.1 per 1 000 hours of exposure (Szeles, Costa, Cunha, 2020). A previous study have attempted to estimate the incidence rates of CRMIs (Liebenson, 2019), but most have relied on a retrospective methodology (Meyer, Morrison and Zuniga, 2017). There is widespread agreement that prospective studies are a superior method for investigating the prevalence of health issues, including sports injuries (Weisenthal et al., 2014).

A systematic review by Whiteman-Sandland, Hawkins and Clayton (2018) confirmed that the current evidence on CRMIs is of low quality due to a high risk of bias within the existing trials. Meyer, Morrison and Zuniga (2017) also produced a systematic review examining CrossFit and its potential injury effects. Various studies with small sample sizes have reported no occurrence of CRMIs (Hak, Hodzovic and Hickey, 2013). However, the potential for injuries such as muscle tears, stress fractures, ligament tears, tendinopathies, tenosynovitis, and other forms of musculoskeletal pain and dysfunction have not been adequately explored by significant research.

It has been observed that taller- and heavier athletes are more prone to injuries due to the larger biomechanical movements and extra loading on the musculoskeletal systems during training (Faude et al., 2006). Athletes who spend more time training are less susceptible to injuries, as they gain better skills and techniques over time (Montalvo et al., 2017).

A study conducted by Sprey et al. (2016) compared athletes' profiles, training routines, and sports history with recorded injury rates. The study found that 31% of athletes experienced injuries.

Montalvo et al. (2017) conducted a study to determine the injury rate and risk factors associated with CrossFit over six months. The study revealed that out of 191 athletes, 26% suffered from injuries. The most commonly affected areas were the shoulder, knee, and lower back. The findings suggested that athletes could reduce the risk of injury, particularly in the shoulder, by improving their flexibility, strength, and skill level.

Another injury profile study conducted on Dutch CrossFit athletes showed similar results, with the shoulder, knee, and lower back being the most commonly injured areas (Mehrab et al., 2017). Out of the Dutch athletes studied, 56.1% suffered from injuries. The study also found that athletes who had been participating in CrossFit for more than six months were more likely to sustain these injuries (Mehrab et al., 2017). Furthermore, of the Dutch athletes involved in this study, 56.1% sustained injury. This study also concluded that athletes who had been participating in CrossFit for more than six months were more likely to sustain one of these injuries (Mehrab et al., 2017).

Researchers have investigated the risk factors for injuries in football players and collected data including athlete age, body composition, height, weight, leg extension power, jump height, peak oxygen uptake, joint stability, and previous injury history (Arnason et al., 2004). The collected data was then compared to any injury sustained during the competitive football season for any significant correlations. The study found that older football players were more at risk of sustaining injuries (Arnason et al., 2004).

## **2.6 SITE OF INJURY**

Injury patterns investigated by several sources revealed that shoulder injuries are the most common site of injury affecting CrossFit athletes. In a study of 187 individuals undertaken by Summitt, Cotton et al. (2016), 44 participants (23.5%) indicated that they had experienced a shoulder injury during CrossFit training over the previous six months. Of those who reported an injury, 17 (38.6%) stated that this injury was an exacerbation of a previous injury sustained before starting CrossFit. The most common causes of injury were improper form and exacerbation of a previous injury (Summitt, Cotton et al., 2016). The rate of CrossFit weight-related injuries has been reported to be lower than that of Olympic weightlifting, powerlifting, and gymnastics, and lower still than in competitive contact sports such as rugby union and rugby league. Common injuries include dislocations of the shoulder and injuries to the spinal cord (Meyer, Morrison and Zuniga, 2017). Montalvo et al. (2017) conducted a study to determine the injury rate and risk factors in CrossFit athletes. Fifty (26%) of 191 athletes were reported to have been injured during the six-month observation period. The most commonly injured areas were the shoulder, knee and lower back. Further findings suggested that to reduce injury, particularly that of the shoulder, athletes should improve flexibility, strength and skill (Montalvo et al., 2017). In comparison, the shoulder and lower back have also been reported to be the most commonly injured in gymnastic and power-lifting movements (Christopher et al., 2014).

### **2.6.1 Shoulder injuries**

CrossFit is a high-intensity fitness program that includes Olympic-style lifts and kipping pull-ups (Klimek, Ashbeck, Brook, Durall, 2018). These exercises require the shoulders to move beyond their normal ROM, which can put significant strain on the joint. Furthermore, CrossFit sessions usually involve a high volume of repetitions, leading to muscular fatigue. This fatigue can be particularly harmful to the glenohumeral joint, which relies on sustained muscular activation to maintain congruency (Klimek et al., 2018). As a result of fatigue, exercise techniques may suffer, increasing the risk of injury. Therefore, while CrossFit can be an effective way to improve fitness, it is essential to exercise caution to avoid potential shoulder

injuries caused by these factors. Another potential contributor to CrossFit-related injuries in general and shoulder injuries, in particular, is muscular fatigue due to the high number of repetitions performed during CrossFit sessions. Muscular fatigue may have particularly deleterious effects on the GH joint, as the congruency of this joint is dependent on sustained muscular activation. Muscular fatigue may also contribute to the loss of proper exercise technique and resultant injury (Klimek et al., 2018).

### **2.6.2 Elbow joint injuries**

The elbow joint is susceptible to injuries in CrossFit due to the sport's high-intensity and varied movements (Hak, Hodzovic, Hickey, 2013). CrossFit workouts encompass exercises that put significant stress on the elbow joint, such as Olympic weightlifting movements, i.e. clean-and-jerk and snatch, pull-ups, muscle-ups, and various forms of pressing movements, such as push-ups and handstand push-ups (Hak, Hodzovic, Hickey, 2013). These movements entail repetitive bending, extending, and twisting motions of the elbow joint which can heighten the risk of overuse injuries and acute trauma (Shim, Confino, Vance, 2023).

### **2.6.3 Wrist injuries**

Performing repetitive arm- or wrist curls with high resistance can cause a condition called intersection syndrome (Yu, Paula, 2005). This condition is characterized by pain and swelling on the front and side of the wrist, specifically along the radial aspect. Intersection syndrome is a type of friction syndrome that develops when the tendons of the abductor pollicis longus and extensor pollicis brevis rub against the radial wrist extensors. The friction causes inflammation and irritation, which can result in discomfort and tenderness in the affected area (Yu et al., 2005).

### **2.6.4 Lumbar spine injuries**

Most lumbar spine injuries in weightlifting are non-contact overuse injuries that strain the muscles around the lumbar spine (Alabbad, Muaidi, 2016). The lumbar spine moves in multiple directions, including flexion, extension, and rotation, among others

(Alabbad, Muaidi, 2016). Weightlifting exercises often involve flexion and extension movements, which can predispose the spine to disc injuries (Calhoon, Fry, 1999).

Techniques that involve full flexion can also result in injuries. Additionally, repetitive extension movements can cause compressing injuries to the facet joint. However, the percentage of spinal fractures in weightlifting is very low, possibly because the sport is non-contact and the risk of impact trauma to the spine is low (Alabbad, Muaidi, 2016).

### **2.6.5 Knee injuries**

There are different types of injuries in the knee, which are reported as patellar disorders, injury of the meniscus, cruciate ligament tear or sprain, and instability of the knee (Alabbad, Muaidi, 2016). Overuse injuries happen in the knee such as iliotibial band syndrome (ITBS), and it is common in sports that include activities with repetitive bending of joints and is characterized by pain at the lateral aspect of the knee (Smith, 2004).

When a person performs leg presses, the force generated is evenly distributed throughout the knee joint, thereby minimizing the pressure on any specific area (Smith, 2004). When they do a knee extension exercise, the force is primarily concentrated on the kneecap joint, which becomes the fulcrum of all the weight. This increase in force can cause the cartilage in the joint to wear down (Smith, 2004).

### **2.6.6 Ankle injuries**

Injuries to the ankle joint can occur when practising CrossFit or weightlifting due to the dynamic and varied movements involved in these activities (Funk, 2011).

CrossFit workouts often involve exercises that require rapid changes in direction, jumping, and landing, while weightlifting involves lifting heavy loads from the ground, which places significant stress on the lower body, including the ankles.

There are several reasons why ankle injuries are common in CrossFit and weightlifting. When performing movements like box jumps, double-unders, and

burpees, jumping and landing incorrectly can put a lot of stress on the ankle (Hak, Hodzovic, Hickey, 2013). Poor landing mechanics, such as landing with too much force or in the wrong foot position, can increase the risk of ankle sprains or strains. Additionally, overuse of the ankle joint without proper rest and recovery can lead to inflammation, tendonitis, or stress fractures (Hak, Hodzovic, Hickey, 2013). CrossFit workouts often involve high-intensity and high-volume activities that require repetitive movements like running, jumping, and skipping which can lead to overuse injuries, if not done correctly (Hak, Hodzovic, Hickey, 2013).

## **2.7 FACTORS AFFECTING INJURY SUSCEPTIBILITY**

The muscles are susceptible to injury due to several factors, both intrinsic and extrinsic. These factors can be described as follows:

### **2.7.1 Intrinsic Factors:**

Imbalances in muscle strength or flexibility can increase the risk of injury (Croisier, 2004). As individuals age, the tendons can undergo degenerative changes, making them more prone to injury. These changes can weaken the tendon tissue over time (DeHaven, Lintner, 1986). Repeatedly performing overhead activities or motions involving lifting, such as in weightlifting or CrossFit, can subject the body to overuse and repetitive stress. This can lead to wear and tear on the tendons, eventually causing injuries (Aicale, Tarantino, Maffulli, 2018).

### **2.7.2 Extrinsic Factors:**

Incorrect form and technique during exercises, especially those involving overhead movements or heavy weights, can place excessive strain on the body (Bahr, Holme, 2003). Rapidly increasing the intensity or load of exercises without allowing the muscles to adapt can overload and injure these muscles (Malisoux, Frisch, Urhausen, Seil, Theisen, 2013). A lack of proper warm-up exercises before engaging in high-intensity workouts can leave the body less prepared for the demands of the activity, increasing the risk of injury (Fradkin, Gabbe, Cameron, 2006). Direct impact or trauma to the body, such as a fall or collision, can cause injuries. Some individuals

may have a genetic predisposition to muscular skeletal injuries. Additionally, age-related changes in tendon quality and blood supply can contribute to vulnerability (DeHaven, Lintner, 1986).

## **2.8 INJURY RATES ASSOCIATED WITH GENDER**

Gender is described as an intrinsic risk factor for injury, but there is conflicting evidence as to whether or not males or females are more likely to sustain injury. Research observing powerlifting athletes revealed that male athletes had reported marginally higher injury rates than females, which included chest and thigh injuries (Keogh et al., 2006). Contradictory to these findings, athletes examined in a study conducted by (Taunton et al., 2002) found that female runners had higher injury rates.

According to a study conducted by Quatman et al. (2009), female weightlifting athletes are more prone to lower extremity injuries, while male athletes are more prone to sprains and strains. This difference may be attributed to the distinct types of equipment used in their training, as stated in a study by Lund and Myklebust (2011).

A systematic review by Meyer, Morrison and Zuniga (2017) demonstrated that males were more likely to be injured during CrossFit and that injury rates were lower when trainers were present. The injury rate and patterns among CrossFit athletes' study (Weisenthal et al., 2014) reported that males were more likely to experience injuries than females; however, the study was limited by only being conducted upon "athlete-level" CrossFit participants.

A study from the United States reported an injury rate of approximately 20% and that males were more susceptible to injury than females (Weisenthal et al., 2014). They also reported a decrease in injury rates when trainers were present to help athletes with their form. This was echoed by Hopkins, Li, Svet, Kesavabhotla and Dahdaleh (2019), who also found that beginners, males and athletes older than 34 years were more likely to be susceptible to injury. Sugimoto, Zwicker, Quinn, Myer, and Stracciolini (2020) found that females sustained lower extremity injuries more frequently than males, and the shoulder was the most commonly injured body part in

males. The most common cause of both injury in weightlifting and CrossFit has been reported to be overuse and improper form (Calhoon, Fry, 1999), which forms the background hypothesis for the planned study (Weisenthal, Beck, Maloney, 2014).

