THE INJURY PATTERNS IN POLE SPORTS ATHLETES IN GAUTENG

A research dissertation presented to the Faculty of Health Sciences, University of Johannesburg, in partial fulfilment of the requirements for the degree of Master of Technology, Chiropractic by

Amber Kukard
(Student number: 201474658)

Johannesburg, 2019.

Supervisor: Dr D. M. Landman Date: 9/9/2019

Co-supervisor: Dr F. Ismail Date: 09/09/2019

DECLARATION

I, Amber Kukard, declare that this dissertation is my own, unaided work. It is being submitted for the Master's Degree of Technology at the University of Johannesburg, Johannesburg. It has not been submitted before for any degree or examination in any other Technicon or University.

Amber Kukard

9th day of September 2019.

DEDICATION

To my parents, Sandi and Derek, thank you for all the love and support you so willingly gave to me over the last six years. Thank you for helping me achieve all my goals - this dream would not have been possible without you both.

To my sister, Meagan, thank you for your kindness and encouragement, and for being a friendly distraction when I needed a break.

To my husband, Christopher, thank you for being so understanding and kind when I was feeling overwhelmed. Thank you for encouraging me, supporting me, and loving me. I love you.

ACKNOWLEDGEMENTS

I would like to acknowledge the following individuals, organisations and institutions:

- My supervisor and co-supervisor, Dr D M Landman and Dr F Ismail, for all their knowledge, guidance and support, it has been an honour working with you both.
- The Health Sciences Faculty of the University of Johannesburg for their financial assistance.
- The pole sports community of Gauteng, for their contribution to the data collection.
- Mrs Juliana Van Staden, for her services as a statistician.
- My proof reader, Ron Gill, for his contribution to the editing of this dissertation.
- My friends and colleagues for their support.

ABSTRACT

Purpose: To determine the types of injuries occurring in pole sports athletes in Gauteng. In addition, this study aimed to identify potential risk factors that may have predisposed certain athletes to developing musculoskeletal injuries. Risk factors such as: age, weight, skill level, frequency of training and the duration of training were investigated.

Method: A questionnaire-based quantitative study was conducted in order to establish the injury patterns occurring in 100 pole sports athletes in Gauteng. A pilot study was used to test the questionnaires before commencing the data collection. Participants were recruited at their pole sports studios after permission was granted by the studio owners. The information letters, consent forms and questionnaires were distributed and completed in hard copy format. The questionnaires were completed anonymously and the participants were free to withdraw from the study at any time before they handed in their completed questionnaire. Once the data collection was completed, a statistician was consulted in order to assist with the data analysis.

Results: The majority of the study participants (58%) sustained an injury as a direct result of participating in pole sports. The greatest proportion of the injuries sustained were muscle strains (58%) followed by ligament sprains (29%). The most commonly injured region of the body was the upper limb (41,6%). The risk factors identified that predisposed participants to sustaining a musculoskeletal injury were: skill level, duration of training per day and frequency of training per week. Additionally, the number of years of participation also presented as a risk factor in this study.

Conclusion: Injury occurrence was prevalent in this study population, with the upper limb being the most commonly injured body region. The injury patterns were not in accordance with a similar study conducted internationally; however, the setting for these two studies was vastly different which could therefore explain the differences noted between the data collected by each study.

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE – INTRODUCTION

1.1 GENERAL INTRODUCTION

The Global Association of International Sports Federations (GAISF) has provisionally recognised pole sports by awarding it Observer status. This is an essential step towards having pole sports recognised as an Olympic sport. Pole sports is an extremely demanding physical activity that is performed on a vertical pole. The athlete requires a combination of strength, flexibility, agility, power and athleticism in order to successfully participate in pole sports (Coates, 2018). Currently, there is limited research available on the types of injuries that occur in pole sports athletes which needs to be addressed in order to facilitate a better understanding of these potential patients.

1.2 AIMS OF THE STUDY

The primary aim of this research study was to determine the types of injuries occurring in pole sports athletes in Gauteng. It was necessary to establish more knowledge about the injury patterns in pole sports athletes in order to determine whether there is a specific need for chiropractic care. The study could also potentially identify risk factors that may predispose certain athletes to developing injuries such as: age, weight, skill level, frequency of training and the duration of training.

1.3 BENEFITS OF THE STUDY

This research is beneficial because it may provide health care professionals with a knowledge of the types of injuries occurring in pole sports athletes as well as insight into the potential risk factors associated with these injuries. This may facilitate patient education in order to reduce the prevalence of said injuries. Furthermore, this research will be presented to the participating studios in order to educate the pole sports instructors which will hopefully decrease the number of injuries associated with this sport. The information available on this topic currently is insufficient. This research will thus be beneficial as a starting point for further research into this sport.

CHAPTER TWO – LITERATURE REVIEW

2.1 POLE SPORTS

Pole sports became a popular form of fitness in the year 2000. Katie Coates, the President of the International Pole Sports Federation (IPSF), created the term pole sports in 2008 in order to transform pole dancing from a social physical activity into an international sport (Coates, 2018).

The origins of pole sports can be traced back to two ancient sports, Mallakhamba and Chinese pole-climbing. Mallakhamba began in the 12th century as a type of wrestling that was practiced in India. A 2,25m wooden pole and a cotton rope were used to perform acrobatic movements to assist the wrestlers. Today, Mallakhamba has become a contemporary sport (Burtt, 2010). Additionally, Chinese pole-climbing was first documented approximately 2000 years ago. The techniques utilized in this sport were developed from the tree climbing skills used in agriculture. Today, Chinese pole-climbing is an acrobatic sport that is performed by Cirque du Soleil performers and is taught in recreational fitness centres (Quifeng & Xining, 2003).

2.1.1 Popularity

The first World Pole Sports Championships were held in London in 2012 where 43 athletes from 14 countries competed. 5 years later, in 2017, 229 athletes from 36 countries competed. This indicates a 81% increase in participation. In 2012, 95% of the participating pole sports athletes were female. Thereafter, in 2017, male categories were opened which increased male participation by 70% (Coates, 2018).

2.1.2 Apparatus

A static or spinning vertical pole is the primary apparatus used in pole sports. A brass tubular body with a steel core is placed vertically onto a base. The pole is fixed to the floor below and to a support beam above. The internal steel core must measure a minimum of 4mm in diameter and must be fixed to the inner wall of the brass tube (**Figure 2.1**). The total diameter of the pole is 45mm at competition level. The pole should be capable of withstanding a lateral force of 180kg for a period of 48 hours without losing any structural integrity (International Pole Sports Federation, 2016).

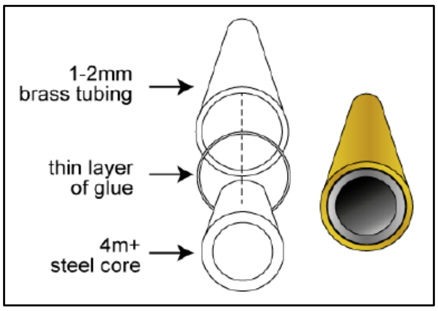


Figure 2.1: Structural design of the pole

(International Pole Sports Federation, 2016)

2.1.3 Associations and organizations

The Pole Fitness Association of South Africa (PFASA) was originally founded in 2010 in order to unite the growing pole sports community and promote pole sports as an athletic, sporting discipline. The primary areas of focus for this association were local competitions, educational workshops and fundraising events. In 2013, the PFASA rebranded itself as the South African Pole Sports Federation (SAPSF) and registered as a non-profit organization within South Africa (Coates, 2018).

The SAPSF is the only Pole Sports Federation in South Africa that is endorsed by the IPSF. The IPSF has obtained numerous achievements; it became a World Anti-Doping Agency signatory in 2016 and was awarded GAISF Observer Status in 2017. The IPSF has more than 30 national federations, including South Africa, which extends over 6 continents and involves over 5000 athletes. The SAPSF has commenced talks with the South African Sports Confederation and Olympic Community (SASCOC) in an attempt to further the progression of pole sports within the country (Coates, 2018).

2.1.4 Athletic requirements

Pole sports is a high-impact sport that requires extensive physical and mental exertion. Both strength and endurance are necessary to lift, spin and hold the athlete's body, in conjunction with a high level of flexibility, to execute techniques, demonstrate lines as well as contort and pose the body. In order to succeed, the athlete must train their motor skills to allow for control of coordination and balance during their routines, which consist of numerous acrobatic movements and sequences. Maximal cardiovascular fitness is essential for maintaining a constant flow of movement throughout the routine. Furthermore, pole sports athletes require an understanding of how certain parts of their bodies can be used to contact the pole. As athletes progress in skill, fewer body parts are required to make contact with the pole and more complex positions can be achieved (Coates, 2018).

2.1.5 Positions

Pole sports athletes will place themselves into a variety of positions whilst on the pole in order to perform prescribed elements. These positions can be either strength-orientated or flexibility-orientated, however, most positions require a combination of the two. These positions may be held upright, horizontally, or inverted by the upper limb which may overload the that limb resulting in an injury (Wolf, Avery & Wolf, 2017).

Appendix A demonstrates a few of the many elements that could be performed during a pole sports routine (International Pole Sports Federation, 2017). The positioning of these elements is further compared to similar elements that may be performed in an artistic gymnastics routine (**Appendix B**) (International Pole Sports Federation, 2017; Fédération Internationale De Gymnastique, 2016). Due to the limited information published on pole sports, it has been likened to the sport of artistic gymnastics for the purpose of this literature review.

2.2 TYPES OF MUSCULOSKELETAL INJURIES

For the purposes of this study, only the occurrence of musculoskeletal injuries will be investigated. Types of musculoskeletal injuries include: fractures, contusions, sprains, strains, and generalized musculoskeletal pain.

2.2.1 Fractures

A fracture is defined as a crack or break in a bone. Fractures to bones may arise from a variety of causes: exposure to increased loads, sudden forceful impacts and stresses from unusual directions (Martini, Nath & Bartholomew, 2014). Acute fractures account for between 5 and 10 percent of all sports-related injuries and can occur at any region within the human body (Swenson, Yard, Collins, Fields & Comstock, 2010).

2.2.2 Contusions

Muscle contusions result from contact injuries during which the muscle sustains a direct force. Contusion injuries in muscles are defined by the following sequence of events: a contact injury, microscopic damage to muscle cells, macroscopic abnormalities in the muscle belly, infiltrative bleeding and lastly, inflammation. This type of injury may be debilitating depending on its severity (Beiner & Jokl, 2002).

2.2.3 Sprains

A sprain is defined as a joint injury in which fibres of a supporting ligament are ruptured. In most cases the continuity of the ligament remains intact, however it is possible for the ligament to completely rupture. Studies have shown that once an individual has suffered a sprain injury to a ligament, they are at a high risk of spraining the same ligament again (Kemler, van de Port, Backx & van Dijk, 2011). There are three stages of ligament sprains which have been outlined in **Table 2.1**.

2.2.4 Strains

Muscle strain injuries result from a high force contraction occurring within a particular muscle while it is in a lengthened position. This type of injury mostly occurs at the musculotendinous junction. When this type of injury occurs, there is an acute inflammatory response within the muscle (Levangie & Norkin, 2005). As with sprains, there are three stages of muscle strains which have been outlined in **Table 2.1**.

Table 2.1: Soft tissue grading scales for sprains and strains (Malliaropoulos, Ntessalen, Papacostas, Longo & Maffulli, 2009)

Grade	Clinical Findings
1	Mild sprain / strain (1-10% fibre damage) No loss of function but range of motion decreased (less than 5°) No point tenderness No ligamentous laxity Little or no bruising and swelling (thickness less than 0,5cm)
2	Moderate sprain / strain (11-50% fibre damage) Slight loss of function with range of motion decreased (between 5° and 10°) Point tenderness present Slight ligamentous laxity Bruising and swelling (thickness between 0,5cm and 2cm)
3	Severe sprain / strain (51-100% fibre damage) Almost total loss of function; range of motion decreased (more than 10°) Extreme point tenderness Extreme ligament laxity Severe bruising and swelling (thickness greater than 2cm)

2.2.5 Musculoskeletal pain

Musculoskeletal pain is defined as a disabling or painful injury to the muscles, nerves or tendons (Labbafinejad, Danesh, & Imanizade, 2017). Pain of a musculoskeletal origin has the potential to negatively impact an individual's quality of life. Sleep interruption, fatigue, limitation of activity and participation as well as depression can all be attributed to musculoskeletal pain (Hawker, 2017).

Myofascial trigger points may also form. A myofascial trigger point is a hyperirritable area in skeletal muscle that is associated with a hypersensitive palpable nodule in a taut band (Dommerholt, del Moral & Grobli, 2006). Regional pain arising from a myofascial trigger point is known as myofascial pain syndrome. Myofascial pain syndrome may arise from a muscle strain, trauma to a muscle or from postural dysfunction (Desai, Saini & Saini, 2013), all of which may potentially occur during pole sports training or performing.

2.3 POTENTIAL POLE SPORTS INJURIES

A case-series study was conducted between December 2015 and July 2016 to describe the epidemiology of injuries in pole sports athletes who presented to the emergency department at the general hospital of Karditsa (a provincial hospital in Greece). A total of 34 participants were included in this study. The results of the study indicated the following injuries: 29.4% lower back and hip, strains and contusions; 20.6% knee sprains and contusions; 17.7% wrist sprains; 14.7% ankle sprains; 5.9% cervical spine strains; 5.9% concussion; 2.9% (1 patient) with a disc herniation and 2.9% with a fifth metatarsal bone fracture (Mitrousias, Halatsis & Bampis, 2017).

The most frequent injuries in the study above were identified to be: strains, sprains and contusions. However, more serious injuries such as a concussion and fractures were also shown to have occurred (Mitrousias et al, 2017). It is important to recognize that the study mentioned above only reports on injuries that were severe enough to require that the individual seek emergency care. Therefore, it is reasonable to assume that less severe injuries may also occur in pole sports athletes.

Due to the limited amount of information published on pole sports, which consists solely of the study by Mitriousias et al (2017), pole sports has been likened to the sport of artistic gymnastics for the purposes of this literature review, since the positioning of the body of the athletes in these two sports demonstrates many similarities. Some of these similarities have been demonstrated by comparing the code of points for both artistic gymnastics and pole sports, and has been documented as **Appendix B** (Fédération Internationale De Gymnastique, 2016; International Pole Sports Federation, 2017).

2.3.1 Upper Limb

In gymnastics, the upper limb is loaded as a weight bearing extremity which may result in a stress response and overuse injuries within the anatomical structures (Wolf et al, 2017). The prolonged overhead position of the arm may also predispose the gymnast to developing an overuse injury within a tendon, with secondary impingement (Wörtler, 2010). Weight bearing of the upper limb and an overhead hanging position are also utilized for the majority of the activities performed in pole sports, and therefore the upper limb is assumed to be the most likely region to sustain an injury (**Appendix B**). The upper limb forms part of the appendicular skeleton and consists of the shoulder joint, elbow joint and wrist joint (Moore et al, 2014).

a) Shoulder Joint

Shoulder Joint Anatomy

The shoulder joint is otherwise known as the glenohumeral (GH) joint. The GH joint is formed by the head of the humerus and the glenoid cavity of the scapula. Together, these structures form a ball and socket joint. The glenoid cavity, or socket, is deepened by the glenoid labrum in an attempt to increase stability within the GH joint. A loose articular capsule originates proximal to the glenoid labrum of the scapula and extends over the GH joint to attach distally onto the anatomical neck of the humerus. This loose articular capsule allows for an extensive range of motion within the joint (Martini, Nath & Bartholomew, 2014).

The coracoacromial arch consists of the coracoid process and the acromion, as well as the coracoacromial ligament. Together, these 3 structures form a cavity or space inside which the rotator cuff tendons, subacromial bursa and the tendon of the long head of biceps brachii are found. This area between the coracoacromial arch and the humeral head is known as the subacromial space. The coracoacromial arch inhibits the humeral head from dislocating superiorly (Levangie & Norkin, 2005).

Further stability within the GH joint is provided by skeletal muscles and their tendons, as well as from numerous ligaments. The most pertinent muscles, and subsequently tendons, required for stability of the shoulder are: subscapularis, teres minor, infraspinatus and supraspinatus. These muscles are collectively referred to as the rotator cuff muscles. These muscles provide selected movements to the upper limb (detailed in **Table 2.2** below) while simultaneously supporting the GH joint and limiting its range of motion. Damage to the rotator cuff can occur during sports that place a significant amount of strain on the shoulder (Martini et al, 2014), such as in pole sports.

Table 2.2: Anatomy of the rotator cuff muscles (Moore, Dalley & Agur, 2014)

Muscle	Proximal Attachment	Distal Attachment	Innervation	Muscle Action
Subscapularis	Subscapular fossa	Lesser tubercle of humerus	Upper and lower subscapular nerves (C5, C6, C7)	Medially rotates arm; holds head of humerus in glenoid cavity
Teres minor	Middle part of lateral border of scapula	Inferior facet of greater tubercle of humerus	Axillary nerve (C5,C6)	Laterally rotates arm; acts with rotator cuff muscles
Infraspinatus	Infraspinous fossa of scapula	Middle facet of greater tubercle of humerus	Suprascapular nerve (C5, C6)	Laterally rotates arm, acts with rotator cuff muscles
Supraspinatus	Supraspinous fossa of scapula	Superior facet of greater tubercle of humerus	Suprascapular nerve (C4, C5, C6)	Initiates and assists deltoid in abduction of the arm; acts with rotator cuff muscles

The most pertinent ligaments for shoulder stabilization are the glenohumeral, coracohumeral, coraco-acromial, coracoclavicular and acromioclavicular ligaments (Martini et al, 2014). A diagram demonstrating the location of these ligaments within the GH joint has been included below as **Figure 2.2**.

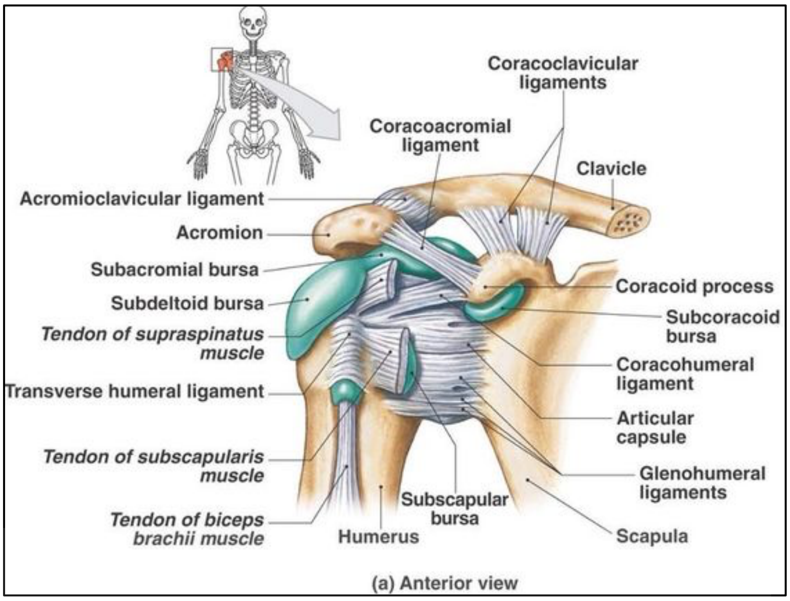


Figure 2.2: Anterior view of the shoulder demonstrating the location of the pertinent ligaments required for GH joint stabilization (Fajrin, 2016)

Shoulder Joint Injuries

In pole sports, the upper limb is utilized to hold the athletes body off the floor for the majority of the routine. The rotator cuff muscles that are utilized to achieve this may be susceptible to strain injuries as a result of overuse or overloading (Wolf et al, 2017).