## **2.9 INJURY RATES ASSOCIATED WITH AGE**

Studies have shown that certain age categories are more prone to injuries than others (Fukuchi et al., 2013). In the field of strength training, master's athletes and skeletally mature athletes are more likely to sustain injuries (Lavallee & Balam 2010). A study was conducted to investigate the risk factors for injuries in football players (Arnason et al., 2004). The study considered athlete age, body composition, height, and weight. Injury data collected during the competitive football season was compared to the previously collected data to find any significant correlation, the results showed that older athletes are more susceptible to sustaining injuries. (Arnason et al., 2004). Athletes over 25 years of age are at a higher risk due to possible degenerative joint disease and chronic conditions, which significantly influence injury rates (Otenberg & Roos, 2000). Additionally, reduced output of muscle force and decreased joint flexibility are further reasons for higher injury rates in older athletes (Lavallee & Balam, 2010; Fukuchi et al., 2013).

## **2.10 CHIROPRACTIC TREATMENT IN CROSSFIT**

A study examining the effects of chiropractic adjustments on CrossFit athletes (Moehlecke, Forgiarini, 2017), reported an increase in ROM in the lumbar spine after treatment, suggesting that with the necessary knowledge of an injury profile, chiropractors can treat and prevent CrossFit injuries from occurring (Moehlecke, Forgiarini, 2017).

For CrossFit athletes, chiropractors can also offer preventative care. According to a study in the *Journal of Manipulative and Physiological Therapeutics*, athletes can benefit from chiropractic care by having the range of motion in their joints increased and their muscular stiffness decreased (Gay et al., 2017). These results suggest that chiropractic treatment may be advantageous for CrossFit competitors looking to

increase their mobility and avoid injuries.

## **2.11 SUMMARY**

Identifying the link between specific risk factors and CrossFit injuries may assist in identifying those athletes more at risk of injury and creating injury prevention plans. Identification of these demographic risk factors may benefit the creation of injury prevention program, coach training and safe exercise recommendations.

Furthermore, the examination of injury rates of various demographic settings may assist in exploring the underlying causes of CrossFit injuries, to guide future research and the development of safety training techniques.

In summary, injuries resulting from CrossFit activities are known to occur. However, information on their prevalence, risk factors and types of injury, as well as treatment approaches, is limited. Furthermore, chiropractors may help guide to avoid injury and treat these injuries where they do occur. The assessment of musculoskeletal imbalances, recommendations for injury prevention measures and treatment for injuries sustained while participating in CrossFit, particularly from a chiropractic and integrated healthcare perspective, may be useful.

# CHAPTER THREE: METHODOLOGY

## 3.1 INTRODUCTION

This chapter describes the research design, sampling method, research procedure, measurement tools, and statistical analysis used in the study.

## 3.2 STUDY DESIGN

The study was a quantitative, retrospective study utilising a descriptive questionnaire administered in the form of a survey. All survey data was captured by the researcher and input into a Microsoft Excel spreadsheet for analysis.

## 3.3 SAMPLING

### 3.3.1 Sample recruitment

The Durban University of Technology Institutional Research Ethics Committee granted permission for this study to proceed (Appendix G).

The letter of information (Appendix B) and consent from the CrossFit box owner (Appendix A), which was required in order to obtain permission to conduct the survey at that box was approved (Appendix H). Each participant signed an informed consent letter (Appendix B) and agreed to its terms, rendering them eligible for study participation. If the participants meet the inclusion criteria, they will answer the questionnaire regarding their CrossFit injuries. The questionnaire included general questions regarding the nature of injury, duration, sporting time lost, working time lost, and if any permanent damage was suffered.

### 3.3.2 Sample size

There is a total number of around 340 CrossFit athletes at the CrossFit boxes that have been included. Based on a population of 340 and an estimated population prevalence of CrossFit injuries of 50%, with 5% precision (half-width of the 95% confidence interval [CI]), this study aimed to recruit 181 participants.

The sample size was calculated using available athlete population statistics that were recorded by the CrossFit facilities. In 2022, their reports stated that 340 athletes were utilising CrossFit boxes. It was assumed that the prevalence of CrossFit injuries is 47.5%, which was equivalent to the mean of 19.4% and 73.5% (Szeles, da Costa, da Cunha, Hespanhol, Pochini, Ramos & Cohen, 2020). This was rounded up to 50% to generate a non-biased and more rational estimate, resulting in a total of 181 participants. For the calculation, we assumed the following: margin of error = .05 alpha = .05 p (probability of incidence of injury from CrossFit).

### **3.3.4 Inclusion criteria**

- Healthy adults that are between the ages of 18-40 years.
- Athletes that train more than or equal to twice a week at a CrossFit box.

### **3.3.5 Exclusion criteria**

- Any athlete approached who declines to participate in the study.
- Any athlete who does not voluntarily sign the letter of information (Appendix B) and informed consent form (Appendix C).
- Members of the focus or pilot study groups.
- Athletes younger than 18 years and/or older than 40 years.
- Athletes that train less than twice a week at a CrossFit facility

## **3.4 MEASUREMENT TOOLS**

### **3.4.1 Questionnaire development**

A descriptive, cross-sectional retrospective survey was used as the research measurement tool to gather information from the CrossFit athletes in KwaZulu-Natal. After the questionnaire was created and the study was approved by IREC, a pilot study was carried out to evaluate the questionnaire's validity. Face validity, construct validity, content validity, and reliability are all aspects of a questionnaire's validity. The following are the definitions of these ideas and how the questionnaire dealt with them. Face validity refers to the degree to which a study or measurement appears to be measuring what it claims to measure at face value (DeVellis, Thorpe. 2016).

Content validity is a type of validity that refers to the extent to which a measurement covers all relevant aspects of the construct being measured (Golino, Epskamp 2017), this has been ensured by the adaption of a validated questionnaire to make sure that these measurements are met. Reliability refers to how consistently a method measures a study. The measurement is regarded as reliable if the same result can be consistently obtained by applying the same techniques under the same conditions (Devellis et al., 2016).

The questionnaire was created by reviewing similar studies with similar surveys, it was modified and adapted to fit the study objectives (Ristolainen, Heinonen, Turunen, Mannström, Waller, Kettunen, Kujala, 2010). These questionnaires included the following categories, musculoskeletal pain, demographics, and injury characteristics (Sprey, Ferreira, de Lima, Duarte, Jorge, & Santili, 2016), and were adapted to focus on risk factors for CrossFit injuries in Kwa-Zulu Natal. The questions in Section A addressed the demographics, Section B focused on athlete characteristics, Section C focused on injury characteristics and Section D focused on extra activities. Both sections B and C involved general questions about the nature of injury, duration, sporting time lost, working time lost, and if there was permanent damage.

### **3.5 FOCUS GROUP**

A focus group was selected to have an organized discussion regarding views, attitudes, and experiences towards the topic to ensure the internal validity of the questionnaire (Nyumba et al., 2018). The focus group included a student and a lecturer in the chiropractic discipline who was engaged in a related study previously. The researcher and supervisor were present including one or more participants who met the inclusion criteria.

The focus group was constructed as follows:

- A date and time was arranged for the group to meet.
- A venue was scheduled.

- Focus group participants included the research supervisor, two chiropractic staff members who are able, willing, and meet the inclusion criteria, and one or two participants who meet the inclusion criteria.
- A letter of consent was handed out and signed by the participants.
- The focus group discussed the questionnaire.
- The response of the focus group to each question could be in agreement, disagreement, or undecided on whether the question should be included in the questionnaire.
- The focus group was completed once all questions have been discussed.
- The focus group discussion was recorded and reviewed.
- Changes were made to the questionnaire and form a new post group.

### **3.6 MAIN STUDY**

Once final approval was granted (IREC 178/23) and the necessary facilities had granted permission for the study to be conducted, the researcher administered the questionnaires in person to the CrossFit athletes who met the inclusion criteria.

#### **3.6.1 Procedure**

- Gatekeeper permission (Appendix H) was obtained to approach the necessary gyms.
- Once permission was obtained, the researcher approached the gym for participant recruitment.
- CrossFit athletes were approached and given the letter of information (Appendix B) and assessed for inclusion and exclusion criteria.
- If the inclusion criteria are met and participants wish to participate, the letter of informed consent (Appendix B) was provided for completion.
- On completion of the letter of informed consent (Appendix B), the letter was placed in a separate box.
- The survey was handed to the participant. The researcher stepped away to allow the participant time to complete the questionnaire.
- If a participant does not understand a question, the researcher or research assistant may provide clarification.

- The signed informed consent form (Appendix C) was kept in a box labelled with the letter "A". This was to guarantee that all forms are kept securely in a container that was sealed until the research is finished.
- To maintain the anonymity of the completed surveys and keep them in a secure container for the duration of the study, they were placed in a box labelled with the letter "B".
- The two boxes will not be opened until all questionnaires, letters of information, and informed consent forms have been completed.
- Researcher thanked participants.

### **3.7 ATHLETE QUESTIONNAIRE**

The athlete questionnaire was generated in order to collect data on the following variables:

1. Information about the athlete, including name, age, weight, height, and race;
2. The amount of time the athlete has engaged in CrossFit workouts;
3. CrossFit-related injuries, past or present, and sporting time lost as a result of these injuries.

The variables were selected to provide relevant data for analysis to determine the relationship between musculoskeletal injuries and demographic factors, as well as any risk factors that may affect the frequency of the injury.

#### **3.7.2 Changes to the focus group questionnaire**

The following changes were made to the questionnaire as recommended by the focus group:

Section A:

- Question six- Add in an additional question, 'Have you been diagnosed with any systemic disease?'

- Question seven- Add in an additional question, 'Are you currently taking any medication?'

#### Section B:

- Question two- Add in an additional question, 'How many times a week do you attend CrossFit?'
- Question three- Add an additional question, 'What skill level of CrossFit are you a part of?' into four categories.
- Question four- Add an additional question, 'How would you rank your fitness in CrossFit?' into five categories.
- Question five- Add an additional question, 'What is the average duration of your CrossFit training sessions?' into four categories.
- Question six- Add an additional question, 'What is your preferred discipline in CrossFit?' into five categories.
- Question seven- Add in additional questions, 7.1 'Do you usually stretch before training?' and 7.2 'Do you usually stretch after training?'
- Question nine- Add in an additional question, 'Is a coach present while training?'

#### Section C:

- Question one- Add categories for the site of injury.
- Question two- Divide diagnosis into categories.
- Question three- Categorise the skill level.
- Question four- Add in an additional question, 'Severity'.
- Question five- Add in an additional question, 'Duration of injury'.
- Question nine- Add in an additional question, 'Type of treatment'.

### **3.8 ETHICAL CONSIDERATIONS**

- The study was approved by gatekeepers (Appendix G) before the survey was conducted.
- No discrimination in respect of race or gender occurred.
- Beneficence- The study will improve the management of CrossFit injuries with regard to demographic factors, providing information and understanding for current management.
- Non-maleficence was justified by making sure no harm was done to participants while administering the surveys.
- Ethical clearance was obtained from the Institutional Research and Ethics Committee at DUT.
- All participating CrossFit athletes provided signed informed consent (Appendix B) before participation in the study.
- Confidentiality was maintained as participants were not required to disclose their identities on the questionnaires, and completed questionnaires were placed in ballot boxes to guarantee anonymity.
- The data and relevant documents, including the questionnaire (Appendix I) and informed consent (Appendix B), will be kept safe for five years before being destroyed.

### **3.9 STATISTICAL ANALYSIS**

The data will be analysed using SPSS version 28 and placed into different categories (gender and age) to determine whether there was a correlation between the type of injury and demographic factors. This was a quantitative study therefore statistical advice was sought and analysed. Descriptive analysis using categorical variables and frequency tables were used to provide a summary of the incidence, prevalence, selected risk factors, site of injuries, impact, and management of musculoskeletal injuries.

### **3.10 SUMMARY**

The methodology chapter of the research study explains the various procedures and techniques used during the research. It outlines the framework that guided the investigation and ensures transparency and replicability.

The chapter has covered the research design, sampling strategy, data collection methods, data analysis techniques, ethical considerations, validity and reliability, limitations, and questionnaire.

## CHAPTER 4: RESULTS

This chapter presents the key findings of the study in the form of a manuscript. The manuscript has been submitted to the South African Journal of Sports medicine on 27 June 2024 (Appendix L) and is currently under review.