Of all the joints in the body, the GH joint has the greatest range of motion, and subsequently the least amount of stability (Martini et al, 2014). The GH joint has 3 degrees of rotational freedom, namely: extension/flexion, adduction/abduction and internal/external rotation. The degree of motion available at these joints is as follows: 50° extension, 120° flexion, 90-120° abduction (depending on the plane in which abduction is performed) and 60-120° combined internal and external rotation, depending on the degree of abduction at the time of rotation (Levangie & Norkin, 2005).

If all the stabilizing structures within the GH joint are intact, movement such as flexion and abduction will occur throughout a stable axis. Over time however, degenerative changes may occur at the GH joint as a result of overuse or stress. All rotator cuff muscles are susceptible to overuse injury, however, the supraspinatus muscle is the most vulnerable and is particularly susceptible to chronic overuse, as it is a key structure for stabilization of the GH joint (Levangie & Norkin, 2005).

Anatomically, the humeral head comes into contact with the underside of coracoacromial arch to prevent superior dislocation. While this is structurally relevant, it also has the potential to result in a painful impingement of one, or all, of the structures that lie within the subacromial space. Most commonly, mechanical compression and impingement of the supraspinatus tendon will occur with sustained overhead arm positioning and heavy lifting (Levangie & Norkin, 2005).

b) Elbow Joint

Elbow Joint Anatomy

The elbow joint is formed by an articulation between the distal aspect of the humerus and the proximal aspects of the radius and the ulna. The strongest articulation within this complex hinge joint is between the trochlea of the humerus and the trochlear notch of the ulna. As a result of it being a hinge joint, the range of motion possible at the elbow joint is limited, especially in extension (Martini et al, 2014).

The elbow joint, unlike the shoulder joint, is extremely stable for 3 reasons (Martini et al, 2014):

- The trochlea of the humerus interlocks with the trochlear notch and olecranon of the ulna.
- The joint has a thick articular capsule that surrounds the humero-ulnar and radio-ulnar joints.
- The articular capsule is reinforced by strong ligaments.

The lateral surface of the elbow joint is stabilized by the radial collateral ligament which extends between the annular ligament and the lateral epicondyle. The annular ligament stabilizes the head of the radius against the ulna. The medial surface of the elbow joint is stabilized by the ulnar collateral ligament which extends between the medial epicondyle of the humerus, the coronoid process of the ulna and the olecranon (Martini et al, 2014). **Figure 2.3** below demonstrates the ligaments of the elbow joint.

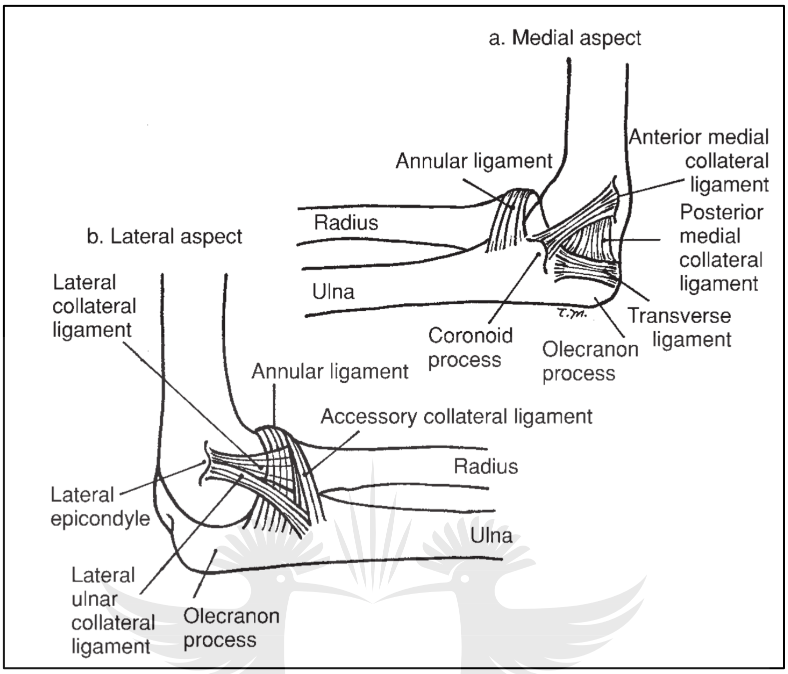


Figure 2.3: Medial and lateral aspect of the elbow joint and associated ligaments
(Levangie & Norkin, 2005)

The muscles that are responsible for movement of the elbow joint can be divided into two compartments, the anterior compartment and the posterior compartment. The anterior compartment consists of the forearm flexors, namely biceps brachii and brachialis, which are supplied by the musculocutaneous nerve. The posterior compartment contains the extensor muscles, triceps brachii and anconeus, which are supplied by the radial nerve (Moore et al, 2014). The full anatomy of these muscles can be found in **Table 2.3** below.

Table 2.3: Anatomy of the elbow muscles (Moore et al, 2014)

Muscle	Proximal Attachment	Distal Attachment	Innervation	Muscle Action
Biceps Brachii	Short head: tip of coracoid process of scapula Long head: Supraglenoid tubercle of scapula	Tuberosity of radius and fascia of forearm via bicipital aponeurosis	Musculocutaneous nerve (C5, C6, C7)	Supinates forearm, and when it is supine, flexes forearm. Short head resists dislocation of the shoulder
Brachialis	Distal half of anterior surface of humerus	Coronoid process and tuberosity of ulna	Musculocutaneous nerve (C5, C6) and Radial nerve (C5,C7)	Flexes forearm in all positions
Triceps Brachii	Long head: infraglenoid tubercle of scapula Lateral head: posterior surface of humerus, superior to radial groove Medial head: posterior surface of humerus, inferior to radial groove	Proximal end of olecranon of ulna and fascia of forearm	Radial nerve (C6, C7, C8)	Chief extensor of forearm; long head resists dislocation of humerus; especially important during adduction
Anconeus	Lateral epicondyle of humerus	Lateral surface of olecranon and superior part of posterior surface of ulna	Radial nerve (C7, C8, T1)	Assists triceps in extending forearm, stabilizes elbow joint; may abduct ulna during pronation

Elbow Joint Injuries

The upper limb is loaded as a weight-bearing joint in artistic gymnastics and similarly in pole sports (**Appendix B**). However, the anatomical structures of the elbow are not designed for weight-bearing, and thus undergo a large amount of unnatural stresses during pole sports training (Wolf et al, 2017).

The limited range of motion in the elbow contributes to its susceptibility to injuries. Elbow flexion in active range of motion is between 135-145°, whereas elbow flexion in passive range of motion is between 150-160°. The passive range of motion is greater because the muscle bulk is not in a contracted state. In pronation and supination, a total of 150° of motion may be achieved when the elbow is flexed to 90°. There is no degree of motion at the elbow joint for abduction and adduction (Levangie & Norkin, 2005).

Elbow strains result from inflammation which is caused by repetitive bending, rotating, compression and stretching of the joint (Qu, Liu & Li, 2000). More specifically, repeated abduction during loading has the potential to result in medial epicondylitis (Grana, 2001). Furthermore, by increasing the abduction angle of the elbow joint, traction injuries may result in the medial structures, and compression injuries may result in the lateral and posterior structures due to the lack of motion in this plane at the elbow joint (Dahm, 2001).

c) Wrist Joint

Wrist Joint Anatomy

The wrist complex (**Figure 2.4**) contains the radiocarpal joint and the midcarpal joint. The radiocarpal joint is created proximally by the articulation between the radius and the radioulnar disc which forms part of the triangular fibrocartilage complex. The scaphoid, triquetrum and lunate form the distal segment of this joint. The midcarpal joint is created proximally by the articulation between the triquetrum, lunate and scaphoid, and distally by the articulation between the hamate, capitate, trapezoid and trapezium. The midcarpal joint is a functional unit (Levangie & Norkin, 2005).

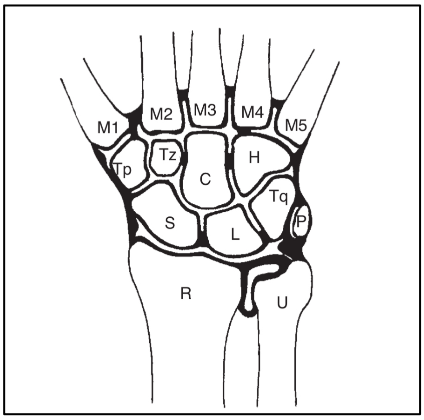


Figure 2.4: A schematic representation of the wrist complex

(Levangie & Norkin, 2005)

The wrist joint is stabilized by a multitude of ligaments that can be divided into two categories: extrinsic ligaments which connect the carpals to the radius or the ulna proximally, or to the metacarpals distally; and intrinsic ligaments which interconnect the carpals. The ligaments of the wrist can be further divided into dorsal carpal ligaments and volar carpal ligaments. The dorsal carpal ligaments, which have been demonstrated in **Figure 2.5**, consist of the dorsal intercarpal ligament and the dorsal radiocarpal ligament (Levangie & Norkin, 2005).

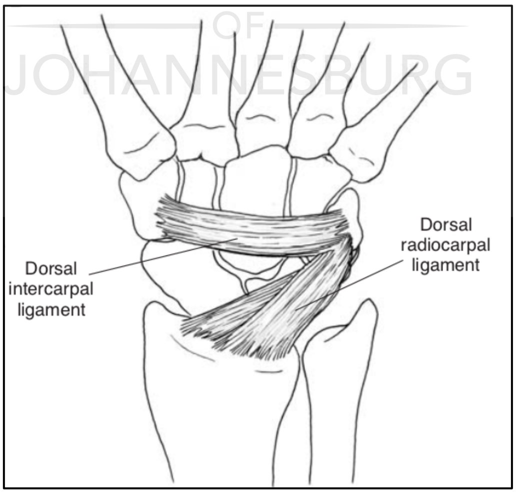


Figure 2.5: Dorsal ligaments of the wrist joint

(Levangie & Norkin, 2005)

The volar carpal ligaments consist of the lunatotriquetral ligament, ulnar collateral ligament, ulnolunate ligament, radioscapholunate ligament, radioscaphocapitate ligament, radial collateral ligament, scapholunate ligament and the radiolunate ligament (Levangie & Norkin, 2005). The volar carpal ligaments have been demonstrated in **Figure 2.6** below.

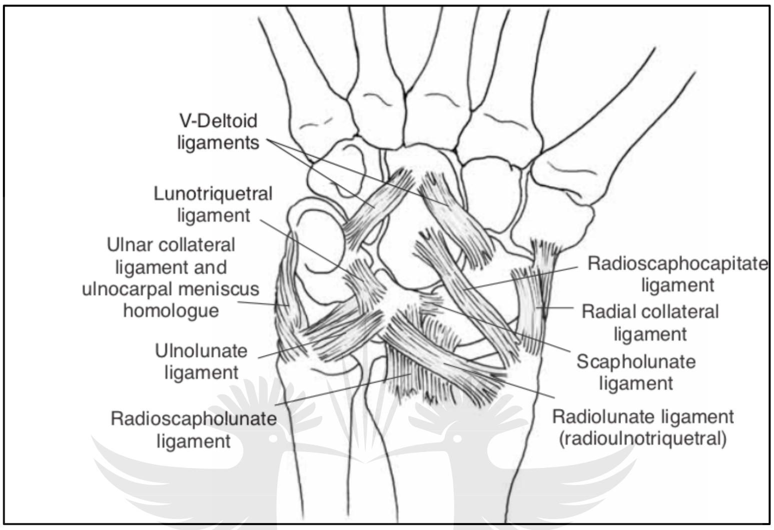


Figure 2.6: Volar ligaments of the wrist joint

(Levangie & Norkin, 2005)

The muscles of the wrist are responsible for providing a stable base for the hand whilst simultaneously controlling the positioning of the hand. Wrist muscles are either considered as primary muscles or secondary muscles. The primary muscles function solely at the wrist joint; whereas secondary wrist muscles function primarily at the digits of the hand and have a secondary action at the wrist (Levangie & Norkin, 2005).

Furthermore, the wrist muscles are categorized as being volar or dorsal, depending on their anatomical location in relation to the wrist joint. The primary volar wrist muscles are: palmaris longus, flexor carpi radialis and flexor carpi ulnaris. The primary dorsal wrist muscles are: extensor carpi radialis longus, extensor carpi radialis brevis and extensor carpi ulnaris (Levangie & Norkin, 2005). The anatomy of these muscles has been described in **Table 2.4** below.

Table 2.4: Primary muscles of the wrist complex (Moore et al, 2014)

Muscle	Proximal Attachment	Distal Attachment	Innervation	Action
Palmaris longus	Medial epicondyle of humerus (common flexor origin)	Distal half of flexor retinaculum	Median nerve (C7, C8)	Flexes the hand at the wrist
Flexor carpi radialis	Medial epicondyle of humerus	Base of second metacarpal	Median nerve (C6, C7)	Flexes and abducts hand at the wrist
Flexor carpi ulnaris	Medial epicondyle of humerus, olecranon and posterior border of ulna	Pisiform, hook of hamate, 5^{th} metacarpal	Ulnar nerve (C7, C8)	Flexes and adducts hand at the wrist
Extensor carpi radialis longus	Lateral supra-epicondylar ridge of humerus	Dorsal aspect of base of 2^{nd} metacarpal	Radial nerve (C6,C7)	Extend and abduct hand at the wrist joint
Extensor carpi radialis brevis	Lateral epicondyle of humerus	Dorsal aspect base of 3^{rd} metacarpal	Deep branch of radial nerve (C7, C8)	Extend and abduct hand at the wrist joint
Extensor carpi ulnaris	Lateral epicondyle of humerus	Dorsal aspect of base of 5^{th} metacarpal	Deep branch of radial nerve (C7, C8)	Extend and adduct hand at the wrist joint

Wrist Joint Injuries

In artistic gymnastics, the wrist is subjected to a multitude of stresses from repetitive movements, axial compression, multidirectional distraction, and torsional forces. These stresses are increased when the upper limb is placed into a weight-bearing position which predisposes the wrist to injury (Webb & Rettig, 2008). Since pole sports also utilizes the upper limb for weight bearing at varying degrees of wrist flexion, extension, radial and ulnar deviation (**Appendix A & B**), it is reasonable to assume that the injury patterns in the wrist would be similar for pole sports athletes.

The wrist joint is biaxial, and its range of motion is as follows: 65-85° flexion, 60-85° extension, 15-21° of radial deviation and 20-45° of ulnar deviation. If the range of motion is exceeded past the anatomical limits, rupturing of ligamentous fibers will occur resulting in an injury as well as compromise the integrity of the joint structures (Gatterman, 2005).

2.4 RISK FACTORS FOR MUSCULOSKELETAL INJURY

According to research studies performed in the past, numerous risk factors have been identified that predispose athletes to musculoskeletal injury. These risk factors are: age (Green & Pizzari, 2017), weight (Murphy, Connolly & Beynnon, 2003), skill level (Chomiak, Junge, Peterson & Dvorak, 2000; Peterson, Junge, Chomiak, Graf-Baumann, & Dvorak, 2000), as well as the frequency of training and the duration of training (Lee, Reld, Cadwell & Palmer, 2017).

2.4.1 Age

Increasing age is linked to an increased risk for musculoskeletal injury (Green & Pizzari, 2017). This may be attributed to numerous physiological factors, including, but not limited to: loss of skeletal muscle quality and function, loss of power output (Mitchell, Williams, Atherton, Larvin, Lund & Narici, 2012) and reduced motor unit discharge rates (Dalton, Jakobi, Allman & Rice, 2010). The exact age at which this occurs is yet to be determined because of the various effects that an individual's lifestyle has on the rate at which the aging process occurs.

2.4.2 Weight

Some studies show that increased body weight can be a risk factor for injury due to the increased amount of force that is placed on the soft tissue (ligaments, muscles, tendons) and hard tissue (bones and cartilage) during physical activity (Murphy et al, 2003). Conversely, other studies report that there is no correlation between body weight and injury risk (Knapik, Sharp, Canham-Chervak, Hauret, Patton & Jones, 2001).

2.4.3 Skill level

Various studies have been conducted in order to determine the association between skill level and the risk of injury within a variety of sports. Some studies indicate that athletes with a lower level of skill are more likely to suffer injury (Chomiak et al, 2000; Peterson et al, 2000); whereas other studies indicate that athletes with a high level of skill are more likely to suffer an injury (Hosea, Carey & Harrer, 2000).

It is important to note that the studies mentioned above were conducted on different types of sports. Therefore, it is reasonable to assume that the relationship between skill level and injury occurrence may be sport dependent (Murphy et al, 2003).

2.4.4 Training frequency and duration

A recent study has demonstrated a link between the amount of training exposures per month and the rate of injury occurrence; the higher the training exposure, the more likely it is that an injury will occur (Lee et al, 2017). In addition, an increased number of hours spent training for a sport reduces the recovery time available to the athlete and thus increases the risk of occurrence of overuse injuries (DiFiori, Benjamin, Brenner, Gregory, Jayanthi, Landry & Luke, 2014). Furthermore, athletes participating in individual sports often partake in highly repetitive training programmes which may result in a high incidence of overuse injuries (Lemoyne, Poulin, Richer & Busssières, 2017).

2.5 MUSCULOSKELETAL INJURY PREVENTION

While there are risk factors for musculoskeletal injury, there are also injury prevention strategies such as warming-up and stretching which may aid in decreasing the risk of musculoskeletal injury occurrence in athletes. Whether performing a warm-up is beneficial to the athlete or not is still a topic that is largely debated. Therefore, warm-up protocols are usually developed by an athlete or coach depending on their past experiences, rather than on scientific evidence (Fradkin, Zazryn & Smoliga, 2010). It also appears that recreational and amateur participants do not rely as heavily on warm-up protocols as professionals do (Fradkin, Cameron & Gabbe, 2007). However, a recent study has proven that participating in a warm-up does in fact improve performance and reduce the risk of injury in a variety of aerobic and anaerobic sports (Fradkin et al, 2010).