### **An injury profile of musculoskeletal injuries in CrossFit athletes in KwaZulu-Natal, South Africa**

NA Simmons<sup>1</sup>, JD Pillay<sup>2</sup>, PhD

<sup>1</sup>Department of Chiropractic, Faculty of Health Sciences, Durban University of Technology, South Africa.

<sup>2</sup>Faculty of Health Sciences, Durban University of Technology, South Africa.

#### ABSTRACT

**Background:** CrossFit is a strength and conditioning program that has been identified as fairly new sport and has gained widespread popularity since its inception approximately 15 years ago. Consequently, there is limited literature on the types of injuries and injury profiles associated with the sport.

**Aim:** The aim of this study was to determine the prevalence and injury profile of musculoskeletal injuries in CrossFit athletes and to identify associations between injury profile and selected risk factors as well as the type of professional care sought.

**Methods:** A questionnaire-based study, administered to 181 CrossFit athletes in KwaZulu-Natal, South Africa was performed, included sections on demographics, injury characteristics and professional care sought. The data were analysed using SPSS Software version 28. Categorical variables and frequency tables provided a summary of the prevalence, selected risk factors, site of injuries and management of musculoskeletal injuries.

**Results:** Among the 181 participants, 29% (n=53) reported musculoskeletal injuries. The most frequently reported type of injury was a strain/tear (64.1%, n=34), the shoulder being the most commonly injury site (37.7%, n=20). Participants reported moderate pain levels in 49% of cases; majority of injuries (73%, n=39) were caused by weightlifting.

**Discussion:** Injuries are a relatively common occurrence in CrossFit. This study sheds light on the prevalence, causes, and management of musculoskeletal injuries in a fairly new yet increasingly popular fitness program and highlights the need for injury prevention strategies and proper training techniques to ensure the safety and wellbeing of individuals who participate in this sport.

Keywords: CrossFit, musculoskeletal injuries, prevalence, risk factors

## INTRODUCTION

CrossFit is a strength- and conditioning program that has gained widespread popularity since its inception approximately 15 years ago.<sup>[1]</sup> CrossFit is a form of exercise that incorporates rapid and successive high-intensity ballistic movements.<sup>[2]</sup> and is becoming an increasingly popular fitness option. The program consists of ten fitness categories: cardiovascular/respiratory endurance, stamina, strength, flexibility, power, speed, coordination, agility, balance, and accuracy.<sup>[3]</sup> According to Glassman,<sup>[1]</sup> the purpose of CrossFit is to better equip athletes for the unpredictability they will encounter in their daily lives. This is accomplished by engaging in a routine of functional exercises that change quickly and are performed at a high level of intensity.<sup>[1]</sup> According to Paine et al.<sup>[4]</sup> the aim of CrossFit is to carry out a conditioning workout regimen designed to achieve a generalised and comprehensive level of fitness.

While CrossFit has many advantages, such as increased flexibility, strength, and cardiovascular fitness, concerns have been raised about its resultant risks of musculoskeletal injuries.<sup>[2]</sup> At present, little is known about injury risk associated with this form of training.<sup>[5]</sup> As CrossFit is fairly new to the sporting arena, there are few studies that have been undertaken to examine the sport, with particular reference to injuries.<sup>[6]</sup> Whilst injury rates in CrossFit training appear to be similar to that reported in the literature for sports such as Olympic weightlifting, power-lifting and gymnastics, they remain lower than competitive contact sports such as rugby union and rugby league.<sup>[2]</sup> It is nevertheless important to determine how the rates of injury compare to more traditional forms of exercise.<sup>[7]</sup> Investigating the injury profile of CrossFit athletes is crucial to fully comprehend the difficulties and opportunities related to this fitness regimen, as well as provide tailored interventions towards reducing and managing injuries.

Studies have emphasised the crucial role of utilising proper technique, suitable programming, and progressive advancement in order to reduce the risk of injury.<sup>[8]</sup> Few studies, however, have focused on the injury patterns, as the sport is still fairly new. The lack of locally-focused research further calls for an inquiry that takes into account the demographic, environmental, and training aspects of this area.

The aim of the study was therefore to determine the prevalence and injury profile of musculoskeletal injuries in CrossFit athletes, including the location, nature, and severity of these injuries. Additionally, the study aimed to identify associations, if any, between injury profile and selected risk factors for injury, such as age, gender, height, weight, and ethnicity. Finally, the type of care and management sought by CrossFit athletes for different types of injuries was investigated. In so doing, the study provides insights that can guide injury prevention efforts, training protocols and athlete education, by examining the prevalence, types and potential contributing factors of musculoskeletal injuries.

## **METHODOLOGY**

A questionnaire-based cross-sectional approach was applied in this study.

### **STUDY POPULATION**

The study population included CrossFit athletes in KwaZulu-Natal, South Africa. The population was determined by the number of members belonging to the CrossFit-affiliated facilities who were willing to participate in the study. Individuals between the age of 18 and 40 years who met the inclusion criteria were invited to voluntarily participate in the study.

### **SAMPLE SIZE**

The total number of CrossFit athletes at the included CrossFit affiliated boxes in the eThekweni region was estimated to be 340. Based on a population of 340 and an estimated population prevalence of CrossFit injuries of 50% with 5% precision<sup>[9]</sup> (half-width of the 95% confidence interval), this study aimed to recruit 181 participants.

### **MEASUREMENT TOOL**

The questionnaire was created by reviewing similar studies with similar surveys,<sup>[10, 11]</sup> it was modified and adapted to fit the study objectives. The questionnaire underwent review by an expert focus group consisting of the student researcher, research supervisor, a chiropractic staff member, a chiropractor with relevant research experience and two participants meeting the study's inclusion criteria. Subsequent changes were implemented to the questionnaire, resulting in a modified version to be utilised in the study.

## **ETHICAL CONSIDERATIONS**

The study received ethical clearance from the institutional research ethics committee (IREC 178/23) at Durban University of Technology. Permission was obtained from the gym owners to conduct research within the CrossFit-affiliated gyms. The CrossFit athletes who participated in the study were provided with letters that explained the research and ensured their data were kept confidential. Each individual signed a letter of informed consent before participating.

## **STATISTICAL ANALYSES**

The data were analysed using SPSS Software version 28 and placed into different categories (gender, age and BMI) to determine whether there were any associations between the type of injury and demographic factors. Categorical variables and frequency tables provided a summary of the incidence, prevalence, selected risk factors, site of injuries and management of musculoskeletal injuries.

## **RESULTS**

A total of 186 questionnaires were completed. However, five questionnaires were incomplete and not used in the analysis. A total of 181 questionnaires were thus suitable for analysis, yielding a completion rate of 97.31%.

Approximately half (50.8%, n=92) of the participants identified as female and 48.6% (n=88) identified as male, with one participant identifying as Other. The ethnicity of the participants was predominantly Caucasian, accounting for 77.9% (n=141), followed by Black (8.3%, n=15), Indian (7.7%, n=14) and Coloured (5.5%, n=10). The remaining were classified as Other (0.6%, n=1).

The mean age was  $30.02 \pm 5.6$  years and the mean body weight was 78.6kg. It was found that the height of the athletes who were selected varied within a certain range. The athletes' heights fell between 1.56m minimum and 1.98m maximum values, with a mean value of 173.4 cm.

## Training history and CrossFit participation

Figure 4.1 provides an illustration of training history and CrossFit participation

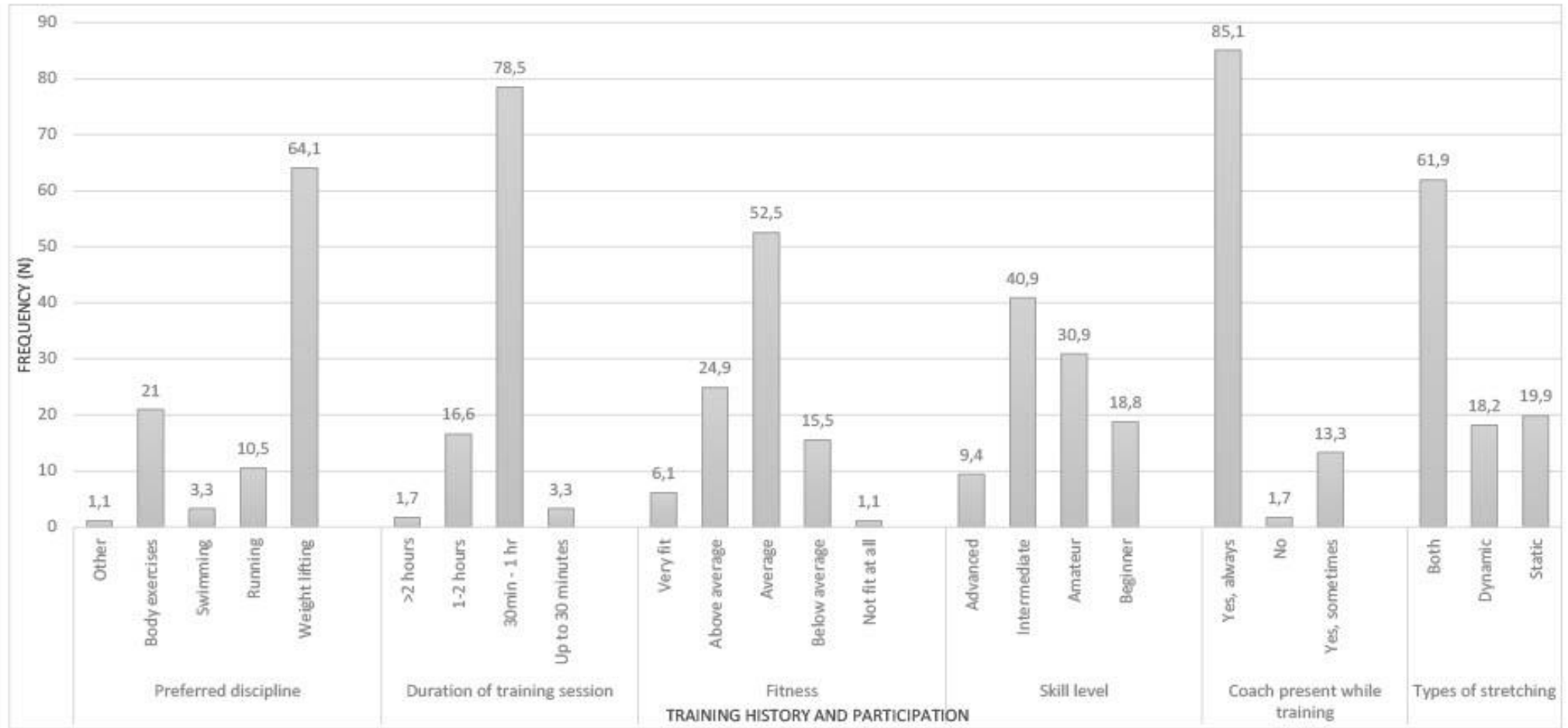


Figure 4.1: Training history and CrossFit participation

Majority of respondents (64.1%, n=116) expressed a preference for weight lifting as their primary form of exercise whilst 21.0% (n=38) of the participants indicated a preference for bodyweight exercises. Even less prevalent, 10.5% (n=19) of respondents selected running as their preferred discipline, and a preference for swimming was indicated by 3.3% (n=6) of the participants.

Skill level was divided into four categories: beginner, amateur, intermediate, and advanced. According to the data, beginners were less prone to injuries with 94.1% (n=32) not recording any injury. Advanced individuals were least prone to injury with 41.2% (n=7) only having recorded one injury and 47.1% (n=8) recording no injury. On the other hand, individuals with an intermediate level of skill were found to be the most vulnerable to injury, with a risk of (17.8%, n=13). Out of the total participants, 77% (n=140) reported that they usually stretched before training, while only 40% (n=72) stretched after training.

In this study it was found that 98.3% (n=178) of CrossFit athletes reported having a coach present or nearby during their training sessions, highlighting the strong prevalence of coaching in the CrossFit community. Only 1.7% (n=3) of participants trained without a coach. Additionally, the study revealed that most participants' (78.4%, n=142) CrossFit training sessions typically lasted between 30 minutes and 1 hour.

## Injuries sustained

**Table 4.1: Overview of the injuries sustained to the CrossFit athletes**

Indicator	Indicator categories	Frequency (n)	Percent (%)	X <sup>2</sup>	df	p-value
Injury location	Shoulder	20	37.7	39.321	6	<0.001
	Elbow	2	3.8			
	Lumbar back	15	28.3			
	Hand/wrist	3	5.7			
	Hip/thigh	3	5.7			
	Knee	6	11.3			
	Foot/ankle	4	7.5			
Diagnosis	Strain/tear	34	64.2	67.094	4	<0.001
	Sprain	6	11.3			
	Bruise/wound	4	7.5			
	Fracture	1	1.9			
	Other	8	15.1			

How it was sustained	Weight lifting	39	73.6	124.849	5	<0.001
	Body resistance training	1	1.9			
	Cardiovascular training	2	3.8			
	Ballistic movements	4	7.5			
	Post workout	2	3.8			
	Other	5	9.4			
Pain level	Very mild	4	7.5	32.000	4	<0.001
	Mild	10	18.9			
	Moderate	26	49.1			
	Severe	10	18.9			
	Very severe	3	5.7			
Duration of injury	<48 hrs	4	7.5	14.264	4	0.006
	a few days - 1 week	4	7.5			
	2-4 weeks	17	32.1			
	1-3 months	14	26.4			
	>3 months	14	26.4			
Duration on effect on training	Not at all	9	17.0	5.538	3	0.136
	Up to 1 month	19	35.8			
	Up to 3 months	15	28.3			
	More than 3 months	9	17.0			

$X^2$ , chi-square; *df*, degrees of freedom

The findings revealed that shoulder injuries were the most prevalent site of injury (37.7%, n=20), followed by lumbar spine injuries (28.3%, n=15), and knee injuries (11.3%, n=6) (Table 1). This indicates that the shoulder region is most likely to be injured, whereas the elbow is comparatively less prone to injuries (3.8%, n=2).

Table 1 further provides a comprehensive breakdown of the different types of injuries observed. The data reveal that strain/ tear were the most frequently observed injury type, accounting for a majority of injuries (64.1%, n=34). The next most frequent were sprains, which accounted for 11.4% (n=6) of all injuries. Contusions also made up a small proportion of the injuries, with a total of 7.5% (n=4). The remaining 15.2% (n=8) of injuries were classified as "Other," which could include a diverse range of injuries not covered by the other categories.

## Professional healthcare in managing musculoskeletal injuries among CrossFit athletes.

Injured CrossFit athletes often seek treatment from various healthcare professionals and undergo a wide range of treatments, which can vary significantly.

**Table 4.2: Treatment sought out and performed on injured CrossFit athletes**

	<i>Frequency (%)</i>		<i>n</i>	<i>p-value</i>	
	Yes	No			
Treatment sought	Chiropractic	28 (58%)	20 (42%)	48	.312
	Physiotherapy	27 (56%)	21 (44%)	48	.471
	Biokineticist	15 (31%)	33 (69%)	48	.013
	Occupational therapist	1 (2%)	47 (98%)	48	<.001
	General practitioner	1 (2%)	47 (98%)	48	<.001
	Home remedy	3 (6%)	45 (94%)	48	<.001
	Other	5 (10%)	43 (90%)	48	<.001
Treatment performed	Chiropractic adjustment	26 (54%)	22 (46%)	48	.665
	Acupuncture/dry needling	34 (71%)	14 (29%)	48	.006
	Pain medication	18 (38%)	30 (62%)	48	.111
	Steroid injections	2 (4%)	46 (96%)	48	<.001
	Therapeutic massage	29 (60%)	19 (40%)	48	.193
	Rest, Ice, Compress, Elevate (RICE)	18 (38%)	30 (62%)	48	.111
	Other	41 (85%)	7 (15%)	48	<.001

*n*, number of participants

*p*-value, Binomial test

It was found that of those having experienced injuries, 58% (n=28) of participants consulted a chiropractor, making this the most consulted practitioner. However, physiotherapists were also frequently consulted (56%, n=27). It is interesting to note that occupational therapists and general practitioners were the least consulted professionals (2%, n=1, respectively). Acupuncture and dry needling were the most commonly utilised forms of treatment, with 71% (n=34) of patients opting for this method. Chiropractic adjustments were the second most popular form of treatment (54%, n=26). On the other hand, steroidal injections as a treatment choice had the lowest uptake with 96%, n=46 of participants not opting for this treatment option.

## **THE ASSOCIATION BETWEEN INJURIES, GENERAL CHARACTERISTICS AND TRAINING HISTORY**

Out of the 91 females surveyed, injuries were distributed as follows: 69.2% (n=63) had no injuries, 19.8% (n=18) had one injury, and 11.0% (n=10) had multiple injuries. Overall, 63 females (69.2%) had no injuries, while 30.8% (n=28) had suffered injuries. Similarly, out of the 88 male participants, 71.6% (n=63) had no injuries, 18.2% (n=16) had one injury, and 10.2% (n=19) had multiple injuries. This translates to 63 males (71.6%) without injuries, and 28.4% (n=25) with injuries.

The correlation analysis showed a correlation between age and CrossFit injuries, with the average age varying significantly based on the number of injuries sustained ( $F(2, 177) = 5.201, p = 0.006$ ). Further analysis using Tukey's post hoc test revealed that individuals who had experienced one injury (n=34, mean age =  $31.9 \pm 5.673$  years) were older than those who had not had an injury (n=127, mean age =  $29.1 \pm 5.391$  years), showing a difference of 2.81 years with a p-value of 0.022. However, the comparison between individuals with one injury (n=34, mean age =  $31.9 \pm 5.673$  years) and those with multiple injuries (n=19, mean age =  $32.1 \pm 5.466$  years) showed very similar data, with a difference of only 0.17 years.

There was no significant correlation between body mass index (BMI) and the frequency of injuries. However, an association between fitness levels and the number of injuries sustained (Fisher's  $\chi^2 = 22.461, p = 0.001$ ) was demonstrated. The data showed that beginners are 94.1% (n=32) less likely to have sustained injuries; individuals with an intermediate skill level tend to have multiple injuries 17.8% (n=13) of the time, and those with advanced skills are more

likely to have sustained a single injury 41.2% (n=7) of the time. Furthermore, there was a moderate positive correlation between the number of injuries sustained and the total years of doing CrossFit ( $\rho = 0.401$ ,  $p < 0.001$ ). A weak positive correlation between the number of injuries sustained and the frequency of CrossFit sessions per week ( $\rho = 0.235$ ,  $p = 0.002$ ) was found.

## **DISCUSSION**

The impact of age on an athlete's risk of injury has been the subject of several studies.<sup>[2,6]</sup> A comparison of injury rates and age in this study reveals that individuals who have experienced one injury (mean age = 31.94 years $\pm$ 5.673 years) are older than those who have not had an injury (mean age = 29.13 years $\pm$ 5.391 years), indicating that age does play a role in an athlete's susceptibility to injury in this population. The musculoskeletal system undergoes age-related changes over time, including the loss of muscle mass, strength, and flexibility. These changes can lead to decreased range of motion (ROM) and increased susceptibility to injury.<sup>[12]</sup> Additionally, a sedentary lifestyle can accelerate these changes, leading to further decline in musculoskeletal health.<sup>[13]</sup> According Hagglund et al.<sup>[14]</sup>, the combination of aging and a lack of physical activity can have a compounding effect on musculoskeletal function.

## **INJURIES SUSTAINED**

In the total sample, 29.2% (n=53) of CrossFit athletes sustained injuries. This falls within the range of rates reported in previous studies. For example, it is similar to the rate reported Feito et al.<sup>[6]</sup> (30.5%) and Sprey et al.<sup>[11]</sup> (31%). However, it is higher than that reported at Weisenthal et al.<sup>[8]</sup> (19.4%) and Montalvo et al.<sup>[15]</sup> (26.0%), but lower than that in Mehrab et al.<sup>[16]</sup> (56.1%) and Hak et al.<sup>[3]</sup> (73.5%). The main difference between the study conducted and the other studies was that the model did not limit responses to injuries that occurred within a specific time frame after the survey was completed. This allowed for the inclusion of participants with previous injuries who may have recovered and then returned to CrossFit, thus having a similar to slightly higher injury rate. However, in a similar retrospective survey of participants in a CrossFit program,<sup>[2]</sup> the injury incidence was 74%, the survey was only distributed on online CrossFit forums, whereas the survey at present was done in person at CrossFit-affiliated gyms.

## SITE OF INJURY

The area most commonly affected was the shoulder, followed by the knee and lower back. CrossFit is a comprehensive fitness program that aims to target all areas of the body, which may account for the even distribution of injuries throughout the body. These injuries are found in the upper limbs, the trunk, and the lower extremities. These findings are consistent with prior injury profile studies.<sup>[2, 8, 15-17]</sup> Montalvo et al.<sup>[15]</sup> discovered that shoulder injuries were the most prevalent injury among those who practice CrossFit, followed by knee and lower back injuries. Additionally, the same areas were found to be the most commonly injured sections of the body among CrossFit athletes.<sup>[8, 16]</sup> The results of this study are consistent with the CrossFit literature, which shows a high frequency of low back injuries.<sup>[3, 8]</sup> However, this high incidence of lower back injuries aligns with studies on gymnastics, where athletes commonly experience such issues.<sup>[18]</sup> Similar trends have been observed among Olympic weight lifters and powerlifters.<sup>[19]</sup> The prevalence of lower back pain among CrossFit athletes warrants further studies, as the high intensity, high repetition, complex techniques, and heavy weights used in CrossFit may contribute to the development of low back pain and injury.<sup>[2]</sup>

The literature on CrossFit describes the knee as a common area of complaint.<sup>[2, 8]</sup> Knee complaints may be due in part to heavy weights that put significant stress on joint structures.<sup>[19]</sup> Ballistic-type lifts, like the snatch and clean and jerk, focus on the rapid movement of heavy weights, placing great stress on the soft tissue structures and leading to strains, thus increasing the risk of injuries.<sup>[19]</sup> The knee is also a common region of complaint in endurance sports such as running.<sup>[20-22]</sup> The combination of lifting weights in a ballistic style and engaging in endurance running in CrossFit may increase the risk of injury for athletes. Possible reasons for these areas commonly sustaining injuries may be due to the structures being placed under high levels of stress at a high frequency and repetition.

There are many overhead exercises performed during CrossFit, which are often at high loads and have many technical aspects to the movements. The structures in the shoulder are therefore especially placed under strain as a repetitive hyper-flexed, abducted and internally rotated position is assumed. The structures eventually fatigue and result in a lack of technique and form, which may result in injury.<sup>[3]</sup> To prevent injuries during training, athletes must be aware of common risk areas and prioritise maintaining proper form.<sup>[8]</sup>

## **TYPE OF INJURY**

Based on the data collected, the most common injury type during CrossFit were muscle strains or tears, accounting for 64.2% (n=34) of the cases. The high emphasis on the soft tissue structures leads to a greater risk of strains, as highlighted in a previous study.<sup>[19]</sup> Regarding the severity of injuries in CrossFit athletes, most injuries were acute (up to 3 months) and required medical attention (79.1%, n=48). Hak et al.<sup>[2]</sup> also reported that most injuries were acute; however, they found that most injuries were mild to moderate. On the other hand, Weisenthal et al.<sup>[8]</sup> discovered that 73.5% of CrossFit athletes reported injuries that prevented them from training. This was further supported by the results of the present study, which showed that 83% (n=44) of athletes were unable to train due to their injuries.

## **RISK FACTORS**

The skill level which was divided into four categories: beginner, amateur, intermediate, and advanced. Before adding intensity and weights, individuals must develop the necessary skills to perform movements correctly and consistently.<sup>[23]</sup> This was proven according to the data, advanced individuals were less prone to injuries at only 9.4% (n=17). The study by Montalvo et al.<sup>[15]</sup> suggests that athletes who dedicate more time to training are less likely to suffer from injuries, possibly due to the gradual improvement of their skills and techniques over time. On the other hand, intermediates were found to be the most vulnerable to injuries, with a risk factor of 40.9% (n=74). In a study conducted by Sprey et al.<sup>[11]</sup> injury rates were examined in relation to athletes' profiles, training routines, and sports history. The findings revealed that 31% of athletes experienced injuries, with those participating in CrossFit for more than six months being at a higher risk of sustaining injuries.