Furthermore, stretching is also a common practice in the warm-up protocols that are used in a variety of sports to reduce the risk of injury (Behm, Blazevich, Kay & McHugh, 2016). This section will address the physiological effects of warm-up and stretching and, where possible, will discuss how these protocols may contribute to reducing the occurrence of injuries.

2.5.1 Warm-up

The purpose of performing a warm-up before physical activity is twofold. The warm-up functions to improve muscular dynamics in order to decrease the risk of injury and it also prepares the athletes body for the increased physiological demands that exercise will place onto the body (Woods, Bishop & Jones, 2007).

It is recommended that individuals participating in physical activity should perform a warm-up beginning with aerobic exercise, followed by stretching, and then finishing with an activity or skill similar to the physical activity that they are preparing to perform. The warm-up should focus on areas of the body that will be utilized in the physical activity being performed but should not be so intense as to fatigue the participant's body (Fradkin et al, 2010).

a) Physiological effects

The act of warming-up one's body has a vasodilatory effect on the precapillary vessels, which in turn increases blood flow to the active muscles. Increased blood flow will also allow for enhanced oxygen supply. Additionally, the rate at which oxyhemoglobin and myoglobin are broken down is increased, which further increases the muscles' ability to extract the oxygen being delivered by the blood vessels (Brunner-Ziegler, Strasser & Haber, 2011).

Furthermore, the rising intramuscular temperature increases enzyme activity which results in increased aerobic contribution to energy metabolism when the physical activity commences. Increased tissue temperatures also result in nerve impulses transmitting more rapidly which improves the rate of muscle contraction as well as the average reaction time (Bishop, 2003).

b) Mechanism of injury prevention

The primary purpose of warming-up before physical activities is to improve performance, decrease muscle soreness and prevent sports-related injuries by increasing the bodies temperature (Brunner-Ziegler et al, 2011). The effect of injury prevention is attributed to increased elasticity in the muscle-tendon unit as well as increased muscle strength (Evans, Knight, Draper & Parcell, 2002).

When the temperature of the muscles is increased, the viscosity of the muscle is decreased which decreases joint and muscle stiffness. Therefore, there is an increase in the range of motion which results in a reduced risk of injury (McHugh & Cosgrave, 2010). Studies indicate that antagonist muscles are most frequently injured during activities that were not preceded by a warm-up. This occurs when the antagonist muscle has not been sufficiently warmed up in comparison to its corresponding agonist muscle. Thus, the antagonist muscle relaxes slower than the corresponding agonist muscle contracts, which decreases free movement and coordination in that particular body segment resulting in an injury (Evans et al, 2002).

2.5.2 Stretching

There is recent evidence to suggest that pre-performance stretching has the ability to reduce the risk of acute muscle strain injuries during a physical activity (McHugh & Cosgrave, 2010). However, evidence also suggests that muscle stretching has a detrimental effect on maximal muscular performance (Kay & Blazevich, 2009; Magnusson & Renstrom, 2006). Therefore, although stretching reduces the acute risk of muscle strains, it simultaneously has a negative effect on physical performance (McHugh & Cosgrave, 2010).

The American College of Sports Medicine agrees with this statement. Guidelines were released which suggest that static stretching should be removed from warm-up routines when strength and power are vital to an athlete's performance in the physical activity to follow (Thompson, Gordon & Pescatello, 2010).

a) Static Stretching

Static stretching is the most commonly utilized form of pre-exercise stretching (Young, 2007). Static stretching is characterized by lengthening a muscle until a stretched sensation is experienced (Cronin, Nash & Whatman, 2008) or until discomfort is experienced (Behm, Bambury, Cahill & Power, 2004), and then holding that position for a pre-determined amount of time (Ebben, Carroll & Simenz, 2004).

Static stretching increases range of motion (Paradisis, Pappas, Theodorou, Zacharogiannis, Skordilis & Smirniotou, 2014), decreases musculotendinous stiffness (Kay & Blazevich, 2008) and reduces activity specific injuries (Hadala & Barrios, 2009).

b) Dynamic Stretching

Dynamic stretching requires the controlled movement of a body part through the range of motion of the active joints (Fletcher, 2010). Dynamic stretching is considered as being superior to static stretching when preparing for physical activity (Behm et al, 2016). This statement can be attributed to the fact that the dynamic stretching will be similar to the movements performed in the physical activity which is to follow. Furthermore, core temperature is elevated by dynamic stretching (Fletcher & Jones, 2004) which will subsequently result in increased nerve conduction velocity and enzyme cycling which will increase energy production (Bishop, 2003).

Dynamic stretching, like static stretching, increases passive range of motion (Sharman, Cresswell & Riek, 2006). However, dynamic stretching will result in a greater degree of flexibility in comparison to static stretching (Amiri-Khorasani, Abu Osman & Yusof, 2011).

CHAPTER THREE – METHODOLOGY

3.1 INTRODUCTION

The primary aim of this research study was to determine the types of injuries occurring in pole sports athletes in Gauteng. This chapter will explain the process that was used to: determine the study participants; create and test the questionnaire; distribute and collect the completed questionnaires as well as analyse the data collected by the questionnaires.

3.2 STUDY DESIGN

This study was a quantitative study. A total of 5 pilot questionnaires were used for subjective information gathering because this study and the questionnaire had never been used before. Given that a questionnaire was utilized to gather the data, there was no objective data in this study. Randomization was not applied because any interested person who met the inclusion criteria was invited to participate in this study. A hardcopy questionnaire was utilized so that multiple participants could complete the questionnaire simultaneously, without having to rely on the individual's private electronic devices.

3.3 PARTICIPANT RECRUITMENT

Meetings were set up with the owners of pole sports studios in order to explain the research being conducted and to request permission to access their members (**Appendix C**). Dedicated dates and times were then arranged with the studio for an initial consultation with its members (the potential participants for this study). The members were informed of the proposed research by a brief discussion that was presented by the researcher. Thereafter, information letters, consent forms and questionnaires were distributed to any interested participants in the form of a stapled bundle.

If any person had questions for the researcher that they needed answered before deciding to participate in the study, they were given the opportunity to ask the researcher. At a later stage, interested individuals could contact the researcher via the contact details that were clearly stated at the end of the information letter. If after reading the information letter the individual decided that they would like to participate in this study, they were asked to sign the consent form before beginning with the questionnaire.

3.3.1 Sample Selection and Size

The sample size was determined by the number of members belonging to the pole sports studios that were willing to participate in this study. 14 pole sports studios were contacted in order to request their members' participation in this study. Of those studios, 8 studios stated that they agreed to have their studio approached in order to discuss participation with their members. All 8 studios signed permission forms thereafter (**Appendix C**).

There was no limit on the total number of participants, however, the consulting statistician recommended a minimum of 100 completed questionnaires in order to ensure that sufficient data was provided for analysis (Van Staden 2018, personal communication, 22 October). Male and female individuals over the age of 18 years who were actively participating in pole sports training were invited to participate in this study.

3.3.2 Inclusion Criteria

Participants:

- Must have been 18 years or older to prevent a need for parent/guardian consent for participation.
- Could have been male or female.
- Should have been actively participating in pole sports training.

3.3.3 Exclusion Criteria

- Members that were not currently participating in pole sports training.
- Members that were younger than 18 years of age.

3.4 THE QUESTIONNAIRE

Questionnaires used for similar studies in other sports were analyzed in order to develop an understanding of the types of questions asked as well as the manner in which the questions were presented (Hollinshead, 2004; Mtshali, 2007). Thereafter, the questionnaire used in this study was developed by the researcher in order to achieve the objectives of this study. A total of 32 questions were included. These questions were categorized according to the following broad topics: demographic, training and injuries.

3.4.1 Content

The questionnaire's content and design were decided upon by the researcher with assistance from the consulting statistician at STATKON as well as the supervisor and co-supervisor. Furthermore, select questions from a similar study were analyzed and adapted in order to suit the needs of this study (Mtshali, 2007). Consultations with qualified pole sports instructors were also utilized for insight into the sport which assisted in determining additional questions that would be relevant to include in the questionnaire. A literature review was also completed in order to ensure that the questions included would cover all of the pertinent aspects related to this sport and its potential injury patterns.

The questionnaire (**Appendix D**) consisted of 3 main sections. Section A pertained to the participants' demographic and consisted of questions 1-5. Section B pertained to the participants' methods of training and consisted of questions 6-21. Section C pertained to injuries, wherein question 22 was compulsory, and the completion of questions 23-32 was dependent on the participant's answer to question 22. If the participant answered "Yes" to question 22, they were required to complete questions 23-32. If they answered "No" to question 22, then there were no further questions to be completed.

3.4.2 Considerations

Numerous factors were considered by the aforementioned individuals involved in the design of this questionnaire in order to establish validity and reliability within the questionnaire itself, and thereafter in the data collected. The following factors were considered (Somerville, 2016):

- Precise and simple wording to prevent misunderstanding of the questions.
- The exclusion of ambiguous questions.
- Close-ended questions needed to include multiple relevant options to ensure that every participant would be able to select an applicable answer.
- Open-ended questions for comment where applicable.
- An option to select "other" and specify their own response, should the question not provide a relevant answer for that particular participant.

3.4.3 Pilot Study

A pilot study was conducted during which 5 pilot questionnaires were distributed to participants who met the inclusion criteria as a means of pre-testing the questionnaire. These participants were asked to complete the questionnaire in its entirety as well as provide feedback on the structure and content of the questionnaire.

The benefit of having a pilot study was that the researcher could ensure that the questionnaire could be interpreted correctly and thus answered well, that the questionnaire was user friendly and that the questions were relevant. Feedback also ensured that the researcher could make the necessary corrections or changes to the questions themselves as well as to the order that the questions appeared in. Data from the pilot study was not included in the final data capture.

3.5 DATA COLLECTION

Individual packages for each potential participant were created by stapling a questionnaire (**Appendix D**), an information letter (**Appendix E**) and a consent form (**Appendix F**) together. These packages were then taken to the participating pole sports studios for distribution to its members. Black pens were also provided. Prior discussion with the studio owners allowed for an estimated number of packages to be created for each studio as determined by the number of members belonging to that specific studio.

After the initial meeting with the studio members to discuss this research, each studio owner agreed to remind their members of this research at the beginning of each class, whereafter they stepped out for a few minutes to give potential participant's privacy and to protect their anonymity, should they wish to participate. Alternatively, potential participants were able to fill out the questionnaire and return it to the relevant box in their own time. If, after reading the information letter the participant felt that they would like to participate in the study, they signed the information letter and consent form. The information letter and consent form were then detached from the questionnaire and the consent form was placed into a box labelled "Consent forms" for safe keeping, before the participant began with the questionnaire. The information letters were kept by the participants.

Once completed, the questionnaires were placed into a second box labelled "Questionnaires", which was separate from the consent forms, to maintain the anonymity of the members participating in this study. From that moment on, withdrawal from the study was no longer possible. One week after the questionnaires were delivered, a call was made to each studio owner to determine how many questionnaires had been completed. This weekly call was made to all studio owners until it was determined that enough questionnaires had been completed in order for the research to be statistically viable. The boxes of completed questionnaires, as well as the boxes of signed consent forms, were then collected by the researcher.

3.6 DATA ANALYSIS

Data analysis was conducted by the researcher, with assistance from the statisticians at STATKON of the University of Johannesburg, in order to prevent bias by the researcher. The data analysis consisted of descriptive statistics in the form of summarizing and tabling the data. The chi-square test of association was utilized to explore the possibility of links or associations between various pairs of categorical variables. A significance level of alpha = ≤0,05 was applied. Details pertaining to these results have been included in Chapter 4.

3.7 ETHICAL CONSIDERATIONS

All participants that wished to partake in this particular study were required to read and sign the information and consent forms specific to this study. The information and consent forms outlined the name and contact details of the researcher, the purpose of the study and the benefits of partaking in the study. The information and consent forms also explained that the participant's privacy would be protected by ensuring their anonymity and confidentiality when compiling the research dissertation. The information letter informed the participants that their participation was on a voluntary basis and that they were free to withdraw from the study before they handed in their anonymous questionnaire, as an anonymous questionnaire would not be identifiable for removal after it had been submitted. If the participant had any further questions, the researcher's contact details were clearly stated at the end of the information letter and answers to these questions were explained by the researcher.

All participants had the right to privacy and anonymity and as such no names appeared on the questionnaires and their information was not shared with other participating members in the study. Participants were recruited at their place of pole sports training after permission was granted by the studio owner. The questionnaire was in paper format which allowed for multiple questionnaires to be filled out simultaneously. The questionnaires took approximately 5-10 minutes to complete.

There were no anticipated risks related to this study as it was merely a questionnaire that was filled out individually by the participants. There were also no direct benefits to the participants of this study aside from a contribution to further knowledge about the sport and its injury patterns.

Once the study was completed, an electronic copy of the dissertation was sent to all participating pole sports studios in order to provide participants with easy access to the results of the study. This also served to educate individuals who did not participate in the study.

Ethical clearance was granted by the Faculty of Health Sciences Research Ethics Committee with clearance number REC-01-185-2018 (**Appendix G**). Furthermore, Turnitin was used to assess and report any plagiarism found within this dissertation. The Turnitin report has been attached as **Appendix H**.

CHAPTER FOUR – RESULTS

4.1 INTRODUCTION

This study involved the participation of 100 pole sports athletes in Gauteng in the form of 100 completed questionnaires (n=100). Statisticians from STATKON assisted in the analysis of the data collected by the questionnaires. From this analysis the demographic data of the participants, the injury patterns observed, the potential risk factors and the potential musculoskeletal injury prevention methods were determined by the researcher. These results have been stated below. Furthermore, cross tabulations have been utilized to analyze relationships between various sets of data.

4.2 DEMOGRAPHIC DATA OF THE STUDY PARTICIPANTS

Table 4.1: Demographic data of the study participants

Characteristics	Mean (SD)	Min-Max	Median
Age	31,49 (8,82)	18-52	30
Weight	62,26 (10,54)	42-100	61
Number of years of participation in pole sports	3,67 (3,37)	1-21	2

Characteristic	Number of participants	Percentage (%)
Gender		
Female	98	98,0
Male	2	2,0
Skill Level		
Beginner	39	39,4
Intermediate	42	42,4
Advanced	18	18,2
Frequency of pole sports training per week		
1	13	13,1
2	39	39,4
3	25	25,3
4	16	16,2
5	3	3,0
6	2	2,0
7	1	1,0

Duration of pole sports training per day		
30 minutes	2	2,0
45 minutes	41	41,0
1 hour	34	34,0
1 hour 30 minutes	14	14,0
2 hours	8	8,0
> 2 hours	1	1,0
Warm-up		
Yes	98	98,0
No	2	2,0
Stretching		
Yes	96	96,0
No	4	4,0
Method of stretching		
Static	29	29,3
Dynamic	1	1,0
Static and Dynamic	69	69,7

The information to follow has been discussed with respect to **Table 4.1** above.

The minimum reported age was **18** years and the maximum reported age was **52** years. The mean age of the participants was **31,49** years.

The minimum reported weight was **42 kg** and the maximum reported weight was **100 kg**. The mean weight of the participants was **62,26 kg**.

With regard to the distribution pattern for the number of years that the study participants had participated in pole sports; the minimum reported was **1 year** and the maximum reported was **21 years**. The mean years of participation for the participants was **3.67 years**. The majority of the study participants (**81,1%**) had been participating in pole sports for 5 years or less.

The gender distribution indicated that female participants made up the majority of this study population with **98,0%** versus the minority of male participants who accounted for **2,0%**.

Furthermore, the majority of study participants were intermediate level pole sports athletes (**42,4%**) followed closely by beginner level pole sports athletes (**39,4%**). The minority were advanced pole sports athletes (**18,2%**).

The majority (**39,4%**) of the study participants attended pole sports training twice a week. Cumulatively, **52,5%** of the study participants attended pole sports training twice a week or less. Furthermore, more than three quarters of the study population (**77,8%**) attended pole sports training for three days a week or less. Only **22,0%** of the study participants attended pole sports training four times a week or more.

In addition, the majority of the study participants (**41,0%**) attended pole sports training for a total of 45 minutes per day. Likewise, more than three quarters of the study participants (**77,0%**) attended pole sports training for 1 hour or less. Only **9,0%** of the study participants attended pole sports training for 2 hours or more per day.

With regard to warm-up protocols, the majority of study participants (**98,0%**) indicated that they performed a warm-up protocol before pole sports training. Only **2,0%** of the study participants indicated that they did not perform a warm-up before training.

In addition to warming-up, **96,0%** of the study participants indicated that they stretched at some point during their pole sports training whereas **4,0%** indicated that they did not stretch at any point during their pole sports training. Further data on the specific type of stretching used by the study participants was collected. The majority of study participants (**69,7%**) indicated that they used a combination of static and dynamic stretching in their stretching protocol. **29,3%** of the study participants indicated that they performed static stretching and only **1,0%** indicated that they used dynamic stretching.

4.3 INJURY PATTERNS

4.3.1 Number of participants that sustained an injury

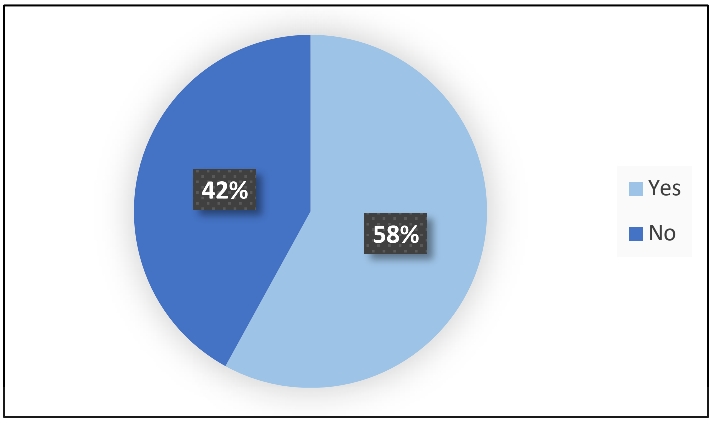


Figure 4.1: Percentage of participants that sustained an injury as a direct result of pole sports

Of the 100 study participants, **58,0%** indicated that they had sustained an injury as a direct result of pole sports. This figure made up the majority. The minority, **42,0%**, indicated that they had not sustained an injury as a direct result of pole sports. This data has been displayed in **Figure 4.1** above.

The remainder of this chapter will focus on the 58% of study participants that indicated that they had been injured as a direct result of participating in pole sports activities.

4.3.2 Region of the body injured

During this response, multiple areas of the body could be selected by each participant. Therefore, this data represents the total number of injuries sustained per region for the 58 study participants that indicated they had suffered an injury as a direct result of pole sports.

The total number of injuries reported by study participants was **125**. A total of **109** of these injuries were classified according to a specific body region. **Figure 4.2** serves to represent the distribution of the 125 injuries across the body regions supplied.

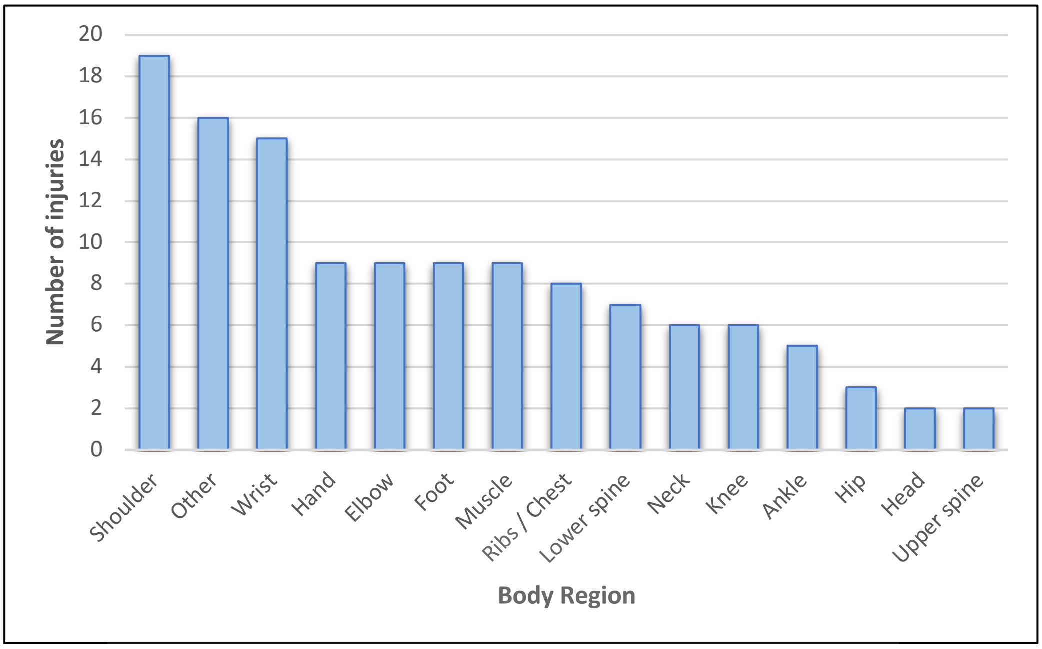


Figure 4.2: The number of injuries reported per body region

According to the data collected, the distribution of injuries across the various regions of the body were as follows: shoulder (**15,2%**), other (**12,8%**), wrist (**12,0%**), hand (**7,2%**), elbow (**7,2%**), muscle (**7,2%**), foot (**7,2%**), rib/chest (**6,4%**), lower spine (**5,6%**), neck (**4,8%**), knee (**4,8%**), ankle (**4,0%**), hip (**2,4%**), head (**1,6%**) and upper spine (**1,6%**).

The most frequently injured region of the body was the shoulder (**15,2%**) and the least frequently injured area was the head (**1,6%**) and the upper spine (**1,6%**).

Overall, the upper limb region (shoulder, elbow, wrist, hand) accounted for the majority of the injuries documented at **41,6%.** The lower limb region (hip, knee, ankle, foot) accounted for **18,4%** of the documented injuries. The spine, ribs/chest accounted for **13,6%** of the injuries. Muscular injuries constituted **7,2%** and the head and neck accounted for **6,4%** of the injuries.

12,8% of the injuries were marked as "other" and were specified during the participant responses. The following regions of the body were specified, by the participants, under the option identified as other: abductor muscles (n=1), gluteal muscles (n=1), forearm (n=3), groin (n=1), hamstring muscles (n=4), hip flexor muscles (n=1), legs (n=1), toe (n=1), trapezius muscle (n=1), ligaments (n=1) and upper back (n=1).

4.3.3 Types of injuries

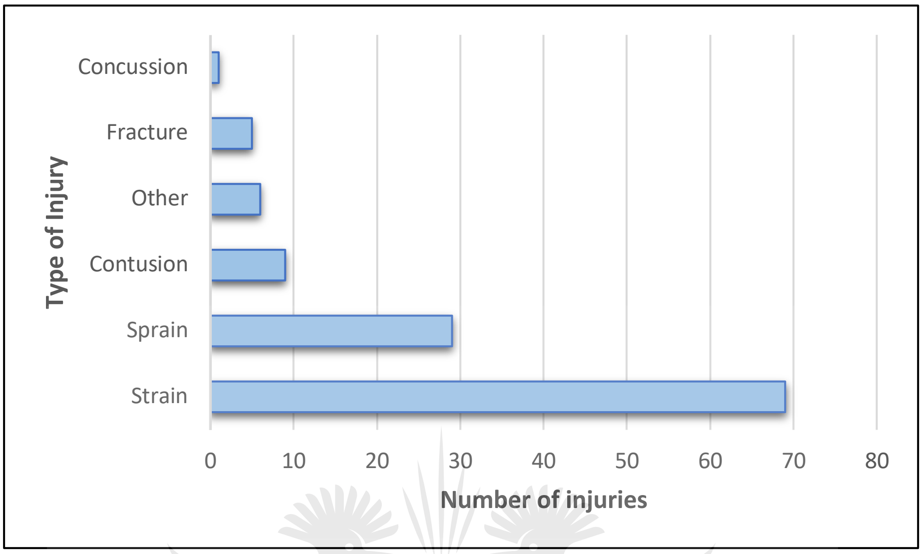


Figure 4.3: The total number of injuries reported categorized by type

The total number of injuries reported by study participants was further categorized according to the type of injury sustained and has been displayed in **Figure 4.3** above. The largest category pertaining to the type of injury sustained was strains **(58,0%)**, followed by sprains (**29,0%**), contusions (**7,6%**), fractures (**4,2%**) and concussions (**0,8%**). A further **5,0%** was indicated as "other" during the data collection and was specified during the participant responses. The following types of injuries were specified, by the participants, under the option identified as "other": abductor muscles (n=1), bruises (n=1), gluteal muscles (n=1), hamstring muscles (n=1), hip flexor muscles (n=1), and forearm (n=1).

4.3.4 Recovery

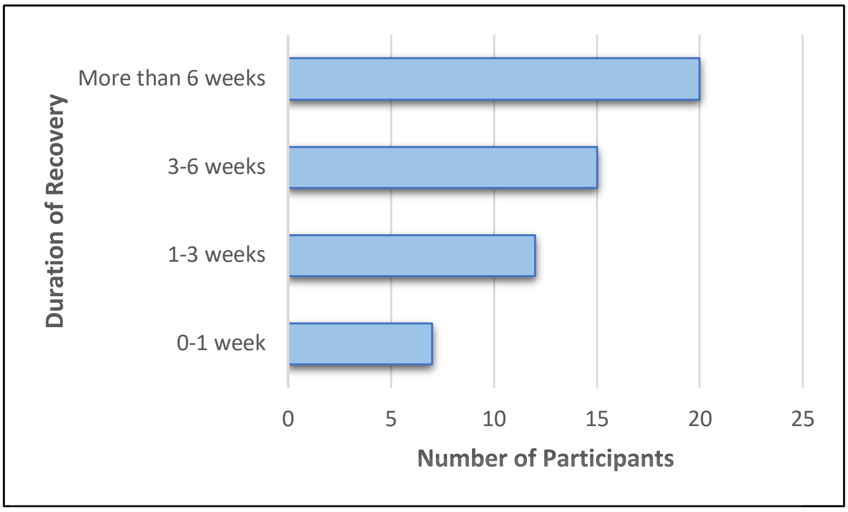


Figure 4.4: The duration of recovery required for the study participants most severe injury

Figure 4.4 details the duration of recovery for each participant's most severe injury. **13,0%** of the participants required 1 week or less to recover from their injury and this represents the minority of the study population that suffered an injury as a direct result of pole sports. **22,2%** of the participants required a recovery period of 1-3 weeks and **27,8%** of the participants required a recovery period of 3-6 weeks. **37,0%** of the participants required more than 6 weeks to recover and this represents the majority of the study population that suffered an injury as a direct result of pole sports. The cumulative percentage indicates that almost two thirds (**64,8%**) of the study population required more than 3 weeks for recovery from their most severe injury.

Further information on the treatment methods used by the study participants during their recovery period was also gathered. During this response in the questionnaire, it was possible to select more than one treatment option. The data in **Figure 4.5** thus represents an overview of the preferred treatment methods for the study participants that suffered an injury as a direct result of pole sports.

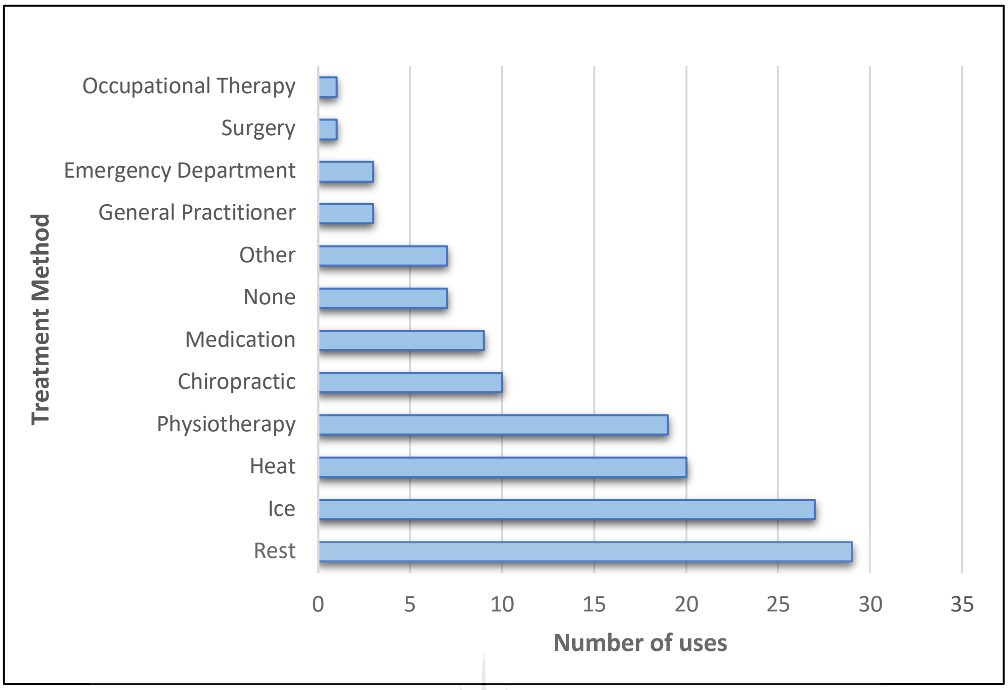


Figure 4.5: The treatment methods used by the participants during their recovery

The treatment methods used, listed from the most common to the least common, are as follows: rest (**21,3%**), ice (**19,9%**), heat (**14,7%**), physiotherapy (**13,9%**), chiropractic (**7,4%**), medication (**6,6%**), general practitioner (**2,2%**), emergency department (**2,2%**), occupational therapy (**0,8%**) and surgery (**0,8%**). Furthermore, **5,1%** indicated that they used a treatment method other than the options provided and **5,1%** indicated that they did not use any treatment methods for their most severe injury.

4.4 POTENTIAL INJURY RISK FACTORS

This section will use various statistical methods of analysis to determine if there is a significant relationship between the potential risk factors identified in Chapter 2 and injury occurrence in pole sports athletes that participated in this study. A significance value of $p = \leq 0,05$ has been applied.

4.4.1 Age

Table 4.2: T-Test statistics: relationship between age and injury

Have you suffered an injury?	N	Mean	Std. Deviation	Std. Error Mean
Yes	58	32,40	9,059	1,190
No	42	30,24	8,436	1,302

Table 4.3: Independent Samples Test: relationship between age and injury

t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Difference	
					Lower	Upper
1,210	98	0,229	2,158	1,784	-1.381	5.698

* Sig. = 0,276 (>0,05) therefore equal variances assumed

An independent-samples t-test was conducted in order to determine whether there was a statistical difference between the mean age scores for participants who were injured in comparison to those who were not injured. Results tabulated in **Table 4.2** and **Table 4.3** indicated that there was no significant difference in data for those who were injured **(**M= 32,40, SD = 9,059) and those who were not injured **(**M = 30,24, SD = 8,436**; p = 0,229** (>0,05)**,** two-tailed). The magnitude of the difference between the means (mean difference = 2.158) was small (eta squared = 0.014).

This result is supported by the Chi-square test for independence:

Table 4.4: Chi-square test: relationship between age and injury

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-square	24,501	30	0,749
Likelihood ratio	32,149	30	0,361
Linear-by-Linear Association	1,457	1	0,227
N of valid cases	100	-	-

Table 4.5: Symmetric measures: relationship between age and injury

		Value	Approximate Significance
Nominal by Nominal	Phi	0,495	0,749
	Cramer's V	0,495	0,749

Table 4.4 and 4.5 above demonstrate that the Chi-square test for independence indicated no significant association between participant age and injury occurrence (n=100), **p = 0,749** (>0,05); phi = 0,495.

4.4.2 Weight

Table 4.6: T-Test statistics: relationship between weight and injury

Have you suffered an injury?	N	Mean	Std. Deviation	Std. Error Mean
Yes	58	63,67	11,279	1,481
No	41	60,27	9,165	1,431

Table 4.7: Independent Samples Test: relationship between weight and injury

t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Difference	
					Lower	Upper
1,595	97	0,114	3,404	2,134	-0,831	7,640

* Sig. = 0,381 (>0,05) therefore equal variances assumed

An independent-samples t-test was conducted in order to determine whether there was a statistical difference between the mean weight scores for participants who were injured in comparison to those who were not injured. Results tabulated in **Table 4.6** and **Table 4.7** indicated that there was no significant difference in data for those who were injured **(**M= 63,67, SD = 11,279) and those who were not injured **(**M = 60,27, SD = 9,165**; p = 0,381** (>0,05), two-tailed). The magnitude of the difference between the means (mean difference = 3,404) was small (eta squared = 0,03).

4.4.3 Number of years of participation

Table 4.8: T-Test statistics: relationship between years of participation in pole sports and injury

Have you suffered an injury?	N	Mean	Std. Deviation	Std. Error Mean
Yes	55	4,71	3,943	0,532
No	40	2,25	1,515	0,240

Table 4.9: Independent Samples Test: relationship between years of participation in pole sports and injury

t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Difference	
					Lower	Upper
4,217	73,932	0,000	2,459	0,583	1,297	3,621

* Sig. = 0,000 (<0,05) therefore equal variances not assumed

An independent-samples t-test was conducted in order to determine whether there was a statistical difference between the mean years of participation scores for participants who were injured in comparison to those who were not injured. Results tabulated in **Table 4.8** and **Table 4.9** indicated that there was a significant difference in data for those who were injured **(**M= 4,71, SD = 3,943) and those who were not injured **(**M = 2,25, SD = 1,515**; p = 0,000** (≤0,05), two-tailed). The magnitude of the difference between the means (mean difference = 2,459) was large (eta squared = 0,16).

4.4.4 Skill level

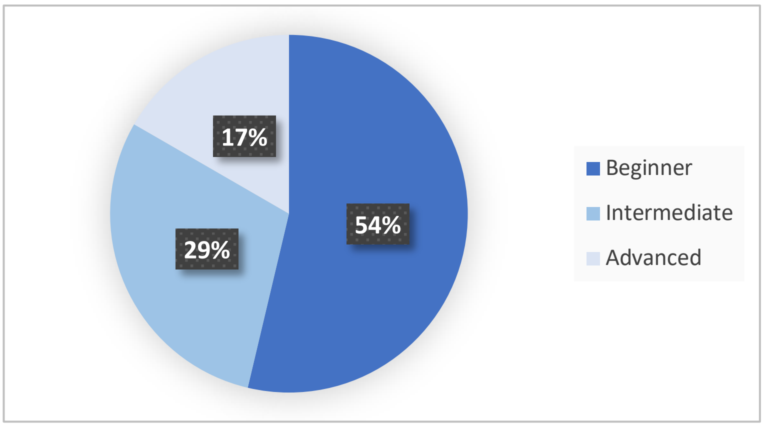


Figure 4.6: Participants skill level at the time of their most severe injury

Figure 4.6 demonstrates the participant's skill level at the time of their most severe injury. 58 cases should have been reported in the data capture. However, 4 cases were reported as missing (possibly due to participants neglecting to answer this question).

The data above indicates that the largest proportion of the sustained injuries occurred in the beginner skill level (**53,7%**), followed by the intermediate skill level (**29,6%**). The advanced skill level had the least number of injuries (**16,7%**). This indicates that over half of all the injuries reported (**53,7%**) occurred in the beginner level.

4.4.5 Frequency of training per week

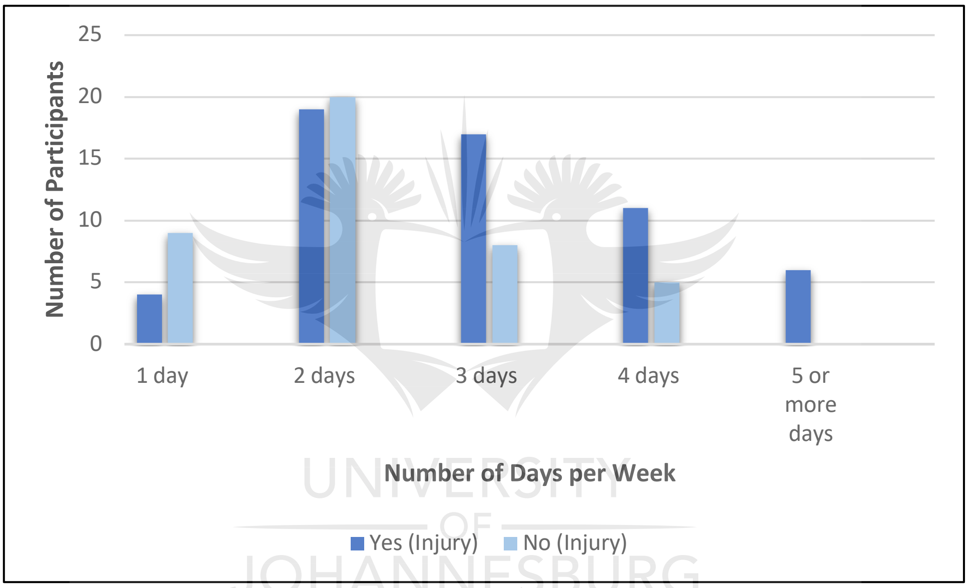


Figure 4.7: The relationship between frequency of training per week and injury occurrence

Figure 4.7 demonstrates the relationship between the frequency of training per week and the occurrence of an injury. The information can be summarized as follows:

- When training for 1 day per week, participants were **less** likely to sustain an injury (Y = 30,8% < N = **69,2%**).
- When training for 2 days per week, participants were **less** likely to sustain an injury (Y = 48,7% > N = **51,3%**).
- When training for 3 days per week, participants were **more** likely to sustain an injury (Y = **68,0%** > N = 32,0%).