The findings on body mass index reveal that weight was not a risk factor for injury. This aligns with the findings of Montalvo et al.<sup>[15]</sup> and may be linked to the limited sample size in both studies preventing the ability to establish a definitive correlation between weight and injury prevalence.

When comparing the monthly duration of CrossFit practice to injury rates among athletes, no significant correlation was found. However, a previous study<sup>[11]</sup> found that athletes who had been practicing CrossFit for more than six months and who were training for competitions were more likely to sustain injuries. In contrast, Montalvo et al.<sup>[15]</sup> found that a longer

duration of CrossFit reduced the rate of injury, which seems to contradict the former study. It's unclear whether a longer period of training decreases injury rates due to an increased skill level, or increases the risk for injury due to athletes attempting more advanced techniques and intense workout programs. Since there are conflicting studies with different outcomes, it's difficult to draw any conclusions, especially since the current study found no correlation between duration and injury rate. Therefore, more finite research is needed to accurately determine which factors influence injury in CrossFit athletes, specifically about the duration of their participation in the sport.

It is important to have coach supervision during CrossFit training, as it can protect against injuries.<sup>[8]</sup> This was revealed in the study as 98.4% (n=178) of the CrossFit athletes had a coach present or nearby monitoring their workout, which could be a factor as to why the injury rate was below 30%. It is crucial to maintain good form during technical movements, as incorrect movements can be unsafe. Coaches play a key role in ensuring proper technique.<sup>[4]</sup>

## **PROFESSIONAL MANAGEMENT**

The data presented that only 2% (n=1) of patients visited a general practitioner, while the majority of patients (57%, n=27) opted for non-invasive care, such as chiropractic and physiotherapy non-invasive care such as chiropractic and physiotherapy.

In a study,<sup>[24]</sup> it was found that the highest proportion of early recovery was observed in Chiropractic manipulation (27.3%), followed by acupuncture (9.4%) and medication (5%). The study concluded that manipulation achieved the best overall results with improvements. However, it emphasized that the treatment for chronic spinal pain should not rely solely on manipulation, acupuncture, or nonsteroidal anti-inflammatory drugs, but rather on a combination of these treatments. According to a study by El-Tallawy et al.,<sup>[25]</sup> patients are increasingly choosing non-invasive care options for musculoskeletal pain and injury, instead of relying on pharmacological or surgical treatment.

## **KEY FINDINGS**

- The most commonly injured areas in CrossFit athletes were the shoulder (37.7%), lower back (28.3%), and knee (11.3%).
- Injury rates for CrossFit athletes were below 30%, which is similar to those in related sports.
- If injuries occurred, they were mostly considered acute injuries.
- Risk factors such as age and skill level increased the risk of injury prevalence in CrossFit athletes.
- When injured, athletes sought treatment preferring chiropractors and physiotherapists over general practitioners for musculoskeletal injuries.
- Acupuncture and dry needling were the most commonly used form of treatment types.

## **STRENGTHS OF THE STUDY**

This study represents the first of its kind in Kwazulu-Natal, South Africa, focusing on the epidemiology of musculoskeletal injuries in CrossFit athletes. While previous South African studies<sup>[26]</sup> focused on the specific activities and events of the CrossFit games, this study specifically directs its attention to the training aspects at CrossFit-affiliated gyms in South Africa, rather than the CrossFit games. Another notable strength of this study is the added knowledge about musculoskeletal injuries in CrossFit athletes, which holds great value for healthcare professionals in managing injuries related to this sport.

## **LIMITATIONS AND RECOMMENDATIONS**

To participate in the study, individuals had to be current members of a CrossFit affiliated facility, however athletes who have stopped due to injury were therefore not included in the study and their information was lost. Additionally, the study had a minimum age requirement of 18 years. This meant that younger CrossFit athletes were unable to participate in the study, which may have excluded a population of athletes more prone to injury due to various age-related factors. For future studies, it is crucial to expand the sample size by incorporating athletes younger than 18 years old and those who have had a history of injuries but are currently inactive, this will be achieved with an online survey which will reach more individuals who do not currently attend the CrossFit-affiliated gym, the survey can have a

broader reach. Due to the limited volume of literature on musculoskeletal injuries in CrossFit athletes, the study required comparison to other sports, such as weightlifting. While this approach was helpful in identifying similarities between the sports, it would have been more beneficial to compare the data to studies that focus solely on CrossFit.

## **CONCLUSION**

The findings of this study suggests that injuries are a relatively common occurrence in the sport. The most frequently reported type of injury was a strain or tear, with the shoulder being the most commonly affected area. Participants reported moderate pain levels in 49% (n=26) of cases, indicating that injuries were not severe enough to result in significant discomfort. The majority of injuries (73%, n=39) were caused by weightlifting, highlighting the importance of proper technique and safety measures when performing this type of exercise.

Overall, this study sheds light on the prevalence, causes and management of musculoskeletal injuries in CrossFit athletes. The findings emphasise the need for injury prevention strategies and proper training techniques to ensure the safety and wellbeing of individuals who participate in this sport.

**Conflict of interest and source of funding:** The authors declare that they have no conflict of interest and funding was provided by Durban university of Technology.

**Acknowledgements:** The authors would like to thank Mrs Gill Hendry for assisting as the statistician of this study.

# CHAPTER 5: DISCUSSION

## 5.1 INTRODUCTION

This chapter presents a detailed discussion of the results obtained in the study in reference to the literature. This chapter seeks to discuss various aspects of CrossFit injuries in athletes, including participation rates, demographics, the prevalence of musculoskeletal injuries, risk factors, impact, and injury management strategies. The objectives of the research will be expounded upon in this chapter, with reference to relevant literature, to support the discussions.

## 5.2 DEMOGRAPHICS

### 5.2.1 Age

A comparison of injury rates and age in the study revealed that individuals who have experienced one injury (mean age = 31.94 years) are older than those who have not had an injury (mean age = 29.13 years), indicating that age does play a role in an athlete's susceptibility to injury in this population.

The impact of age on an athlete's risk of injury has been the subject of several studies (Hak et al., 2013; Feito et al., 2020). Research conducted by Lavallee and Balam (2010) suggested that older athletes and skeletally mature athletes are more prone to injury during strength training. As the athletes age, degenerative joint disease becomes increasingly common (Lavallee & Balam 2010). The musculoskeletal system undergoes age-related changes over time, including the loss of muscle mass, strength, and flexibility (Fukuchi et al., 2013). These changes can lead to a decreased range of motion (ROM) and increased susceptibility to injury. Additionally, a sedentary lifestyle can accelerate these changes, leading to a further decline in musculoskeletal health (Loeser 2010). According to Hagglund et al. (2016), the combination of ageing and a lack of physical activity can have a compounding effect on musculoskeletal function.

## 5.2.2 Gender

The gender distribution of the participants showed that 50.8% identified as female, while 48.6% identified as male, and one participant identified as other. Injury rates among the genders were divided into females 30.1% and males 28.4%. There was no correlation found between gender and the association with CrossFit injury. These percentages are very similar to the research conducted by Montalvo et al. (2017), which included 94 males and 97 females. The study indicated a similar sample size with a slightly different outcome for both genders, with injuries being more prone for men at 30% compared to women at 21%. However, no association was concluded.

Similar findings were emphasised by Costa et al. (2019) who found no significant difference in injury rates between male and female CrossFit athletes, which is consistent with the current study. In their 2016 study, Sprey et al. stressed that gender showed no correlation with the survey results. The sample size was substantial, with 566 individuals participating, comprising 243 women 43% and 323 men 57%. Montalvo et al. (2017) and Sprey et al. (2016) rather emphasised that there was no correlation between gender but rather weight and body mass index (BMI).

The findings of Weisenthal et al. (2014) and Moran et al. (2017) suggest that male athletes have a greater risk of injury during CrossFit participation compared to females. However, both studies took into account previous injuries from different sports as well as injuries from CrossFit, so the findings may not be a true reflection of the injury risk related to participation in CrossFit but rather CrossFit could have aggravated existing injuries. These findings suggest that CrossFit is suitable for individuals of different gender groups when performed in a safe environment and under the guidance of qualified professionals.

## **5.2.4 Height**

It was found that in the study, the height of the athletes who were selected varied within a certain range. The athletes' heights fell between 1.56m minimum and 1.98m maximum values, this meant the mean value was 1.73m. There was no correlation between height and injury weight. However, in contrast, Montalvo et al. (2017) stated that injured athletes were taller and weighed significantly more than uninjured athletes. An association was made that the greater height may be associated with greater biomechanical movements. The evidence suggests that being taller might be connected to higher biomechanical force.

More research is needed to find out if the biomechanical factors related to being taller and being able to lift heavier weights are things that can be changed to reduce the higher risk of injury during CrossFit.

## **5.2.5 Body mass index (BMI)**

The research on BMI did not find that weight was a significant risk factor for injury.

Montalvo et al. (2017) suggested that larger athletes typically use heavier weights and more resistance in training, but this can also directly increase the risk of musculoskeletal injuries. This risk of injury may be linked to the athletes' strength levels rather than their body measurements or proportions.

Similarly, Montalvo et al. (2017) findings align with the presented data and may be due to the small sample sizes in both studies, which may have prevented the establishment of a definitive correlation between weight and injury prevalence.

Additionally, when examining the study by Sprey et al. (2016), which had a much larger sample size (n=566) than the previous study, no correlation was found between BMI and injury prevalence.

## 5.3 MUSCULOSKELETAL INJURIES IN CROSSFIT ATHLETES

### 5.3.1 Injury prevalence

In the total sample, 29.2% of CrossFit athletes sustained injuries in a lifetime prevalence. This falls within the range of rates reported in previous studies such as and similar to the rate reported by Feito et al. (2020) at 30.5%, by Sprey et al. (2016) at 31% and by Montalvo et al. (2017) at 26.0%. However, slightly higher than that reported by Weisenthal et al. (2014) 19.4% but significantly lower than Mehrab et al. (2017) 56.1% and Hak et al. (2013) 73.5%.

Hak et al. (2013) and Mehrab et al. (2017) characterised an injury as "Any injury sustained during training that prevented the participant from training, working, or competing in any way and for any period". This definition's broadness and lack of specificity might account for the study's high injury incidence rates.

The injury rate aligns with those reported for other physical activities involving similar movements, such as weightlifting, powerlifting, and Olympic gymnastics (Hak et al., 2013). We also found similar injury rates of 30.1 % when comparing CrossFit to activities related to physical conditioning and fitness such as running (short, middle, and long-distance) (Buist et al., 2010).

The main difference between our study and that of other studies was that the data collection used in this study did not limit responses to injuries that occurred within a specific time frame after the survey was completed.

The current study included participants with previous injuries who may have recovered and then returned to CrossFit, thus having a similar to slightly higher injury rate. However, in a similar retrospective survey of participants in a CrossFit program, the injury incidence was 74%, the survey was only distributed on online CrossFit forums, whereas the present survey was done in person at CrossFit-affiliated facilities.

### 5.3.2 Location of injury

The areas that are most commonly affected are primarily the shoulder (37.7%), followed by the lower back (28.3%) and then the knee (11.3%). CrossFit is a comprehensive fitness program that aims to target all areas of the body, which may account for the distribution of injuries throughout the body. These injuries are found in the upper extremities, the trunk, and the lower extremities. These findings are consistent with prior injury profile studies conducted by Montalvo et al. (2017), Weisenthal et al. (2014), Mehrab et al. (2017), Chachula et al. (2016), and Hak et al. (2013).

Montalvo et al. (2017) discovered that shoulder injuries were the most prevalent injury among those who practice CrossFit, followed by knee and lower back injuries. Possible reasons for these areas commonly sustaining injuries may be due to the structures being placed under high levels of stress at a high frequency and repetition. There are many overhead exercises performed during CrossFit, which are often at high loads and have many technical aspects to the movements. The structures in the shoulder are therefore placed under significant strain as the repetitive hyper flexed, abducted and internally rotated position is assumed. The structures eventually fatigue and result in a lack of technique and form, which may result in injury (Hak et al., 2013). Knowing which areas are most commonly injured during training, athletes need to be aware of the risks and strive to maintain technique and form during training (Weisenthal et al., 2014).

The literature on CrossFit describes the knee as a common area of complaint (Hak et al., 2013; Wiesenthal et al., 2014). Knee complaints may be due in part to heavy weights that put significant stress on joint structures (Lavelle & Balam, 2010). Ballistic-type lifts, like the snatch and clean and jerk, focus on the rapid movement of heavy weights, placing great stress on the soft tissue structures and leading to strains, thus increasing the risk of injuries (Lavelle & Balam, 2010). The knee is also a common region of complaint in endurance sports such as running (Taunton et al., 2002; Ellapen et al., 2013; Nielsen et al., 2013). The combination of lifting weights in a ballistic style and engaging in endurance running in CrossFit may increase the risk of injury for athletes.

The prevalence of lower back pain among CrossFit athletes warrants further study, as the high intensity, high repetition, complex techniques, and heavy weights used in CrossFit may contribute to the development of lower back pain and injury (Hak et al., 2013). However, the incidence of lower back injuries aligns with studies on gymnastics, where athletes commonly experience such issues (Kruse & Lemmen, 2009). Similar trends have been observed among Olympic weightlifters and powerlifters (Lavallee & Balam, 2010).

Overall CrossFit incorporates a variety of disciplines such as weightlifting, gymnastics, and cardiovascular exercises. CrossFit offers a comprehensive workout experience. Each discipline carries its own risk of injury, and the present study supports this, demonstrating that the combination of these sports leads to specific sites being injured.

### **5.3.3 Type of injury**

According to the collected data, the most common injury types during CrossFit were muscle strains or tears (64.2%), followed by sprains (11.3%), bruises/wounds (7.5%), and fractures (1.9%).

Performing CrossFit exercises under high levels of stress which can lead to a higher risk of injury (Waller et al., 2007). Unlike the precise form used by powerlifting and weightlifting athletes, CrossFit allows for incorrect form when performing complex lifts, as highlighted by Hak et al., (2013). This increased demand places pressure on the musculoskeletal structures in the body, which ultimately leads to strains or tears (Smith et al., 2013). In the Golshani et al. (2018) study, strains were the most commonly reported injuries, comprising 46.1% of all cases, proving that musculoskeletal structures are the first to succumb to injury.

The emphasis on soft tissue structures in CrossFit exercises increases the risk of strains, as noted in the study by Lavelle and Balam (2010). Most of these injuries are relatively mild, with sprains and strains being quite common (Weisenthal et al.,

2014). Studies on weightlifters support this, as muscular strains and ligamentous sprains make up 40-60% of the acute injuries.

The prevalence of skin injuries, particularly hand and tibial (shin) lacerations, is not well-documented in the literature because it is often not reported as an injury (Vidal et al., 2020). These injuries rarely affect an athlete's training schedule. Hand lacerations from frequent high repetitious exercises (pull-ups or muscle-ups) often happen to callused hands. Additionally, tibial wounds can occur from a missed landing during a box jump or from direct trauma to the shin by the barbell during lifts. Fractures can occur due to overuse or direct trauma. However, a study by Gianzina et al. (2019) showed that because of the diverse exercises in the CrossFit program, the risk of fractures can be reduced. This aligns with our study with only 1.9% being affected.

#### **5.3.4 Duration and severity of injury**

In this study on injuries in CrossFit athletes, it was discovered that 79.1% of the injuries were acute, occurring within three months, and requiring medical attention (n=48). This finding was consistent with other studies (Golshani et al., 2018, Montalvo et al., 2017, Hak et al., 2013, Gardiner, Devereux, & Beato, 2020), where the majority of injuries (55%-80%) were classified as acute. Training time missed is usually less than 1 day in about 90.5 % of the injuries (Lavelle & Balam, 2010), Carlhoon et al., 1999). It's important to note that while injuries in CrossFit are not uncommon, they generally exhibit acute characteristics and do not persist over extended periods.

The most common pain experience was described as moderate, with 49.1% of athletes experiencing it (n=26). However, a study conducted by Hak et al. (2013) reported that most injuries were mild.

Weisenthal et al. (2014) stated that 74% of CrossFit athletes experienced injuries that prevented them from training. The results of the present study align with this, showing that 83% of the athletes (n=44) could not train due to their injuries.

However, both studies stated that athletes were back to training within three months.

This points to the fact that while CrossFit does involve some risk of injury, it does not significantly impede long-term participation, allowing athletes to sustain their fitness levels.

## **5.4 RISK FACTORS**

### **5.4.1 Skill Level**

The skill level was divided into four categories: beginner, amateur, intermediate, and advanced. The data revealed that intermediate athletes were most at risk of injury (56%), followed by amateur (23%), then advanced (17%) and the least likely was the beginner (4%).

Bergeron et al. (2011) stated that before adding intensity and weights, individuals must develop the necessary skills to perform movements correctly and consistently and this was proven with only 4% of beginners indicating injury. The study by Montalvo et al. (2017) suggests that athletes who dedicate more time to training are less likely to suffer from injuries, possibly due to the gradual improvement of their skills and techniques over time and being classified as advanced. However, the study reported that there was a 35.1% higher rate of injury for athletes practising for longer than six months. This was emphasised again in a study conducted by Sprey et al. (2016), where injury rates were examined relative to athletes' profiles, training routines, and sports history. The findings revealed that 31% of athletes experienced injuries, with those participating in CrossFit for more than six months being at a higher risk of sustaining injuries.

Overall, the current study supports previous literature by suggesting that the risk of injury is higher for intermediate skill levels and beyond six months of experience, but lower for advanced and beginner levels.

### **5.4.2 Frequency of training**

When comparing the monthly duration of CrossFit practice to injury rates among athletes, no significant correlation was found.

However, a previous study by Sprey et al. (2016) found that athletes who had been practising CrossFit for more than six months and who were training for competitions were more likely to sustain injuries. In contrast, Montalvo et al. (2017) found that a

longer duration of CrossFit reduced the rate of injury, which seems to contradict the former study.

It's unclear whether a longer period of training decreases injury rates due to an increased skill level, or increases the risk for injury due to athletes attempting more advanced techniques and intense workout programs. Since there are conflicting studies with different outcomes, it's difficult to draw any conclusions, especially since the current study found no correlation between duration and injury rate. Therefore, more finite research is needed to accurately determine which factors influence injury in CrossFit athletes, specifically about the duration of their participation in the sport.

#### **5.4.4 Coach presence**

The study revealed that 98.4% of the CrossFit athletes had a coach present or nearby, monitoring their workout.

It is important to have coach supervision during CrossFit training, as it can protect against injuries (Weisenthal et al., 2014). It is crucial to maintain good form during technical movements, as incorrect movements can be unsafe. Coaches play a key role in ensuring proper technique (Paine et al., 2010).

Mazur et al. (1993) stated the significance of good coaching and supervision especially when athletes are using free weights and lifting maximally. The study suggests that the risk of injury is minimal when athletes are involved in well-coached and supervised programs.

The majority of the CrossFit athletes were under the supervision of a coach, this could be a factor as to why the injury rate was below 30%.

## 5.5 PROFESSIONAL MANAGEMENT

Professional management of CrossFit athletes presented as 90.6% who received treatment, and 9.6% did not receive treatment at all. Chiropractors and physiotherapists were seen on an average of 57% if treatment occurred with only 2.1% seeing a general practitioner. According to the data, acupuncture/dry needling (70%), therapeutic massage (60%), and chiropractic adjustment (54%) were the most preferred treatments, while pain medication (63%) and steroid injections (96%) were the least favoured, indicating a preference for alternative treatments.

In other studies, lower percentages of individuals sought treatment for their injuries. Specifically, Alekseyev et al. (2020) reported that 67.1% sought healthcare professionals for diagnosis or treatment, while Sprey et al. (2016) and Montalvo et al. (2017) reported that 42% and 41.9%, respectively, sought similar medical assistance. However, in these studies, it is stated that most injuries were acute in nature, leading to more reliance on home remedies such as rest and ice.

According to a study by El-Tallawy et al. (2021), patients are increasingly choosing non-invasive care options for musculoskeletal pain and injury, instead of relying on pharmacological or surgical treatment. It was reported by Astin (1998) that 34% of adults in the United States used at least one non-westernised form of health care. The most frequently used alternatives to conventional medicine were relaxation techniques such as chiropractic adjustment and massage. This was emphasized in the research presenting that only 2% (n=1) of patients visited a general practitioner, while the majority of patients (57%, n=27) opted for non-invasive care, such as chiropractic adjustment and physiotherapy.

In a study conducted by Giles and Muller in 2003, it was found that the highest proportion of early recovery was observed in Chiropractic manipulation (27.3%), followed by acupuncture (9.4%) and medication (5%). The study concluded that manipulation achieved the best overall results with improvements, however, it emphasized that the treatment for chronic spinal pain should not rely solely on

manipulation, acupuncture, or nonsteroidal anti-inflammatory drugs, but rather on a combination of these treatments.

## **5.6 SUMMARY**

This chapter provided a comprehensive review of the study's results and their comparison to relevant research on musculoskeletal injuries in CrossFit athletes. The study revealed a high prevalence of musculoskeletal injuries among CrossFit athletes, with the shoulder being the most frequently affected area.

Furthermore, the study identified age and skill level as significant risk factors for CrossFit injuries. It also highlighted that while these injuries may be severe, the associated training downtime is typically short-term. It is clear that many CrossFit athletes rely on specialized healthcare, particularly Chiropractic adjustments and physiotherapy, for effective treatment and recovery.

# CHAPTER SIX: CONCLUSION

## 6.1 INTRODUCTION

This chapter summarises the key findings of the study and provides some strengths and limitations. The chapter also provides recommendations for future research and concludes the study.

## 6.2 KEY FINDINGS

- The most commonly injured areas in CrossFit athletes were the shoulder (37.7%), lower back (28.3%), and knee (11.3%).
- Injury rates for CrossFit athletes were below 30%, which is similar to those in related sports.
- If injuries occurred, they were mostly considered acute injuries.
- Risk factors such as age and skill level increased the risk of injury prevalence in CrossFit athletes.
- When injured, athletes sought treatment preferring chiropractors and physiotherapists over general practitioners for musculoskeletal injuries.
- Acupuncture and dry needling were the most commonly used form of treatment types.

## 6.3 STRENGTHS OF THE STUDY

This study represents the first of its kind in Kwazulu-Natal, South Africa, focusing on the epidemiology of musculoskeletal injuries in CrossFit athletes, while previous South African studies by Da Silva (2015) focused on the specific activities and events of the CrossFit games.

In contrast, this study specifically directs its attention to the training aspects at CrossFit-affiliated facilities in South Africa, rather than the CrossFit games. Another notable strength of this study is the added knowledge about musculoskeletal injuries

in CrossFit athletes, which holds great value for healthcare professionals in managing injuries related to this sport.

## **6.4 LIMITATIONS**

The research study aimed to investigate musculoskeletal injuries in CrossFit athletes. To participate in the study, individuals had to be current members of a CrossFit affiliated gym. However, athletes who have stopped participation due to injury are therefore not included in the study and their information was lost.

Additionally, the study had a minimum age requirement of 18 years, which meant that younger CrossFit athletes were unable to participate in the study, which may have excluded a population of athletes more prone to injury due to various age-related factors.

Due to the limited volume of literature on musculoskeletal injuries in CrossFit athletes, the study required comparison to other sports, such as weightlifting. While this approach helped identify similarities between the sports, it would have been more beneficial to compare the data to studies that focus solely on CrossFit.

## **6.5 RECOMMENDATIONS**

- A study is recommended with a larger sample size. It is suggested to investigate CrossFit athletes from all over South Africa, rather than being limited to one city.
- Explore in depth, the most effective recovery and rehabilitation protocols for common CrossFit injuries.
- Further research is needed to understand why the shoulder, knee, and lower back are highly prone to injury.
- Further investigations could investigate and compare athletes'

different types of diets and the possible effects on performance.

- Investigate how psychological factors like competitiveness, stress, and motivation contribute to the occurrence of injuries.
- A study determining the level of re-injury that occurs in CrossFit athletes.

## **6.6 CONCLUSION**

The study revealed a high incidence of musculoskeletal injuries among CrossFit athletes, particularly in the upper limb, with the shoulder being the most affected area and the most common type of injury was found to be strain/ tear injuries.

Significant risk factors for CrossFit injuries were found in the study. These factors include age and skill level. Despite the severity of pain experienced, the loss of training time caused by these injuries was usually short-lived

Interestingly, the management of these injuries was similar among participants, with predominantly non-invasive treatments being favoured. It was noted that only a small number of individuals sought treatment from general practitioners, with most opting for alternative non-Western medical approaches.