- When training for 4 days per week, participants were **more** likely to sustain an injury (Y = **68,8%** > N = 31,2%).
- When training for 5 or more days per week, participants were **more** likely to sustain an injury (Y = **100,0%** > N = 0,0%).

In summary, training for 2 days or less per week resulted in a decrease in injury occurrence, whereas training for 3 days or more per week resulted in an increase in injury occurrence within the study population.

4.4.6 Duration of training per day

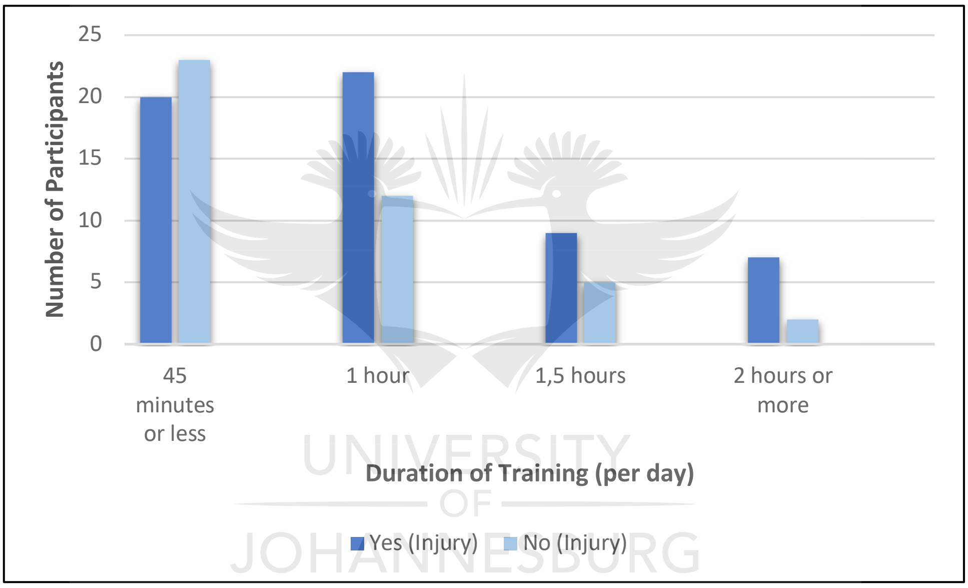


Figure 4.8: The relationship between duration of training per day and injury occurrence

Figure 4.8 demonstrates the relationship between the duration of training per day and the occurrence of an injury. The information can be summarized as follows:

- When training for 45 minutes or less per day, participants were **less** likely to sustain an injury (Y = 46,5% < N = **53,5%**).
- When training for 1 hour per day, participants were **more** likely to sustain an injury (Y = **64,7%** > N = 35,3%).

- When training for 1,5 hours per day, participants were **more** likely to sustain an injury (Y = **64,3%** > N = 35,7%).
- When training for 2 hours or more per day, participants were **more** likely to sustain an injury (Y = **77,8%** > N = 22,2%).

In summary, training for 45 minutes or less per day resulted in a decrease in injury occurrence, whereas training for 1 hour or more per day resulted in an increase in injury occurrence within the study population.

4.4.7 Elements resulting in the participants most severe injury

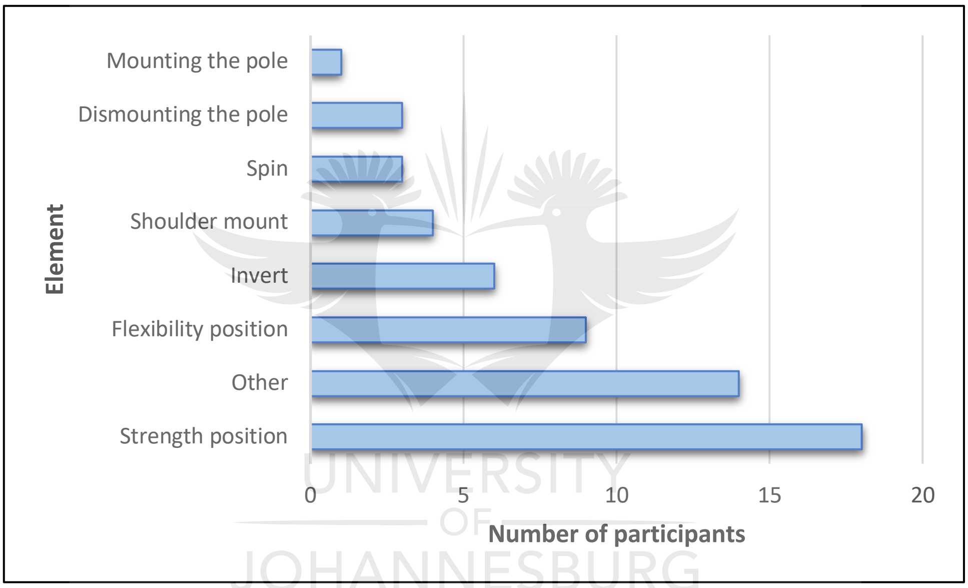


Figure 4.9: The element being performed at the time of the participants' most severe injuries

The elements being performed at the time of the participants' most severe injuries have been illustrated in **Figure 4.9** above. The elements, listed in order from the most common element to result in an injury to the least common element to result in an injury are: strength position (**31,0%**), flexibility position (**15,5%**), invert (**10,3%**), shoulder mount (**6,9%**), spin (**5,2%**), dismounting the pole (**5,2%**) and mounting the pole (**1,7%**). **24,1%** indicated that the element that caused their injury was something other than what was mentioned in the available options. **Appendix A** contains diagrams showing the positioning required for the elements mentioned in **Figure 4.9** above.

24,1% of the injuries were marked as "other" and were specified during the participant responses. The following elements were specified, by the participants, under the option identified as other: boxing (n=1), cupid (n=1), dismounting into handstand (n=1), fell off the pole (n=1), handspring (n=5), handstand (n=1), dancing (n=1), sitting (n=1), spinning (n=2), splits on the pole (n=1) and stretching (n=1).

4.5 POTENTIAL INJURY PREVENTION METHODS

4.5.1 Warm-up

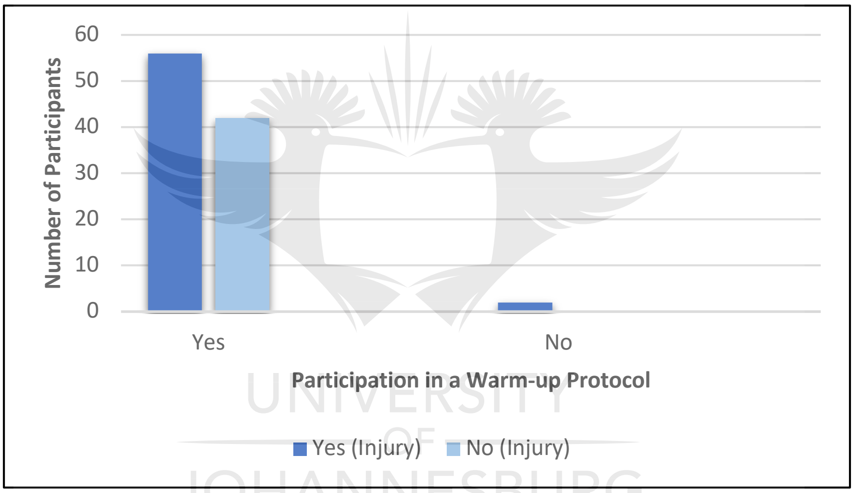


Figure 4.10: The relationship between warm-up and injury prevention

Figure 4.10 illustrates that 98 participants indicated that they performed a warm-up protocol before taking part in pole sports training. Of these 98 participants, **57,1%** reported that they had suffered an injury as a direct result of pole sports and **42,9%** indicated that they had not suffered an injury as a direct result of pole sports. Furthermore, the 2 participants who did not perform a warm-up protocol before pole sports training both suffered an injury.

Table 4.10: Chi-square test: relationship between warm-up and injury prevention

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-square	1,478	1	0,224
Likelihood ratio	2,208	1	0,137
Linear-by-Linear Association	1,463	1	0,226
N of valid cases	100	-	-

Table 4.11: Symmetric measures: relationship between warm-up and injury prevention

		Value	Approximate Significance
Nominal by Nominal	**Phi**	-0,122	0,224
	Cramer's V	0,122	0,224

Table 4.10 and 4.11 above demonstrate that the Chi-square test for independence indicated no significant association between warm-up and injury (n = 100), **p = 0,224** (>0,05); phi = 0,224.

4.5.2 Stretching

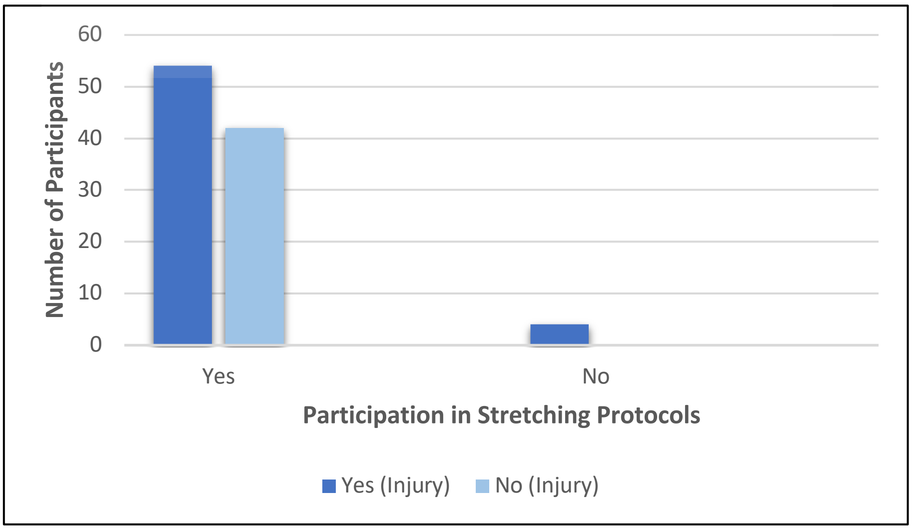


Figure 4.11: The relationship between stretching and injury prevention

Figure 4.11 illustrates that 96 participants indicated that they stretched during pole sports training. Of these 96 participants, **56,3%** reported that they had suffered an injury as a direct result of pole sports and **43,8%** indicated that they had not suffered an injury as a direct result of pole sports. Furthermore, **100%** of the participants who did not stretch during pole sports training suffered an injury.

Table 4.12: Chi-square test: relationship between stretching and injury prevention

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-square	3,017	1	0,082
Likelihood ratio	4,478	1	0,034
Linear-by-Linear Association	2,987	1	0,084
N of valid cases	100	-	-

Table 4.13: Symmetric measures: relationship between stretching and injury prevention

		Value	Approximate Significance
Nominal by Nominal	**Phi**	-0,174	0,082
	Cramer's V	0,174	0,082

Table 4.12 and 4.13 above demonstrate that the Chi-square test for independence indicated no significant association between stretching and injury (n = 100), **p = 0,082** (>0,05); phi = 0,082.

As was discussed in Chapter 2, there are 3 different methods of stretching: static, dynamic, and a combination of both static and dynamic. **Figure 4.12** serves to demonstrate whether there is a link between the method of stretching used and injury occurrence.

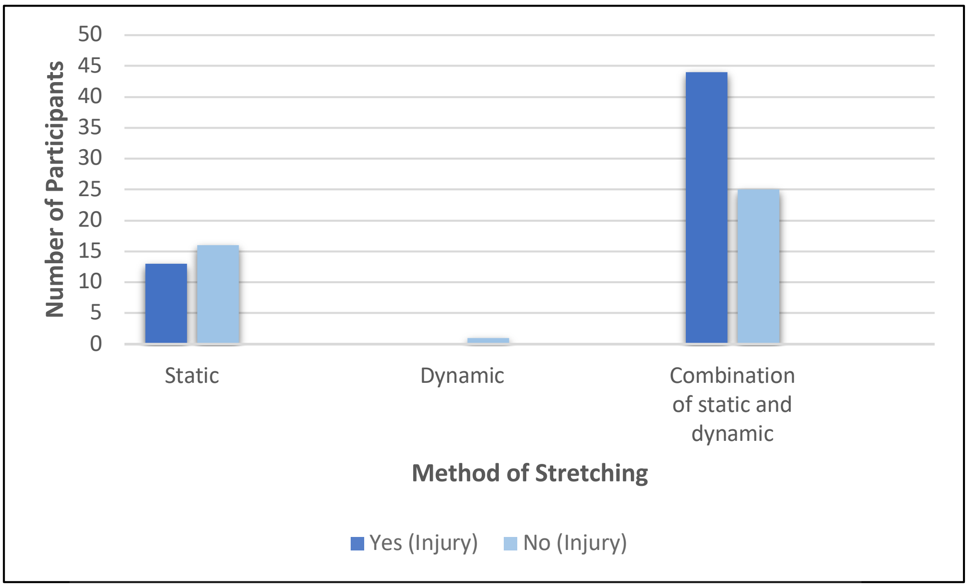


Figure 4.12: The relationship between method of stretching and injury prevention

The majority of study participants (**69,7%**) use a combination of static and dynamic stretching. Of these participants, **63,8%** suffered and injury and **36,2%** did not suffer an injury.

29,3% of study participants use static stretching. Of these participants, **44,8%** suffered an injury and **55,2%** did not suffer an injury.

The minority of study participants (**1%**) use dynamic stretching. Of these participants, **100%** did not suffer an injury.

Table 4.14: Chi-square test: relationship between method of stretching and injury prevention

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-square	4,370	2	0,112
Likelihood ratio	4,716	2	0,095
Linear-by-Linear Association	3,415	1	0,076
N of valid cases	100	-	-

Table 4.15: Symmetric measures: relationship between method of stretching and injury prevention

		Value	Approximate Significance
Nominal by Nominal	**Phi**	0,210	0,112
	Cramer's V	0,210	0,112

Table 4.14 and 4.15 above demonstrate that the Chi-square test for independence indicated no significant association between the method of stretching and injury (n = 100), **p = 0,112** (>0,05); phi = 0,112.

CHAPTER FIVE – DISCUSSION

5.1 INTRODUCTION

This chapter will aim to discuss and explain the results documented in Chapter 4 on the injury patterns in pole sports athletes in Gauteng. Wherever possible, literature that supports or opposes the results has been provided.

5.2 DEMOGRAPHIC DATA OF THE PARTICIPANTS

5.2.1 Gender

The gender distribution of the study population indicated that female participants made up the majority of the study population since **98,0%** of the study population were female and **2,0%** were male.

The prevalence of females can be attributed to the female predominance of the sport. A census conducted in 2012 by the IPSF at the World Pole Sports Championships estimated that 95% of the participating athletes were female (Coates, 2018).

As a result of the large female predominance, the effect that gender may have on predisposing pole sports athletes to injury could not be investigated.

5.2.2 Number of years of participation in pole sports

The minimum number of years of participation reported was **1 year** and the maximum reported was **21 years**. The mean years of participation for the participants was **3.67 years**.

The minimum reported time period of 1 year can be attributed to the inclusion criteria which stated that individuals were required to have participated in pole sports for a minimum of 1 year in order to be a participant in this research. Should this clause not have been stipulated, it is possible that the minimum number of years reported could decrease to a number of months. The minimum number of years, reported to be 1 year, further demonstrates the growing amount of participation within this sport.

There was no limit set in the inclusion criteria with regard to the maximum number of years of participation. The reported maximum number of 21 years indicates that there are members within the pole sports community of Gauteng that began participating in pole sports before it became a popular form of fitness in the year 2000 (Coates, 2018).

Furthermore, the data reported demonstrated that the majority of the study participants (**81,1%**) had been participating in pole sports for 5 years or less. Since the popularity of this sport had a major increase between 2012 (where 43 athletes competed at the World Pole Sports Championships) and 2017 (where 229 athletes competed) (Coates, 2018), this trend was expected.

5.2.3 Skill level

The majority of the study population were intermediate level pole sports athletes (**42,4%**) followed closely by beginner level pole sports athletes (**39,4%**). The minority of the population were advanced pole sports athletes (**18,2%**).

A correlation can be identified between the number of years of participation in this sport and the skill level of the study participants; **81,1%** of the study participants had been participating in pole sports for 5 years or less, and **81,8%** of the study participants belonged to the beginner and intermediate levels of skill. Thus, the trend presented by this study indicates that the advanced level of skill in pole sports may be attained after approximately 5 years of training.

5.2.4 Recovery

The treatment methods used, listed from the most common to the least common, are as follows: rest (**21,3%**), ice (**19,9%**), heat (**14,7%**), physiotherapy (**13,9%**), chiropractic (**7,4%**), medication (**6,6%**), general practitioner (**2,2%**), emergency department (**2,2%**), occupational therapy (**0,8%**) and surgery (**0,8%**). Furthermore, **5,1%** indicated that they used a treatment method other than the options provided and **5,1%** indicated that they did not use any treatment methods for their most severe injury.

Rest, ice and heat are all easily accessible treatment methods for the population of this sport as they can be accessed and performed within the comfort of one’s home without incurring a large expense. Thus, it was expected that these three treatment methods would be ranked highly.

Chiropractic was listed as the fifth most commonly used treatment method, after physiotherapy, for pole sports athletes recovering from a musculoskeletal injury. Chiropractic is defined by the Chiropractic Association of South Africa (2019) as “a health profession specializing in the diagnosis, treatment and prevention of mechanical disorders of the musculoskeletal system and the effects of these disorders on the functioning of the nervous system and general health”. Since all of the injuries in this study were musculoskeletal in nature, chiropractors should ideally be the primary healthcare provider for the treatment of these injuries. Furthermore, the Compensation for Occupational Injuries and Diseases Act allows for full reimbursement for treatments received by a registered chiropractor; thus, chiropractic care is considered a cost-effective form of treatment for musculoskeletal injuries (Chiropractic Association of South Africa, 2019).

With regard to recovery time, **13,0%** of the participants required 1 week or less to recover from their most severe injury. **22,2%** of the participants required a recovery period of 1-3 weeks and **27,8%** of the participants required a recovery period of 3-6 weeks. **37,0%** of the participants required more than 6 weeks to recover and this represented the majority of the study population that suffered an injury as a direct result of pole sports. Since chiropractic care was used only **7,4%** of the time, there is an opportunity to integrate chiropractic care within the pole sports community which could see a reduction in the amount of time required for recovery by the athletes of this sport.

5.3 INJURY PATTERNS

5.3.1 Number of participants that sustained an injury

Of the 100 study participants, **58,0%** indicated that they had sustained an injury as a direct result of pole sports. This figure makes up the majority. The minority, **42,0%**, indicated that they had not sustained an injury as a direct result of pole sports.
The rest of this chapter will focus on the 58% of study participants that indicated that they had been injured as a direct result of participating in pole sports.

5.3.2 Region of the body injured

According to the data collected, the distribution of injuries across the various regions of the body are as follows: shoulder (**15,2%**), other (**12,8%**), wrist (**12,0%**), hand (**7,2%**), elbow (**7,2%**), muscle (**7,2%**), foot (**7,2%**), rib / chest (**6,4%**), lower spine (**5,6%**), neck (**4,8%**), knee (**4,8%**), ankle (**4,0%**), hip (**2,4%**), head (**1,6%**) and upper spine (**1,6%**).

Overall, the upper limb region, which consists of the shoulder, elbow, wrist and hand (Moore et al, 2014) accounted for the majority (**41,6%**) of the injuries. A study conducted by Wolf et al (2017) identified that the upper limb may sustain stress responses and overuse injuries within its anatomical structures when the limb is loaded as a weight-bearing extremity. Furthermore, Wörtler (2010) stated that a chronic overhead position of the upper limb would produce chronic tendon overuse with secondary impingement. Since both weight-bearing, and a prolonged overhead position of the upper limb is commonly utilized in pole sports, it was hypothesized in the literature review that the upper limb would be the most likely region to be injured in pole sports athletes.

The injuries occurring in the upper limb can be further analyzed by acknowledging each joint complex in order to fully understand the injury patterns occurring within the upper limb as a whole.

a) Shoulder Joint

The shoulder joint was identified as the region that sustained the most injuries (**15,2%**) in this study. With respect to pole sports activities, shoulder injuries may be attributed to one of the following potential causes previously identified in the literature review:

- Overuse or overloading of the rotator cuff muscles (Wolf et al, 2017).
- Decreased stability as a result of the joint having a large range of motion (Martini et al, 2014).
- Degenerative changes occurring as a result of overuse or stress (Levangie & Norkin, 2005).
- Impingement of the structures within the subacromial space (Levangie & Norkin, 2005).

b) Wrist Joint

The wrist joint sustained the second largest number of injuries (**12,0%**) according to the data collected by this study. With respect to pole sports activities, wrist injuries may be attributed to the multitude of forces that are placed onto the structures of the wrist (repetitive movements, axial compression, multidirectional distraction and torsional forces), especially during upper limb weight bearing (Webb & Rettig, 2008). These forces have the potential to result in overuse, sprain and strain injuries within the structures of the joint which may result in a further compromise of the integrity of the joint structures (Gatterman, 2005).

c) Elbow Joint

The elbow joint was identified as the third most commonly injured region of the body in this study, accounting for **7,2%** of the injuries sustained by study participants. With respect to pole sports activities, the following may be identified as potential causes for the occurrence of elbow injuries:

- The anatomical structures of the elbow are not designed for weight-bearing and thus undergo a large amount of unnatural stress when placed into a weight-bearing position (Wolf et al, 2017).

- Repetitive motion of the elbow joint into flexion, extension, rotation and compression produces strains within the structures of the joint (Qu et al, 2000).

The **12,8%** of the injuries marked as other during the participant responses were specified as: abductor muscles (n=1), gluteal muscles (n=1), forearm (n=3), groin (n=1), hamstring muscles (n=4), hip flexor muscles (n=1), legs (n=1), toe (n=1), trapezius muscle (n=1), ligaments (n=1) and upper back (n=1). By analyzing this information, it is reasonable to assume that participants were unable to assign specific muscles such as abductor, gluteal, hamstring and trapezius to the option entitled "Muscular". Furthermore, toe could have been included in the "Foot" region, ligaments could have been allocated to a specific region and upper back could have been assigned to "Upper spine" or potentially "Muscular" (depending on that participants specific injury).

Comparatively, the data gathered by this study differs from the results of the study by Mitrousias et al (2017) which identified the lower back and hip as the regions with the greatest percentage of injuries (29,4%), followed by the knee (20,6%), wrist (17,7%), ankle (14,7%), and cervical spine (5,9%). This study by Mitrousias et al (2017) was conducted by analyzing the records from an emergency department in a provincial hospital in Greece. Thus, only the injuries that were severe enough to require that the pole sports athlete attend a hospital were included in this study. This difference in setting may account for the differences noted in the injury patterns of the participants of each study, since minor injuries were more likely to be included in this research study in comparison to the one conducted by Mitrousias et al (2017).

5.3.3 Types of injuries

The total number of injuries reported by the study participants was further categorized according to the type of injury sustained. The largest category pertaining to the type of injury sustained was strains (**58,0%**), followed by sprains (**29,0%**), contusions (**7,6%**), fractures (**4,2%**) and concussions (**0,8%**). A further **5,0%** was indicated as "other" during the data collection.

The predominance of strain injuries (**58,0%**) can be attributed to the need for a substantial amount of muscular strength which is required to lift, spin and hold the pole sports athlete's body in numerous positions whilst performing prescribed pole sports elements (Coates, 2018). The mechanism by which the strain will occur is the result of a high force contraction occurring within a muscle while that muscle is in a lengthened position (Levangie & Norkin, 2005).

Sprain injuries also accounted for a substantial portion of the injuries reported by the participants of this study (**29,0%**). This was expected as pole sports athletes require a high level of flexibility (known medically as range of motion), in conjunction with muscular strength, in order to execute elements by demonstrating lines as well as contorting and posing their bodies (Coates, 2018). When the anatomical range of motion of a joint is exceeded, the ligamentous fibers are ruptured which results in a sprain injury. This injury may be attributed to a variety of factors, namely: fatigue, decreased strength, or insufficient stretching of the required ligaments and muscles before performing a pole sports element (Gatterman, 2005).

Collectively, the number of reported contusions and fractures are likely the result of the sport's high-impact nature (Coates, 2018). During the transitioning from one element into another, numerous parts of the body may come into contact with the pole. If there is a lack of muscular control during these movements, contusion injuries will occur as a result of the direct force exerted onto the muscle by the apparatus. The extent of this type of injury will vary depending on the magnitude of the force exerted on the muscle and surrounding tissue (Beiner & Jokl, 2002). Furthermore, fractures may result in a similar fashion but with a much higher magnitude of force, or alternatively from exposure to an increased load or a stress that is exerted from an unusual direction (Martini et al, 2014).

5.4 POTENTIAL INJURY RISK FACTORS

This section uses various statistical methods of analysis to determine whether there was a significant relationship between the potential risk factors identified in Chapter

2 and injury occurrence in the pole sports athletes that participated in this study. A significance level of p = ≤0,05 has been applied.

5.4.1 Age

An independent-samples t-test was conducted in order to determine whether there was a statistical difference between the mean age scores for participants who were injured in comparison to those who were not injured. Results indicated that there was no significant difference in data for those who were injured **(**M= 32,40, SD = 9,059) and those who were not injured **(**M = 30,24, SD = 8,436**; p = 0,229**, two-tailed). The magnitude of the difference between the means (mean difference = 2.158) was small (eta squared = 0.014). The Chi-square test for independence also indicated no significant association between participant age and injury occurrence (n = 100), **p = 0,749**; phi = 0,495.

Review of the literature indicated that increased age is potentially linked to an increased risk for musculoskeletal injury (Green & Pizzari, 2017). This may be the result of numerous physiological factors, including, but not limited to: loss of skeletal muscle quality and function, loss of power output (Mitchell et al, 2012) and reduced motor unit discharge rates (Dalton et al, 2010). Since the mean age of the participants of this study was quite low (31,49 years), it is doubtful that any of the above physiological changes would be occurring in the majority of the study population. Thus, the absence of a statistically relevant association between the age and injury occurrence within this study was expected.

5.4.2 Weight

An independent-samples t-test was conducted in order to determine whether there was a statistical difference between the mean weight scores for participants who were injured in comparison to those who were not injured. Results indicated that there was no significant difference in data for those who were injured **(**M= 63,67, SD = 11,279) and those who were not injured **(**M = 60,27, SD = 9,165**; p = 0,381**, two-tailed). The magnitude of the difference between the means (mean difference = 3,404) was small (eta squared = 0,03).

Review of the literature indicated that**,** in some studies, increased body weight can be a risk factor for injury due to the increased amount of force that is placed on the soft tissue (ligaments, muscles, tendons) and the hard tissue (bones and cartilage) during physical activity (Murphy et al, 2003). Conversely, other studies reported that there is no correlation between body weight and injury risk (Knapik et al, 2001). This study falls into the latter category since no statistical association was found between the weight of the participants that were injured and the weight of the participants that were not injured.

5.4.3 Number of years of participation

An independent-samples t-test was conducted in order to determine whether there was a statistical difference between the mean years of participation scores for participants who were injured in comparison to those who were not injured. Results indicated that there was a significant difference in data for those who were injured **(**M= 4,71, SD = 3,943) and those who were not injured **(**M = 2,25, SD = 1,515**; p = 0,000**, two-tailed). The magnitude of the difference between the means (mean difference = 2,459) was large (eta squared = 0,16).

According to these results, injury occurrence increased in the study population as the number of years of participation increased. Comparatively, this supports the statement made by Lee et al (2017) that the higher the training exposure of an athlete is, the more likely it is that an injury will occur.

5.4.4 Skill level

The largest proportion of the sustained injuries occurred in the beginner skill level (**53,7%**), followed by the intermediate skill level (**29,6%**) The advanced skill level had the least number of injuries (**16,7%**). This indicates that over half of all the injuries reported (**53,7%**) occurred in the beginner level.

Some studies indicate that athletes with a lower level of skill are more likely to suffer injury (Chomiak et al, 2000; Peterson et al, 2000), whereas other studies indicated that athletes with a high level of skill are more likely to suffer an injury (Hosea et al, 2000). It is important to note that the studies mentioned above were conducted on different types of sports. Therefore, it is reasonable to assume that the relationship between skill level and injury occurrence may be sport dependent (Murphy et al, 2003).

With respect to pole sports, this study indicates that participants were more likely to sustain an injury when they belonged to a lower level of skill. Lower skill levels may be associated with a lack of strength, lack of confidence and lack of experience within the sport which may contribute overall to the increased incidence of injuries within that skill category.

5.4.5 Frequency of training per week

The relationship between the frequency of training per week and the occurrence of an injury is summarized as follows:

- When training for 1 day per week, participants were **less** likely to sustain an injury (Y = 30,8% < N = **69,2%**).
- When training for 2 days per week, participants were **less** likely to sustain an injury (Y = 48,7% > N = **51,3%**).
- When training for 3 days per week, participants were **more** likely to sustain an injury (Y = **68,0%** > N = 32,0%).
- When training for 4 days per week, participants were **more** likely to sustain an injury (Y = **68,8%** > N = 31,2%).
- When training for 5 or more days per week, participants were **more** likely to sustain an injury (Y = **100,0%** > N = 0,0%).

A recent study by Lee et al (2017) has demonstrated a link between the amount of training exposures per month and the rate of injury occurrence; the higher the training exposure, the more likely it is that an injury will occur. The same appears to be true for the participants of this study since training for 2 days or less per week resulted in a decrease in injury occurrence; whereas training for 3 days or more per week resulted in an increase in injury occurrence within the study population.

5.4.6 Duration of training per day

The relationship between the duration of training per day and the occurrence of an injury is summarized as follows:

- When training for 45 minutes or less per day, participants were **less** likely to sustain an injury (Y = 46,5% < N = **53,5%**).
- When training for 1 hour per day, participants were **more** likely to sustain an injury (Y = **64,7%** > N = 35,3%).
- When training for 1,5 hours per day, participants were **more** likely to sustain an injury (Y = **64,3%** > N = 35,7%).
- When training for 2 hours or more per day, participants were **more** likely to sustain an injury (Y = **77,8%** > N = 22,2%).

DiFioiri et al (2014) states that an increased number of hours spent training for a sport reduces the recovery time available to the athlete and thus increases the risk of occurrence of overuse injuries. The same trend can be seen in the participants of this study since training for 45 minutes or less per day resulted in a decrease in injury occurrence, whereas training for 1 hour or more per day resulted in an increase in injury occurrence.

5.5 POTENTIAL INJURY PREVENTION METHODS

5.5.1 Warm-up

98 participants indicated that they performed a warm-up protocol before partaking in pole sports training. Of these 98 participants, **57,1%** reported that they had suffered an injury as a direct result of pole sports and **42,9%** indicated that they had not suffered an injury as a direct result of pole sports.

Brunner-Ziegler et al (2011) stated that the primary purpose of warming up before physical activity is to improve performance, decrease muscle soreness and prevent sports-related injuries. Overall, the results of this study do not appear to support this statement, since the Chi-square test for independence indicated no significant association between warm-up and injury prevention (n = 100), **p = 0,224**; phi = 0,224.

However, **100%** of the participants who did not perform a warm-up protocol before pole sports training suffered an injury according to this study. The reason for these injuries may be attributed to the following physiology: the participant did not warm-up, therefore the temperature of the muscles was not increased, and thus joint range of motion (controlled by the muscle-tendon unit) was not increased which may predispose the participant to injury occurrence (McHugh & Cosgrave, 2010). This is because the effect of injury prevention is attributed to increased elasticity in the muscle-tendon unit as well as increased muscle strength (Evans et al, 2002).

5.5.2 Stretching

Evidence suggests that pre-performance stretching has the ability to reduce the risk of acute muscle strain injuries during a physical activity (McHugh & Cosgrave, 2010). 96 of the participants in this study indicated that they stretched during pole sports training. Of these 96 participants, **56,3%** reported that they had suffered an injury as a direct result of pole sports and **43,8%** indicated that they had not suffered an injury as a direct result of pole sports. The Chi-square test for independence indicated no significant association between stretching and injury prevention (n = 100), **p = 0,082**; phi = 0,082. It is however important to note that **100%** of the participants who did not perform stretching during pole sports training suffered an injury.

As was previously identified in the literature review, there are 3 different methods of stretching: static stretching, dynamic stretching and a combination of the two. The majority of study participants (**69,7%**) used a combination of static and dynamic stretching. Of these participants, **63,8%** suffered and injury and **36,2%** did not suffer an injury.

Static stretching is characterized by lengthening a muscle until a stretched sensation is experienced (Cronin et al, 2008) or until discomfort is experienced (Behm et al, 2004), and then holding that position for a pre-determined amount of time (Ebben et al 2004). The purpose of static stretching is to increase range of motion (Paradisis et al, 2014), decreases musculotendinous stiffness (Kay & Blazevich, 2008) and reduce activity specific injuries (Hadala & Barrios, 2009). **29,3%** of study participants used static stretching. Of these participants, **44,8%** suffered an injury and **55,2%** did not suffer an injury. Since the majority of the participants in this study that use static stretching did not suffer and injury, the above statement can be supported by the results of this study.

Dynamic stretching requires the controlled movement of a body part through the range of motion of the active joints (Fletcher, 2010). Dynamic stretching also typically displays a similarity to the movements performed in the physical activity which is to follow and has the ability to elevate core temperature of the body (Fletcher & Jones, 2004), subsequently resulting in an increased nerve conduction velocity and enzyme cycling ability, which will further increase energy production (Bishop, 2003). Dynamic stretching is also capable of increasing passive range of motion (Sharman et al, 2006). However, when compared to static stretching, dynamic stretching will result in a greater flexibility (Amiri-Khorasani et al, 2011). In this study, the minority of study participants **(1%)** used dynamic stretching. Of these participants, **100%** did not suffer an injury.

The Chi-square test for independence indicated no significant association between the methods of stretching and injury prevention (n = 100), **p = 0,112**; phi = 0,112.

CHAPTER SIX – CONCLUSION

6.1 CONCLUSION

The aim of this research was to determine the injury patterns occurring in pole sports athletes in Gauteng. This was necessary in order to establish more knowledge on the types of injuries occurring in this sport as well as to determine whether there is a specific need for chiropractic care. Furthermore, this study aimed to identify the individual risk factors that may predispose pole sports athletes to developing musculoskeletal injuries.

Of the 100 study participants, 58 suffered an injury as a direct result of pole sports. This represents a significant portion of the study population which gives merit to the purpose of this study. The majority of the musculoskeletal injuries sustained by the study population occurred within the upper limb (more specifically in the shoulder), however, other regions of the body were also affected by these injuries. The greatest proportion of the musculoskeletal injuries were muscle strains, followed by ligament sprains.

The treatment methods used by the study population were predominately identified as rest, ice and heat, which are all easily accessible treatment options. Chiropractic treatment was ranked as the 5^{th} most commonly used treatment protocol, after physiotherapy. Since chiropractic is the health care profession that specializes in the diagnosis and treatment of musculoskeletal disorders, it is important that the chiropractic profession aims to become more involved with this sport (especially since pole sports is on the path to becoming a potential Olympic sport in the future). This will not only help to further the profession and its professional reaches but will also provide comprehensive and cost-effective care to pole sports athletes with musculoskeletal injuries.

The individual risk factors for musculoskeletal injury were identified in the literature review as: age, weight, skill level, frequency of training and duration of training. After analysis of the data, the results for the study population were as follows:

- Participants' age and weight did not reveal any statistical relevance when compared to injury occurrence.
- The largest proportion of musculoskeletal injuries occurred in the beginner skill level category.
- Training for 3 days or more per week resulted in an increase in injury occurrence, whereas training for 2 days a week or less resulted in a decrease in injury occurrence.
- Training for 1 hour or more per day resulted in an increase in injury occurrence, whereas training for 45 minutes or less per day resulted in a decrease in injury occurrence.

In addition to the risk factors listed above, other risk factors were identified during the course of the data analysis. The 3 most common pole sports elements to result in an injury within the study population were: strength positions, flexibility positions and inverts. Furthermore, a statistically relevant ($p = \leq 0{,}05$) association was found between the number of years of participation in pole sports and injury occurrence.

The association between warm-up and stretching and the prevention of musculoskeletal injuries was also investigated during this study. Warm-up protocols do not appear to have had an effect on injury prevention when they are performed, however, all of the participants that did not warm-up suffered an injury. With respect to stretching, the majority of the study population performed a combination of static and dynamic stretching. Few performed static stretching and only 1 person performed dynamic stretching. Again, no statistical relevance was identified when the method of stretching used was compared to injury occurrence.

6.2 LIMITATIONS

To the researcher's knowledge, only one other study has been conducted on pole sports injuries. This study by Mitrousias et al (2017) took place at a provincial hospital in Greece where the emergency department records were analyzed. Thus, the settings for these two studies were vastly different and this showed when the data was compared. Furthermore, the limited research available on pole sports required it to be compared to artistic gymnastics for the purposes of the literature review. While this served its purpose, it is far from ideal.

6.3 RECOMMENDATIONS

The following recommendations are made with regard to future research:

- A study completed on the same research problem but in a different region (province or country) so that comparisons and further conclusions can be made between the data collected by each study.
- A study that combines the individual risk factors identified in this study in order to determine if collectively they are statistically relevant predictors for musculoskeletal injury.
- A study that provides more specific detail on the injuries occurring within each joint and not simply the types of injuries occurring overall in order to further understand the potential of integrating chiropractic care into this sport.
- A study to compare the injuries occurring within each skill level category, wherein the number of participants per category is equal, in order to determine the specific injuries associated with that particular category.