This study sheds important light on the prevalence, causes, and management of musculoskeletal injuries in CrossFit athletes. These findings underscore the pressing need for injury prevention strategies and proper training techniques to safeguard the well-being of individuals involved in this sport.

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## APPENDICES

### Appendix A- Advertisement

ARE YOU A CROSSFIT  
ATHLETE CURRENTLY  
PARTICIPATING IN  
CROSSFIT TRAINING?

Participate in a research study  
today.

Contact Nicholas 0840218345

## Appendix B- Letter of Information – Main Study



### LETTER OF INFORMATION

**Title of Research Study:** An injury profile on musculoskeletal injuries in CrossFit athletes in Kwa-Zulu Natal.

**Principal Investigator / Researcher:** Nicholas Simmons (MHSc: Chiropractic)

**Supervisor:** Prof Julian Pillay (PHD)

Dear research participant

I am a 6th year student completing my research for my Master's degree in Chiropractic at DUT. I am very passionate about fitness and especially CrossFit as a sport. However, as it is a new sport, there is very little research pertaining to musculoskeletal injuries related to demographics as a result of the sport and how they can best be managed. I would like to invite you to participate in my research. Your time is appreciated and will assist in providing valuable information regarding how best health professionals, especially us as Chiropractors can help manage and treat your injuries.

#### **What is Research**

Research is a systematic search for generalized new knowledge. Your participation will help us contribute to the knowledge that exists on the relationship between injuries in CrossFit athletes and how best health professionals can assist in managing these injuries. You are welcome to ask as many questions as you need, I am happy to explain more in detail. You are under no obligation to commit at this stage.

#### **Outline of the Procedure**

The aim of this study is to determine the prevalence, selected risk factors and types of injuries that CrossFit athletes are prone to as well as the level of Chiropractic care used and the influence this has on their participation in the sport, performance levels and their quality of life. Participants will be approached and asked to fill out the questionnaire. The expected time to complete the questionnaire is approximately 10 minutes. You will be expected to complete and sign Informed Consent as well as the questionnaire. Once the questionnaire is completed, the process is complete and you will not be contacted further.

#### **Risks or discomfort to the participant**

There are no risks or risk of discomfort to you during this study.

#### **Reason why you may be withdrawn from the study**

If you are non-compliant and have not completed at least 80% of the questionnaire, you will be withdrawn from the study. As a voluntary participant in this research study, you are free to withdraw from the study at any given time without giving a reason for withdrawing and without consequence.

### **Benefits**

By volunteering to partake in this study, you will allow Chiropractors and other health care professionals to build our knowledge of the correlation between musculoskeletal injuries and CrossFit athletes.

### **Remuneration**

You will not be receiving any monetary or other type of remuneration for participation in this study.

### **Cost of the study**

You will not be expected to cover any costs towards the study.

### **Confidentiality**

All patient information is confidential. You will not be expected to record any personal details that could identify you. The results of this study will be used for research purposes only. Only individuals that are directly involved in this study (Professor Pillay and myself) will be allowed to access these records.

### **Results**

Once the information has been collected, the results from the study will be published in the dissertation section of the DUT Library which can be taken out through normal library protocol. There will also be an online copy available to you through the DUT online library system.

### **Research Related Injury**

There is no risk or injury that you can sustain by participating in this study.

### **Storage of all electronic data**

All electronic data on a computer and external storage device, will be kept for five years after which it will be deleted.

### **Persons to contact should you have any problems or questions**

Should you wish to contact me, feel free to do so on 0840218345

Alternatively, DUT-Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Acting Director: Research and Postgraduate Support on [researchdirector@dut.ac.za](mailto:researchdirector@dut.ac.za)

Thank you for participating in my research study

## Isithasiselo A

Incwadi Yolwazi

Isihloko Socwaningo: Iphrofayili yoklimala kwemsipha kubasubathi abeCross-Fit esfundazweni saKwaZulu\_Natal

Umcwaningi/ Umphenyi oyinhloko: Nicholas Simmons (MHSc: Chiropractic)(udokotela wamathambo nemsipha)

Umphathi: uProfesa Julian Pillay (PHD)

Mhlanganyeli wocwaningo othandekayo

Ngingumfundi owenza unyaka westhupha oqedela iziquzeMasters kwiChiropractic enyuvesi yochwepheshe EThekwini (DUT). Ngingentshisekelo enkulu ngokufaneleka, kakhulukazi ngomdlalo weCross Fit. Khepha, kuwumdlalo omusha, futhi luncane kakhulu ugcwaningo mayelana nokulimala kwemsipha ehlobene nokubalwa kwabantu, njengemphumela yezemdlalo, nokuthi ingalawulwa kanjani. Ngicela ukuvula isimemo kuwe ukuthi ubeyinxenye wogcwaningo lwami ngokuba ubeumhlanganyeli. Isikhathi sakho ngingasthokozela kakhulu futhi sisize ekuhlinzekeni ulwazi olubalulekile mayelana nokuthi abezepilo benza kanjani okungcono kakhulu, kakhulukazi thina odokotela bamathambo nemsipha engasiza ukulawula nokwelapha ukulimala..

### Luyini ugcwaningo

Ugcwaningo uhlelo lokusesha ulwazi olusha jikelele. Inhlanganyelo yakho izosisiza ngokufaka isandla kulwazi olukhona kubuhlobo phakathi kwemidlali ye CrossFit nokuthi ochwepheshe abezempilo bangasiza kanjani ekulawuleni ukulimala. Wamkelekile ubukuza imibuzo noma engakanani odinga uyibuze, ngingakujabulela ukuk'chazela kabanzi. Awuphoqelekile ukuba ubeyinxenye yogcwaningo kulesisgaba.

### Uhlaka logcwaningo

Inhloso yalolugcwaningo ukuthi inqume ukusabalala, izici ezikhethiwe nokulimala okwahlukene kwabadlali beCrossFit abasengozini yoklimala, nokuthi izinga lokusizakala kwechiropractic olusetshenziswayo nokuthonya ekubambeni iqhaza kulomdlalo, izinga lokudlala Kanye nekhwalithi yempilo. Abahlanganyeli bazosondezwa bacelwe ukugcwalisa imibuzo. Isikhathi esilindelwe ukuqeda lemibuzo kuzocishe kuthathe imizuzu elishumi. Kuzolindeleka ukuthi ugcwalise usayinde imvume enolwazinemibuzo. Masiqediwe ukuphendulwa imibuzo, inqubo iyobeisiphelile mese ungabe usathintwa ngocingo.

### Izingozi nomaukulimaza umhlanganyeli

Akukho okungalimaza nomaubungozi oluqondiswe kuwe kulolugcwaningo.

### Izizathu zokwenza ukuthi ungahle uhoxiswe kulolugcwaningo

Mawungavumelani nemibandela nemgomo yogcwaningo, nokungagcwalisi ingxenye ewu 80% yemibuzo, uzohoxiswa kugcwaningo. Njengomhlanganyeli ozikhethile ukubayingxenye yogcwaningo,

ukhululekile ukuhoxisa kugcwaningo nomangasiphi isikhathi ngaphandle kwesizathu ekuhoxiseni nangaphandle kwemiphumela.

#### Izinzuzo

Ngokuzikhethela ukubayingxenywe yogcwaningo, uzovumela odokotela bamathambo nemsipha (Chiropractors) nabanye ochwepheshe bezempilo bakhe ulwazi lwethu phakathi kokulimala kwemisipha nabadlali be CrossFit.

#### Inkokhelo

#### Izindleko zogcwaningo

Ayikho imali elindeleke ukuba uyikhokhe ngokuba yingxenywe yogcwaningo.

#### Imfihlo

Yonke imininingwane yeziguli ziyimfihlo. Ngeke kulindeleke ukuthi ubhale imininingwanya yakho engakhomba isiqu sakho. Imiphumela yalolugcwaningo izosetshenziselwa ukugcwaninga kuphela. Abantu abazobe beqondane nogcwaningo ngqo (uProfesa Pillay nami) abazovumeleka ukuthola amarekhodi yogcwaningo.

#### Imiphumela

Maseluqoqiwe ulwazi, imiphumela yogcwaningo izoshicilelwa kwingxenywe ye-dissertation emtapo wolwazi wase DUT olungakhishwa ngokwemgomo nenqubo yomtapo lwazi. Kuzobakhona ikhophi etholakala kwi inthanethi evumela uyithole ngompato lwazi weinthanethi eDUT.

#### Ukulimala okuhlobene nogcwaningo

Azikho izingozi noma ukulimala okulindelekile ukuthi ukthole ngokuba yingxenywe yogcwaningo.

#### Istoreji sayo yonke imniningwane

Yonke imniningwane egciniwe kwikhompyutha nakuzilondolozisi zangaphandle, zizogcinwa iminyaka emihlanu mese iyasuswa.

#### Abantu ongaxhumana nabo umakwenzeka uhlangabezane nezinkinga

Mawunesifiso sokungithinta ngocingo, ungashayela kulenombolo 0840218345. Noma ungashayela isikhungo sase DUT yogcwaningo yokuziphatha kulenombolo 031 373 2375. Izikhalo zingabikwa kumqondisi: Research and Postgraduate Support ku [researchdirector@dut.ac.za](mailto:researchdirector@dut.ac.za).

Ngibonga kakhulu ukuba ubeyingxenywe yogcwaningo lwami.

## Appendix C: Consent Form – Main Study



### Consent

**Full Title of the Study:** An injury profile on musculoskeletal injuries in CrossFit athletes with relation to selected demographic factors in Kwa-Zulu Natal

**Names of Researcher/s:** Nicholas Simmons

#### Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Nicholas Simmons, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: IREC 178/23
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
<b>Full name of Participant</b>	<b>Date</b>	<b>Time</b>	<b>Signature</b>

I, Nicholas Simmons herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____	_____
<b>Full name of Researcher</b>	<b>Date</b>	<b>Time</b>	<b>Signature</b>

## Appendix D: Letter of Information – Focus Group

### LETTER OF INFORMATION

#### Focus group

**Title of Research Study:** An injury profile on musculoskeletal injuries in CrossFit athletes in Kwa-Zulu Natal.

**Principal Investigator / Researcher:** Nicholas Simmons (MHSc: Chiropractic)

**Supervisor:** Prof Julian Pillay (PHD)

Dear research participant

I am a 6th year student completing my research for my Master's degree in Chiropractic at DUT. I am very passionate about fitness and especially CrossFit as a sport. However, as it is a new sport, there is very little research pertaining to musculoskeletal injuries related to demographics as a result of the sport and how they can best be managed. I would like to invite you to participate in my research. Your time is appreciated and will assist in providing valuable information regarding how best health professionals, especially us as Chiropractors can help manage and treat your injuries.

#### **What is Research**

Research is a systematic search for generalized new knowledge. Your participation will help us contribute to the knowledge that exists on the relationship between injuries in CrossFit athletes and how best health professionals can assist in managing these injuries. You are welcome to ask as many questions as you need, I am happy to explain more in detail. You are under no obligation to commit at this stage.

#### **Outline of the Procedure**

The aim of this study is to determine the prevalence, selected risk factors and types of injuries that CrossFit athletes are prone to as well as the level of Chiropractic care used and the influence this has on their participation in the sport, performance levels and their quality of life. Participants will be approached and asked to fill out the questionnaire. The expected time to complete the questionnaire is approximately 10 minutes. You will be expected to complete and sign Informed Consent as well as the questionnaire. Once the questionnaire is completed, the process is complete and you will not be contacted further.

#### **Risks or discomfort to the participant**

There are no risks or risk of discomfort to you during this study.

#### **Reason why you may be withdrawn from the study**

If you are non-compliant and have not completed at least 80% of the questionnaire, you will be withdrawn from the study. As a voluntary participant in this research study, you are free to

withdraw from the study at any given time without giving a reason for withdrawing and without consequence.

### **Benefits**

By volunteering to partake in this study, you will allow Chiropractors and other health care professionals to build our knowledge of the correlation between musculoskeletal injuries and CrossFit athletes.

### **Remuneration**

You will not be receiving any monetary or other type of remuneration for participation in this study.

### **Cost of the study**

You will not be expected to cover any costs towards the study.

### **Confidentiality**

All patient information is confidential. You will not be expected to record any personal details that could identify you. The results of this study will be used for research purposes only. Only individuals that are directly involved in this study (Professor Pillay and myself) will be allowed to access these records.

### **Results**

Once the information has been collected, the results from the study will be published in the dissertation section of the DUT Library which can be taken out through normal library protocol. There will also be an online copy available to you through the DUT online library system.

### **Research Related Injury**

There is no risk or injury that you can sustain by participating in this study.

### **Storage of all electronic data**

All electronic data on a computer and external storage device, will be kept for five years after which it will be deleted.

### **Persons to contact should you have any problems or questions**

Should you wish to contact me, feel free to do so on 0840218345

Alternatively, DUT-Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Acting Director: Research and Postgraduate Support on [researchdirector@dut.ac.za](mailto:researchdirector@dut.ac.za)

Thank you for participating in my research study

## Appendix E: Confidentiality Statement – Focus Group



**IMPORTANT NOTICE: This form is to be read and filled in by every member participating in the focus group, before the focus group meeting convenes.**

### **CONFIDENTIALITY STATEMENT AND CODE OF CONDUCT: Focus group**

1. All information contained in the research documents and any information discussed during the focus group meeting must be kept private and confidential. This is especially binding to any information that may identify any of the participants in the expert group.
2. None of the information shall be communicated to any other individual or organisation outside of this specific focus group as to the decisions of this focus group.
3. The information from this focus group will be made public in terms of a dissertation/thesis and/or journal publication, which will in no way identify any of the participants involved in this focus group.
4. The returned questionnaires will be coded and kept anonymous in the research process.
5. The focus group may be either voice or video recorded, as a transcript of the proceedings will need to be made. The data will be stored securely under password protection.
6. All data generated from this expert group (including the recording) will be kept for five years in a secure location at Durban University of Technology and thereafter will be destroyed.

Once this form has been read and agreed to, please fill in the appropriate information below and sign to acknowledge agreement.

Please print in block letters:

Focus Group Member: \_\_\_\_\_ Signature: \_\_\_\_\_

Witness Name: \_\_\_\_\_ Signature: \_\_\_\_\_

Researcher's Name: \_\_\_\_\_ Signature: \_\_\_\_\_

Supervisor's Name: \_\_\_\_\_ Signature: \_\_\_\_\_

## Appendix F: Consent Form – Focus group



### Consent

#### Focus group

**Full Title of the Study:** An injury profile on musculoskeletal injuries in CrossFit athletes with relation to selected demographic factors in Kwa-Zulu Natal

**Names of Researcher/s:** Nicholas Simmons

#### Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Nicholas Simmons, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: IREC 178/23
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
<b>Full name of Participant</b>	<b>Date</b>	<b>Time</b>	<b>Signature</b>

I, Nicholas Simmons herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____	_____
<b>Full name of Researcher</b>	<b>Date</b>	<b>Time</b>	<b>Signature</b>

## Appendix G: Gatekeepers Permission



### Request for Permission to Conduct Research

Dear xxxx (owner of CrossFit gym)

My name is Nicholas Simmons a MHSsc chiropractic student at the Durban University of Technology. The research I wish to conduct for my Masters Dissertation involves An injury profile of musculoskeletal injuries in CrossFit athletes in KwaZulu-Natal.

I am hereby seeking your consent to conduct a survey at the your CrossFit gym.

I have provided you with a copy of my proposal which includes copies of the data collection tools and consent and/ or assent forms to be used in the research process, as well as a copy of the approval letter which I received from the DUT-Institutional Research Ethics Committee (DUT-IREC).

If you require any further information, please do not hesitate to contact me on 0840218345 or nicholassimmons@live.co.za or 21325083@dut4life.ac.za . Thank you for your time and consideration in this matter.

Yours sincerely,

Nicholas Simmons

Durban University of Technology

## Appendix H: Pilot Group Feedback Form



### Pilot Group Feedback Form

Please provide any feedback you feel is relevant regarding the sections of the questionnaire in the appropriate boxes below:

Section	Feedback
A	Demographics
B	Training History
C	Musculoskeletal Injury and management

## Appendix I: Questionnaire



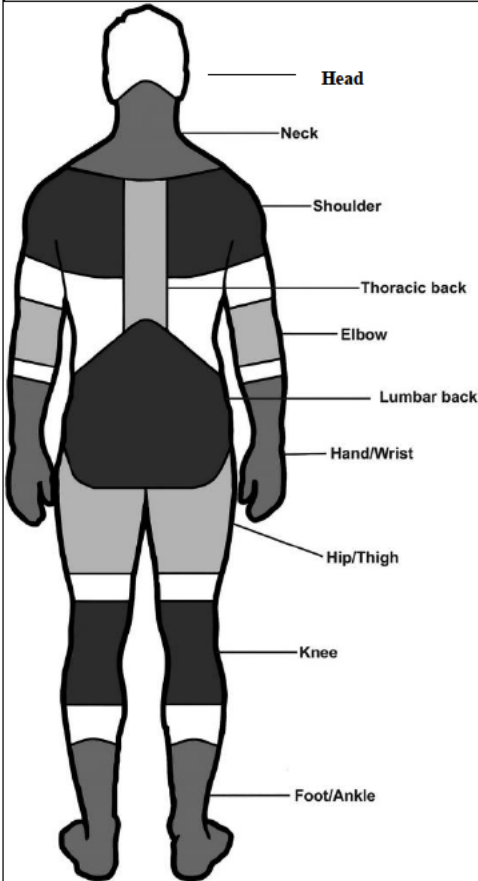
An injury profile of musculoskeletal injuries in CrossFit athletes in KwaZulu-Natal

<b>Section A</b>					
<b>Demographics: Select the response option/s that best applies to you</b>					
<b>1. Age (in years)</b>					
<b>2. Gender</b>	Female	Male	Other (please specify)	Prefer not to disclose	
<b>3. Race</b>	Black	Coloured	Indian	White	Other (please specify)
<b>4. Weight (in kg)</b>					
<b>5. Height (in cm)</b>					
<b>6. Have you been diagnosed with any systemic disease?</b>	Hypertension (High blood pressure)	High cholesterol	Auto-immune	Diabetes	
	Other (Please specify)				
<b>7.1 Are you currently taking any medication?</b>	Yes			No	
<b>7.2 If answered YES to 7.1 please specify what medication?</b>					
<b>8. Have you had any surgeries?</b>	Yes			No	
	If 'Yes' please elaborate:				

<b>Section B</b>				
<b>Training History: ( Select the ONE response option that best applies to you or fill in the information, where relevant )</b>				
<b>1. How many years (cumulative) have you been participating in CrossFit?</b>				
<b>2. How many times a week do you attend CrossFit?</b>	Less than 3 times	3-5 times		More than 5 times
<b>3. What skill level of CrossFit are you a part of?</b>	Beginner	Amateur	Intermediate	Advanced
<b>4. How would you rank your fitness in CrossFit?</b>	Not fit at all	Below average	Average	Above average Very Fit
<b>5. What is the average duration of your CrossFit training sessions?</b>	Up to 30 minutes	From 30 min to 1 hour	1-2 hours	More than 2 hours
<b>6. What is your preferred discipline in CrossFit? (Select ONE option only)</b>	Weight lifting	Running	Swimming	Body exercises Other (Please specify)
<b>7.1 Do you usually stretch before training?</b>	Yes		No	
<b>7.2 Do you usually stretch after training?</b>	Yes		No	
<b>8. What type of stretching do you perform?</b>	Static	Dynamic		Both
<b>9. Is a coach present while training?</b>	Yes, always	Yes, sometimes		No, never
<b>10. Do you currently participate in any other form of exercise?</b>	Yes	No		
	<b>If 'Yes' please elaborate:</b>			
<b>11. Have you sustained any injuries from CrossFit?</b>	No	Yes, one		Yes, multiple
<p><b>If you answered 'No' to question 11, you have completed the survey.</b>  <b>Thank you for your time.</b>  <b><u>If you answered 'yes' to question 11 please continue to answer Section C</u></b></p>				

**Section C**

**Musculoskeletal Injury: Answer the questions below with regard to the type of injury most commonly sustained AS A RESULT OF CROSSFIT:**



(Monnier *et al.* 2015)

**1. Using the diagram above as a guide, choose the area where you have most commonly sustained a musculoskeletal injury as a result of CrossFit?**

- Head
- Neck
- Shoulder
- Thoracic back (mid back)
- Elbow
- Lumbar back (low back)
- Hand/Wrist
- Hip/Thigh
- Knee
- Foot/ Ankle

**2. Please provide the diagnosis of the injury.**

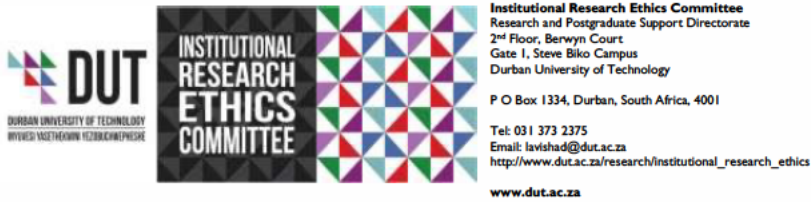
Strain/tear	Sprain	Bruise/wound	Fracture	Dislocation
Other (Please specify)				

<b>3. How was the injury sustained?</b>	Weightlifting	Body resistance training	Cardiovascular training	Ballistic movements	Injury occurred post workout	
	Other (please specify)					
<b>4. Overall, how severe would you rate the musculoskeletal pain experienced at the time of injury and immediately afterwards (i.e. 0-48 hours)?</b>	Very mild	Mild	Moderate	Severe	Very severe	
<b>5. For how long did the injury last?</b>	Less than 48 hours	A few days-1 week	2-4 weeks	1-3 months	More than 3 months	
<b>6. Did the injury affect subsequent CrossFit training?</b>	Yes		No			
<b>7. If yes, to question 7, for how long were you unable to train optimally as a result of the injury?</b>	Up to 1 month	Up to 3 months	More the 3 months			
<b>8.1 Did you receive treatment for the injury?</b>	Yes		No			
<b>8.2 If YES, indicate which of the following health care professionals treatment was sort (you may select more than one option)</b>	Chiropractor	Physiotherapist	Biokineticist	Occupational therapist	General Practitioner	Home remedy
	Other (Please specify)					
<b>9.3 What type of treatment was performed?</b>	Chiropractic adjustment	Acupuncture / dry needling	Pain medication	Steroid injections	Therapeutic massage	RICE (Rest, Ice, Compression, Elevation)

	Other (Please specify)
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**THANK YOU FOR YOUR TIME**

## Appendix J: Institutional Research Ethics Committee Clearance



29 January 2024

Mr N Simmons  
47 Beresford Road  
Woodstock  
Cape Town

Dear Mr Simmons

**An injury profile of musculoskeletal injuries in CrossFit athletes in KwaZulu-Natal**  
**Ethical Clearance number IREC 178/23**

The DUT-Institutional Research Ethics Committee acknowledges receipt of your gatekeeper permission letters.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the DUT-IREC according to the DUT-IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the DUT-IREC as outlined in the DUT-IREC SOP's.

**It is compulsory for a student or researcher to apply for recertification on an annual basis. The failure to do so will result in withdrawal of ethics clearance. It is the responsibility of the researcher and the supervisor to apply for recertification.**

**Please note that you are required to submit a Notification of Completion of Study form together with an abstract to the DUT-IREC office on completion of your study.**

Yours Sincerely

Prof J K Adam  
Chairperson: DUT-IREC

## Appendix K: Plagiarism Report

# Appendix L: South African Journal of Sports Medicine [SAJSM] Submission Acknowledgement Report

[SAJSM] Submission Acknowledgement

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Emeritus Professor Mike Lambert via Khulisa Journals <Journals@assaf.org.za>  
To: N Simmons (21325083)



Thu 6/27/2024 12:38 PM

**CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.**

Hello,

Prof Julian David Pillay has submitted the manuscript, "An injury profile of musculoskeletal injuries in CrossFit athletes in KwaZulu-Natal, South Africa: Musculoskeletal injuries in CrossFit athletes" to South African Journal of Sports Medicine.

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Emeritus Professor Mike Lambert

The following message is being delivered on behalf of South African Journal of Sports Medicine.

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