REFERENCES

Amiri-Khorasani, M., Abu Osman, N. & Yusof, A. (2011). Acute effect of static and dynamic stretching on hip dynamic range of motion during instep kicking. *Journal of Strength and Conditioning Research*, 25: 1647-1652.

Battista, C. (2019). Hip Anatomy - Recon - Orthobullets. [online] Orthobullets.com. Available from: https://www.orthobullets.com/recon/12769/hip-anatomy.

Behm, D., Bambury, A., Cahill, F. & Power, K. (2004). Effect of Acute Static Stretching on Force, Balance, Reaction Time, and Movement Time. *Medicine & Science in Sports & Exercise*, 36(8): 1397-1402.

Behm, D., Blazevich, A., Kay, A. & McHugh, M. (2016). Acute effects of muscle stretching on physical performance, range of motion, and injury incidence in healthy active individuals: a systematic review. *Applied Physiology, Nutrition, and Metabolism*, 41(1): 1-11.

Beiner, J. and Jokl, P. (2002). Muscle Contusion Injury and Myositis Ossificans Traumatica. *Clinical Orthopaedics and Related Research*, 403: 110-119.

Bishop, D. (2003). Warm Up I. *Sports Medicine*, 33(6): 439-454.

Bishop, D. (2003). Warm Up II: Performance changes following active warm-up and how to structure the warm-up. *Sports Medicine*, 33(7): 483-498.

Brunner-Ziegler, S., Strasser, B. & Haber, P. (2011). Comparison of Metabolic and Biomechanic Responses to Active vs. Passive Warm-up Procedures before Physical Exercise. *Journal of Strength and Conditioning Research*, 25(4): 909-914.

Burtt, J. (2010). Mallakhamb. *The International Journal of the Arts in Society: Annual Review*, 5(3): 29-38.

Coates, K. (2018). History of Pole Sports and the IPSF. [online] Polesports.org. Available from: http://www.polesports.org/about-us/history-of-pole-sports/

Chiropractic Association of South Africa. (2019). *Conditions & Treatment – Chiropractic Association of South Africa.* Available from: https://www.chiropractic.co.za/conditions-treatment/

Chomiak, J., Junge, A., Peterson, L. & Dvorak, J. (2000). Severe Injuries in Football Players. *The American Journal of Sports Medicine*, 28(5_suppl): 58-68.

Cronin, J., Nash, M. & Whatman, C. (2008). The acute effects of hamstring stretching and vibration on dynamic knee joint range of motion and jump performance. *Physiotherapists in Sports Medicine*, 9(2): 89-96.

Dahm, D. L. (2001). The shoulder and upper extremities. In N. Swedan (Ed.), *Women's sports medicine and rehabilitation* (pp. 7–17). Philadelphia, PA: Lippincott Williams & Wilkins.

Dalton, B., Jakobi, J., Allman, B. & Rice, C. (2010). Differential age-related changes in motor unit properties between elbow flexors and extensorrs. *Acta Physiologica*. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1748-1716.2010.02100.x

Desai, MJ., Saini, V. & Saini, W. (2013). Myofascial Pain Syndrome: A Treatment Review. *Pain and Therapy,* 2(1):21-36.

DiFiori, J., Benjamin, H., Brenner, J., Gregory, A., Jayanthi, N., Landry, G. & Luke, A. (2014). Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. *British Journal of Sports Medicine*, 48(4):287-288.

Dommerholt, J., del Moral, OM. & Grobli, C. (2006). Trigger Point Dry Needling. *The Journal of Manual & Manilpulative Therapy*, 14(4): 70-87.

Ebben, W., Carroll, R. & Simenz, C. (2004). Strength and Conditioning Practices of National Hockey League Strength and Conditioning Coaches. *The Journal of Strength and Conditioning Research*, 18(4): 889-897.

Evans, R., Knight, K., Draper, D. & Parcell, A. (2002). Effects of warm-up before eccentric exercise on indirect markers of muscle damage. *Medicine & Science in Sports & Exercise*, 34(12): 1892-1899.

Fajrin, L. (2016). Articulations - Anatomy. [online] Anatomy Labelled - Human Anatomy. Available from: https://humananatomylibrary.co/photos/95634/articulations-they-reduce-friction-between-bone-tendons-ligaments-and-soft-tissue-synovial-tendon-sheaths-surround-tendons-that-move-across-bony-surfaces.asp.

Fédération Internationale De Gymnastique. (2016). "Code of Points". Available from: http://www.fig-gymnastics.com/publicdir/rules/files/en_WAG%20CoP%202017-2020.pdf

Fletcher, I. (2010). The effect of different dynamic stretch velocities on jump performance. *European Journal of Applied Physiology*, 109(3): 491-498.

Fletcher, I. & Jones, B. (2004). The Effect of Different Warm-Up Stretch Protocols on 20 Meter Sprint Performance in Trained Rugby Union Players. *The Journal of Strength and Conditioning Research*, 18(4): 885-888.

Fradkin, A., Cameron, P. & Gabbe, B. (2007). Is there an association between self-reported warm-up behaviour and golf related injury in female golfers?. *Journal of Science and Medicine in Sport*, 1(10): 66-71.

Fradkin, A., Zazryn, T. & Smoliga, J. (2010). Effects of Warming-up on Physical Performance: A Systematic Review With Meta-analysis. *Journal of Strength and Conditioning Research*, 3(24): 140-148.

Gatterman, M. (2005). *Foundations of Chiropractic website*. 2nd ed. London: Elsevier Health Sciences, p.95.

Grana, W. (2001). Medial epicondylitis and cubital tunnel syndrome in the throwing athlete. *Clinics in Sport Medicine*, 20: 541–548.

Green, B. & Pizzari, T. (2017). Calf muscle strain injuries in sport: a systematic review of risk factors for injury. *British Journal of Sports Medicine*, 51(16): 1189-1194.

Hadala, M. & Barrios, C. (2009). Different strategies for sports injury prevention in an America's Cup yachting crew. *Medicine & Science in Sports & Exercise*, 41(1): 1587-1596.

Hawker, GA. (2017). The assessment of musculoskeletal pain. *Clinical and Experimental Rheumatology*, 35(5): 8-12.

Hollinshead, T. (2004). *The possible aetiologies for the incidence of rugby injuries among medium-level Gauteng rugby-playing schools* (Master's Thesis). Johannesburg: Technikon Witwatersrand.

Hosea, T., Carey, C. & Harrer, M. (2000). The Gender Issue: Epidemiology of Ankle Injuries in Athletes Who Participate in Basketball. *Clinical Orthopaedics and Related Research*, (372): 45-49.

International Pole Sports Federation. (2016). "Apparatus Norms" . Available from: http://www.polesports.org/about-us/document-policies/

International Pole Sports Federation. (2017). "Code of Points". Available from: http://www.polesports.org/about-us/document-policies/

Kay, A. & Blazevich, A. (2008). Reductions in active plantar flexor moment are significantly correlated with static stretch duration. *European Journal of Sport Science*, 8(1): 41-46.

Kay, A. & Blazevich, A. (2009). Moderate-duration static stretch reduces active and passive plantar flexor moment but not Achilles tendon stiffness or active muscle length. *Journal of Applied Physiology*, 106(4): 1249-1256.

Kay, A. & Blazevich, A. (2012). Effect of Acute Static Stretch on Maximal Muscle Performance. *Medicine & Science in Sports & Exercise*, 44(1): 154-164.

Kemler, E., van de Port, I., Backx, F. & van Dijk, C. (2011). A Systematic Review on the Treatment of Acute Ankle Sprain. *Sports Medicine*, 41(3): 185-197.

Knapik, J., Sharp, M., Canham-Chervak, M., Hauret, K., Patton, J. & Jones, B. (2001). Risk factors for training-related injuries among men and women in basic combat training. *Medicine and Science in Sports and Exercise*, 33(6): 946-954.

Kruse, D. & Lemmen, B. (2009). Spine Injuries in the Sport of Gymnastics. *Wolters Kluwer*, January-February, 8(1): 20-28.

Labbafinejad, Y., Danesh, H. & Imanizade, Z. (2017). Assessment of upper limb musculoskeletal pain and posture in workers of packaging units of pharmaceutical industries. *Medline*, 56(2): 337-344.

Lee, L., Reld, D., Cadwell, J. & Palmer, P. (2017). Injury incidence, dance exposure and the use of the movement competency screen (mcs) to identify variables associated with injury in full-time pre-professional dancers. *The International Journal of Sports Physical Therapy*, 12(3): 352-361.

Lemoyne, J., Poulin, C., Richer, N. & Busssières, A. (2017). Analysing injuries among university-level athletes: prevalence, patterns and risk factors. *The journal of the Canadian Chiropractic Association*. 61(2): 88-95.

Levangie, P. & Norkin, K. (2005). Joint Structure & Function – A Comprehensive Analysis. F. A. Davis Company, 4th ed, pp. 135-311.

Magnusson, P. & Renström, P. (2006). The European College of Sports Sciences Position statement: The role of stretching exercises in sports. *European Journal of Sport Science*, 6(2): 87-91.

Malliaropolous, N., Ntessalen, M., Papacostas, E., Longo, U. & Maffulli, N. (2009). Reinjury after acute lateral ankle sprains in elite track and field athletes. *The American Journal of Sports Medicine,* 37(9): 1755-1761.

Martini, F., Nath, J. & Bartholomew, E. (2014). Fundamentals of anatomy & physiology. 9th ed. Harlow: Pearson, pp.227-316.

McHugh, M. & Cosgrave, C. (2010). To stretch or not to stretch: the role of stretching in injury prevention and performance. *Scandinavian Journal of Medicine & Science in Sports*, 20(1): 169-181.

Mitchell, W., Williams, J., Atherton, P., Larvin, M., Lund, J. & Narici, M. (2012). Sarcopenia, Dynapenia, and the Impact of Advancing Age on Human Skeletal Muscle Size and Strength; a Quantitative Review. *Frontiers in Physiology*, 3: 1-14.

Mitrousias, V., Halatsis, G. & Bampis, I. (2017). Epidemiology of injuries in pole sports: Emerging challenges in a new trend. *British Journal of Sports Medicine*. 51: 363.

Moore, K., Dalley, A. & Agur, A. (2014). Clinically oriented anatomy. 7th ed. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins Health, pp. 440-739.

Mtshali, P.T.S. (2007). *Common Lower Extremity Injuries in Female High School Soccer Players in Johannesburg East District* (Masters Thesis). Johannesburg: University of the Witwatersrand.

Murphy, D., Connolly, D. & Beynnon, B. (2003). Risk factors for lower extremity injury: a review of the literature. *British Journal of Sports Medicine*, 37(1): 13-29.

Netter, F. H. (2011). Atlas of Human Anatomy. 5th ed. Philadelphia: Elsevier Saunders, pp. 475.

Paradisis, G., Pappas, P., Theodorou, A., Zacharogiannis, E., Skordilis, E. & Smirniotou, A. (2014). Effects of static and dynamic stretching on sprint and jump performance in boys and girls. *Journal of Strength and Conditioning Research*, 28(1): 154-160.

Peterson, L., Junge, A., Chomiak, J., Graf-Baumann, T. & Dvorak, J. (2000). Incidence of Football Injuries and Complaints in Different Age Groups and Skill-Level Groups. *The American Journal of Sports Medicine*, 28(5_suppl): 51-57.

Qu, Y., Liu, P. & Li, G. (2000). Comparison of elbow angles in gymnasts with and without chronic elbow pain in horse vault routines. *Paper presented at the XVIII International Symposium of Biomechanics in Sports*. Hong Kong, China.

Quifeng, F. & Xining, L. (2003). A primer of Chinese Acrobatics. *Foreign Language Press.*

Sharman, M., Cresswell, A. & Riek, S. (2006). Proprioceptive Neuromuscular Facilitation Stretching: mechanisms and clinical implications. *Sports Medicine*, 36(11): 929-939.

Somerville, S. (2016). *A Survey on Paediatric Care by Chiropractors in South Africa* (Master's thesis). Johannesburg: University of Johannesburg.

Swenson, D., Yard, E., Collins, C., Fields, S. & Comstock, R. (2010). Epidemiology of US High School Sports-Related Fractures, 2005-2009. *Clinical Journal of Sport Medicine*, 20(4): 293-299.

Thompson, W., Gordon, N. & Pescatello, L. (2010). American College of Sports Medicine Resource Manual for Guidelines for Exercise Testing and Prescription. 8th ed. Philadelphia, pp.173.

Webb, B. & Rettig, L. (2008). Gymnastic Wrist Injuries. *Current Sports Medicine Reports*, 7(5): 289-295.

Wolf, M., Avery, D. & Wolf, J. (2017). Upper Extremity Injuries in Gymnasts. *Hand Clinics*, 33(1): 187-197.

Woods, K., Bishop, P. & Jones, E. (2007). Warm-Up and Stretching in the Prevention of Muscular Injury. *Sports Medicine*, 37(12): 1089-1099.

Wörtler, K. (2010). Shoulder injuries in overhead sports. *Der Radiologe*, 50(5): 453-459.

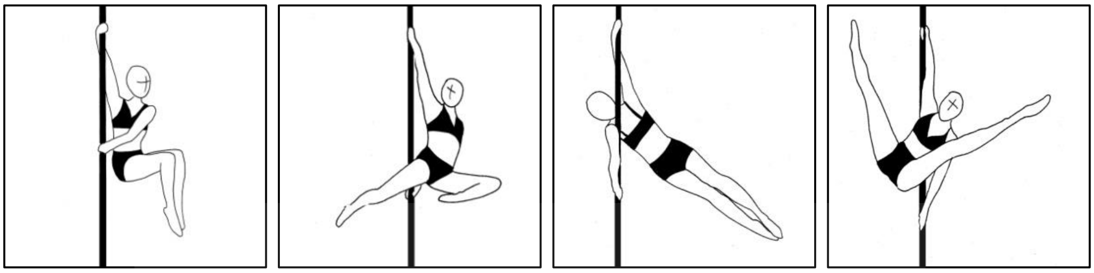
Young, W. (2007). The Use of Static Stretching in Warm-Up for Training and Competition. *International Journal of Sports Physiology and Performance*, 2(2): 212-216.

APPENDIX A

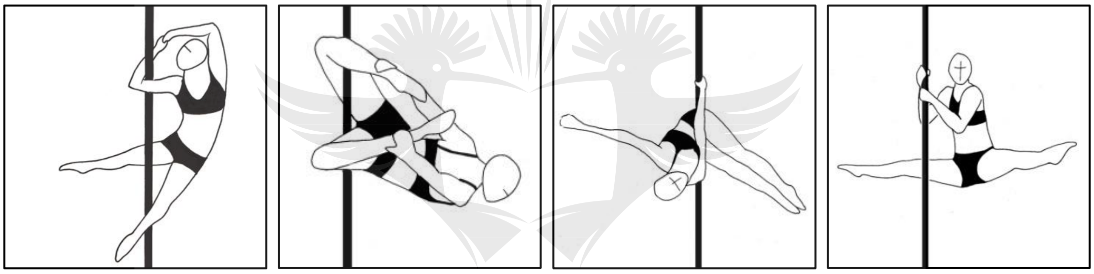
A few examples of the broader categories of elements that may be performed during pole sports training and in pole sports routines:

a) Spins

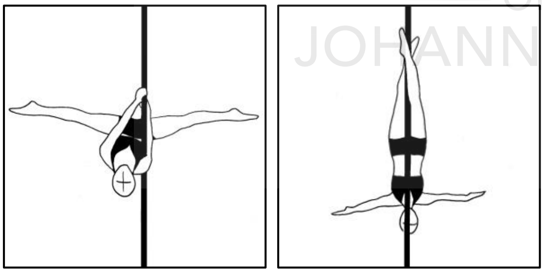
Static pole:



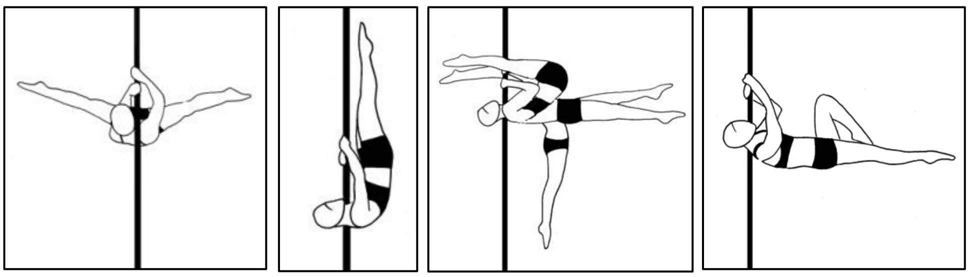
Spinning pole:



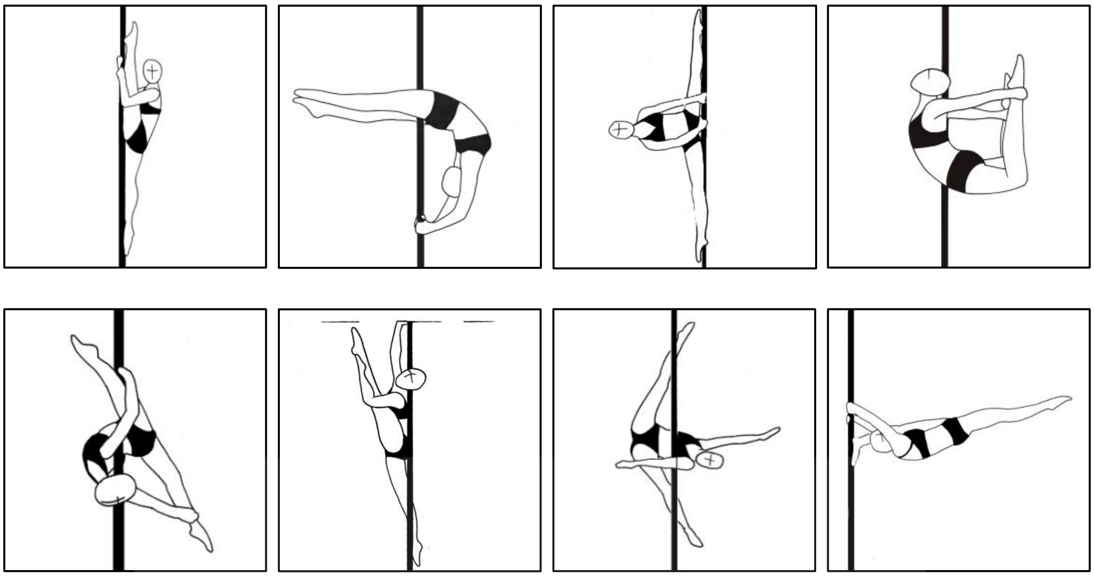
b) Inverts



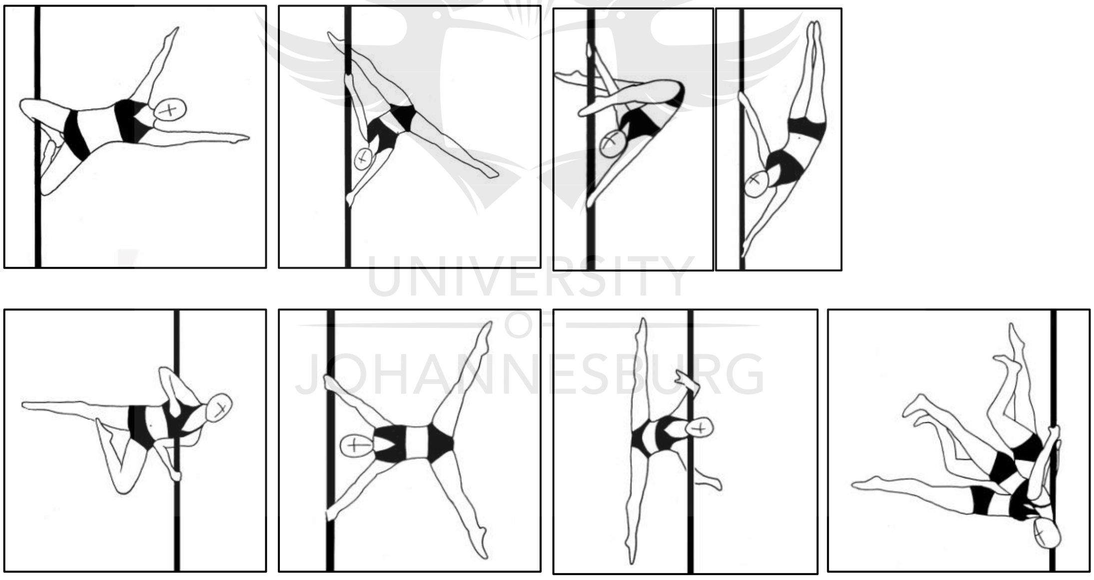
c) Shoulder mounts



d) Flexibility positions

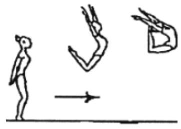
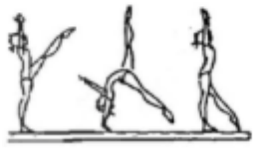
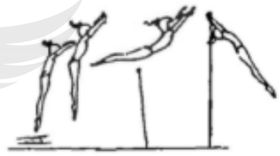
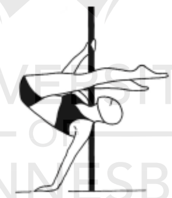
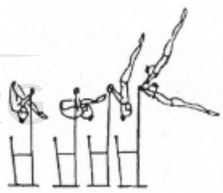
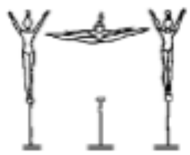
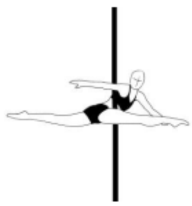


e) Strength positions



APPENDIX B

A table demonstrating a few common similarities between pole sports and gymnastics

Position	Pole Sports		Gymnastics
Hyperextension of the spine	Inside leg hang back split		*Jump with upper back arch and head release with feet almost touching head (Sheep jump)* 
Upper limb weight bearing	Butterfly Split		*Walkover fwd, with support of one arm* 
Arm position above head (upper limb weight bearing)	Cup grip spin pencil		*Free stretch jump over LB with legs together to hang on HB* 
Hyperflexion of the spine (and upper limb weight bearing)	Shoulder stand floor based straddle		*Underswing bwd (inverted pike swing), dislocate (Schleudern) to hang on HB* 
Hyperabduction of the hip joint (with associated hyperflexion of the spine)	Cross bow elbow hold		*Straddle pike jump (both legs above horizontal), or side split jump from cross position* 
Hyperflexion and hyperextension of the hip joints	Chopsticks		*Split jump (leg separation 180°) from cross position* 

APPENDIX C

UNIVERSITY OF JOHANNESBURG

DEPARTMENT OF CHIROPRACTIC

RESEARCH STUDY PERMISSION LETTER

Good Day

My name is Amber Kukard and I would like to request your permission to conduct my research at your pole sports studio.

I am currently completing my Master's Degree in Chiropractic at the University of Johannesburg and have elected to do my thesis on "The Injury Patterns in Pole Sports Athletes in Gauteng".

The data collection for this research topic will be in the form of questionnaires that are completed by pole sports athletes.

I would like to attend your pole sports studio in order to request participation from your studio members and collect my research data. I will arrange dates and times with you in advance so as not to inconvenience you in any way. Participation from members will be on a voluntary basis.

On the arranged day(s), participants will be given an information letter and a consent form to sign and will then be asked to fill in a questionnaire. The questionnaire should not take longer than 10 minutes to complete. Anonymity will be maintained, and participants may withdraw from this research at any time.

I have attached the information letter and consent form, should you wish to view it. My supervisor's details can be found on the information form should you have any queries.

Please complete the permission form attached to indicate that you are willing to allow me to conduct my research at your studio as well as request your members participation in this research.

Kind regards

Researcher:
Amber Kukard
083 447 8599
amberkukard@gmail.com

Date: ________________________________

Name and Surname: ____

Name of pole sports studio:
____

I, ____ hereby grant Amber Kukard permission to attend my studio, on an arranged date and time, in order to obtain the required data from the members of my studio (that are willing to participate) for her research study entitled "The Injury Patterns in Pole Sports Athletes in Gauteng".

_______________________________ ____________________

Signature Date

APPENDIX D

UNIVERSITY OF JOHANNESBURG

Department of Chiropractic

Questionnaire: The Injury Patterns in Pole Sports Athletes in Gauteng

Thank you for taking the time to complete this questionnaire. Please answer the questions honestly and do not falsify any data as it may impact the results of this study. All answers will be kept anonymous throughout the study. If you do not understand a question, please do not hesitate to ask for an explanation.

Please mark applicable answers with a 'X'

Section A: Demographic

1. What is your gender?

Female	
Male	

2. What is your age in years?

3. What is your height in centimetres?

4. What is your weight in kilograms?

5. How would you describe your body type?

Ectomorph (Slim)	
Endomorph (Curvy)	
Mesomorph (Muscular)	

Section B: Pole Sports Training

6. For how many years have you been participating in pole sports?

7. On average, how frequently do you participate in pole sports training per week?

1 day per week	
2 days per week	
3 days per week	
4 days per week	
5 days per week	
6 days per week	
7 days per week	

8. Which pole sports skill level do you belong to?

Beginner	
Intermediate	
Advanced	

9. How would you classify your overall fitness in pole sports?

Not fit at all	
Below average	
Average	
Above average	
Very fit	

10. How would you classify your overall strength in pole sports?

Not strong at all	
Below average	
Average	
Above average	
Very strong	

11. Which side is your most dominant side?

Right side	
Left side	

12. What type of shoes do you wear during pole sports training?

None – bare foot	
Soft modern shoes	
High Heels	

13. During pole sports training, do you partake in any of the following? Please mark all applicable and indicate the number of days per week dedicated to this activity.

TYPE	X	FREQUENCY PER WEEK
Flexibility training		
Strength training		

14. On average, how long is the duration of your pole sports training each day?

Less than 30 minutes	
30 minutes	
45 minutes	
1 hour	
1,5 hours	
2 hours	
More than 2 hours	

15. Do you warm-up before a pole sports session?

Yes	
No	

16. Do you stretch at any point during a pole sports session?

Yes	
No	

If yes, when do you stretch? Please mark all applicable answers.

Before warm-up	
After warm-up	
Before cool down	
After cool down	

17. Which method of stretching do you use?

Static	
Dynamic	
Both static and dynamic	

18. Did you participate in any dancing lessons prior to beginning pole sports?

Yes	
No	

19. Did you participate in any acrobatic training (ie gymnastics) prior to beginning pole sports?

Yes	
No	

20. Do you currently participate in other forms of exercise / sport or dancing?

Yes	
No	

21. If yes, please mark all the applicable activities in the table below. Please also indicate the average number of times that you participate in this form of exercise per week.

SPORT	X	DAYS PER WEEK
Weight lifting		
Gym		
Running		
Walking		
Yoga		
Pilates		
CrossFit		
Boxing		
Soccer		
Netball		
Hockey		
Tennis		
Ballroom dancing		
Ballet		
Modern / Contemporary dancing		
Gymnastics		
Aerial silks		
Lyra		
Other *Please specify:*		

Section C: Injuries

22. Have you suffered any injuries as a direct result of pole sports?

Yes	
No	

If you answered "Yes" to question 22, please complete the section below. If you answered "No" to question 22, the rest of this section may be left blank.

23. What was your skill level at the time of the injury?

Beginner	
Intermediate	
Advanced	

24. Which areas of your body were affected by the injury? More than one answer may be selected to indicate multiple injuries / sites of injury. Please indicate the number of times that the area has been injured.

AREA	X	NUMBER OF TIMES
Head		
Neck		
Upper spine		
Lower Spine		
Ribs / Chest		
Hand		
Wrist		
Elbow		
Shoulder		
Foot		
Ankle		
Knee		
Hip		
Muscular *Please specify:*		
Other *Please specify:*		

25. What type of injury was it? More than one answer may be selected if multiple injuries occurred.

AREA	FRACTURE	SPRAIN (LIGAMENTS)	STRAIN (MUSCLES AND TENDONS)	CONTUSION (SEVERE BRUISE)	CONCUSSION	Other
Head						
Neck						
Upper spine						
Lower Spine						
Ribs / Chest						
Hand						
Wrist						
Elbow						
Shoulder						
Foot						
Ankle						
Knee						
Hip						
Muscular *Please specify:*						
Other *Please specify:*						

For the remainder of this section, please answer the questions *with respect to the single worst injury* you incurred by participating in pole sports, i.e. The injury that most negatively affected you.

26. Based on the table above (question 25), please select the injury that you feel was the most severe / the injury that most negatively affected you and write it in the space provided below: (*For example: Area of the body: Wrist, Type of injury: Sprain)*

Area of the body:________________________

Type of injury: _________________________

27. Which activity were you performing when you sustained your most significant injury?

Spin	
Climb	
Invert	
Shoulder mount	
Mounting the pole	
Dismounting the pole	
Flexibility position	
Strength position	
Other *Please specify:*	

28. Which setting was the pole on?

Static configuration	
Spinning configuration	

29. Where did the injury occur?

At the pole sports studio where you train	
At another pole sports studio you were visiting i.e. at a workshop	
At a competition	
At a private location i.e. at home, at a party etc.	

30. Was a qualified instructor present when you were injured?

Yes	
No	

31. How long did it take you to recover from the injury?

0-1 week	
1-3 weeks	
3-6 weeks	
More than 6 weeks	

32. What treatment approach did you use for your injury? Please mark all applicable answers.

No treatment	
Ice	
Heat	
Rest	
Medication	
Physiotherapy	
General Practitioner	
Chiropractic	
Emergency Department	
Surgery	
Occupational Therapy	
Other (*Please specify*)	

Thank you for participating in this survey.

APPENDIX E

DEPARTMENT OF CHIROPRACTIC
RESEARCH STUDY INFORMATION LETTER

20 February 2019

Good Day

My name is Amber Kukard **I WOULD LIKE TO INVITE YOU TO PARTICIPATE** in a research study on "The injury patterns in pole sports athletes in Gauteng".

Before you decide on whether to participate, I would like to explain to you why the research is being done and what it will involve for you. **I will go through the information letter with you and answer any questions you have.** This should take about 10 to 20 minutes. The study is part of a research project being completed as a requirement for a Masters Degree in Chiropractic through the University of Johannesburg.

THE PURPOSE OF THIS STUDY is to determine the prevalence of injuries occurring in pole sports athletes and analyse the potential risk factors involved in developing these injuries.

Below, I have compiled a set of questions and answers that I believe will assist you in understanding the relevant details of participation in this research study. Please read through these. If you have any further questions I will be happy to answer them for you.

DO I HAVE TO TAKE PART? No, you don't have to. It is up to you to decide to participate in the study. I will describe the study and go through this information sheet. If you agree to take part, I will then ask you to sign a consent form.

WHAT EXACTLY WILL I BE EXPECTED TO DO IF I AGREE TO PARTICIPATE? You will be required to complete a written questionnaire related to the topic of this study. The questionnaire will take approximately 10 minutes to complete.

WHAT WILL HAPPEN IF I WANT TO WITHDRAW FROM THE STUDY? If you decide to participate, you are free to withdraw your consent at any time without giving a reason and without any consequences. If you wish to withdraw your consent, you should inform me as soon as possible. However, once the questionnaire has been submitted, withdrawal of consent is not possible due to the anonymous nature of the research.

IF I CHOOSE TO PARTICIPATE, WILL THERE BE ANY EXPENSES FOR ME, OR PAYMENT DUE TO ME: You will not be paid to participate in this study and you will bear no expenses.

RISKS INVOLVED IN PARTICIPATION: There are no anticipated risks.

BENEFITS INVOLVED IN PARTICIPATION: There are no direct benefits to participating in this study.

WILL MY PARTICIPATION IN THIS STUDY BE KEPT CONFIDENTIAL? Yes. Your name will not appear on the questionnaire. Consent forms will also be kept confidential to protect your identity as a participant in this study. All data and back-ups thereof will be kept in password protected folders and/or locked away as applicable. Only I or my research supervisor will be authorised to use and/or disclose your anonymised information in connection with this research study. Any other person wishing to work with your anonymised information as part of the research process (e.g. an independent data coder) will be required to sign a confidentiality agreement before being allowed to do so.

WHAT WILL HAPPEN TO THE RESULTS OF THE RESEARCH STUDY? The results will be written into a research report that will be assessed. In some cases, results may also be published in a scientific journal. In either case, you will not be identifiable in any documents, reports or publications. You will be given access to the study results if you would like to see them, by contacting me.

WHO IS ORGANISING AND FUNDING THE STUDY? The study is being organised by me, under the guidance of my research supervisor at the Department of Chiropractic in the University of Johannesburg. This study has not received any funding.

WHO HAS REVIEWED AND APPROVED THIS STUDY? Before this study was allowed to start, it was reviewed in order to protect your interests. This review was done first by the Department of Chiropractic, and then secondly by the Faculty of Health Sciences Research Ethics Committee at the University of Johannesburg. In both cases, the study was approved.

WHAT IF THERE IS A PROBLEM? If you have any concerns or complaints about this research study, its procedures or risks and benefits, you should ask me. You should contact me at any time if you feel you have any concerns about being a part of this study. My contact details are:

Amber Kukard
0834478599
amberkukard@gmail.com

You may also contact my research supervisor:
Dr DM Landman (Doctor of Chiropractic)
dirkiel@uj.ac.za

Or my research co-supervisor:
Dr F Ismail (Doctor of Chiropractic)
fismail@uj.ac.za

If you feel that any questions or complaints regarding your participation in this study have not been dealt with adequately, you may contact the Chairperson of the Faculty of Health Sciences Research Ethics Committee at the University of Johannesburg:

Prof. Christopher Stein
Tel: 011 559-6564
Email: cstein@uj.ac.za

FURTHER INFORMATION AND CONTACT DETAILS: Should you wish to have more specific information about this research project information, have any questions, concerns or complaints about this research study, its procedures, risks and benefits, you should communicate with me using any of the contact details given above.

Researcher:

Amber Kukard

APPENDIX F

UNIVERSITY OF JOHANNESBURG

DEPARTMENT OF CHIROPRACTIC

RESEARCH CONSENT FORM

"The injury patterns in pole sports athletes in Gauteng"

Please initial each box below:

☐ I confirm that I have read and understand the information letter dated 20 February 2019 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

☐ I understand that my participation is voluntary and that I am free to withdraw from this study at any time without giving any reason and without any consequences to me.

☐ I agree to take part in the above study.

______________________	___________________________	_______________
Name of Participant	Signature of Participant	Date

______________________	___________________________	_______________
Name of Researcher	Signature of Researcher	Date

APPENDIX G

FACULTY OF HEALTH SCIENCES
RESEARCH ETHICS COMMITTEE

NHREC Registration: REC 241112-035

ETHICAL CLEARANCE LETTER
(RECX 2.0)

Student/Researcher Name	Kukard, A	Student Number	201474658
Supervisor Name	Dr DM Landman	Co-Supervisor Name	Dr F Ismail
Department	Chiropractic		
Qualification	387		
Research Title	The Injury Patterns in Pole Sports Athletes in Gauteng		
Date	31 January 2019	Clearance Number	REC-01-185-2018

Approval of the research proposal with details given above is granted, subject to any conditions under 1 below, and is valid until 31 January 2020.

1. Conditions:
None.

2. Renewal:
It is required that this ethical clearance is renewed annually, within two weeks of the date indicated above. Renewal must be done using the Ethical Clearance Renewal Form (REC 10.0), to be completed and submitted to the Faculty Administration office. *See Section 12 of the REC Standard Operating Procedures.*

3. Amendments:
Any envisaged amendments to the research proposal that has been granted ethical clearance must be submitted to the REC using the Research Proposal Amendment Application Form (REC 8.0) prior to the research being amended. Amendments to research may only be carried out once a new ethical clearance letter is issued. *See Section 13 of the REC Standard Operating Procedures.*

4. Adverse Events, Deviations or Non-compliance:
Adverse events, research proposal deviations or non-compliance must be reported within the stipulated time-frames using the Adverse Event Reporting Form (REC 9.0). *See Section 14 of the REC Standard Operating Procedures.*

The REC wishes you all the best for your studies.

Yours sincerely,

Prof. Christopher Stein
Chairperson: REC
Tel: 011 559 6564
Email: cstein@uj.ac.za

Secretariat: Ms Raihaanah Pieterse
Tel: 011 559 6073 email: rpieterse@uj.ac.za

APPENDIX H

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	A KUKARD
Assignment title:	Submit proposals, theses, dissertati…
Submission title:	THE INJURY PATTERNS IN POLE S.
File name:	THE_INJURY_PATTERNS_IN_POL…
File size:	37.48M
Page count:	65
Word count:	15,798
Character count:	84,974
Submission date:	03-Sep-2019 06:47PM (UTC+0200)
Submission ID:	1164788533

THE INJURY PATTERNS IN POLE SPORTS ATHLETES IN GAUTENG

ORIGINALITY REPORT

17%	9%	7%	15%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of the Western Cape Student Paper	1%
2	Submitted to University of Johannsburg Student Paper	1%
3	healtheappointments.com Internet Source	1%
4	Submitted to University of Southern Queensland Student Paper	1%
5	Submitted to Rasmussen College Student Paper	1%
6	wvuscholar.wvu.edu:8881 Internet Source	1%
7	Submitted to Thames Valley University Student Paper	<1%
8	Submitted to Athlone Institute of Technology Student Paper	<1%