The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sports athletes in eThekwini municipality

By

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This work is submitted in partial compliance with the requirements for the Master's Degree in Health Sciences: Chiropractic at the Durban University of Technology

I, Kim Worth, declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary).

13/03/2024

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DEDICATION

I would like to dedicate this dissertation to my parents. Mom and Dad, despite all the challenges that have been thrown at you, your strength and resilience has been something I have always admired. Thank you for instilling those characteristics in me and for being my brightest light even in the darkest times.

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ABSTRACT

Background: Pole sport has gained popularity worldwide, especially in South Africa. Due to the nature of the sport, there is growing evidence of unique musculoskeletal injuries that accompany the sport. Despite this, there is little information regarding the specific musculoskeletal injuries that occur in pole sport athletes and, thus, the sport has been compared to gymnastics and circus arts which include certain similarities. Research in pole sports specifically is essential in order to assist healthcare professionals to manage the injuries specific to the sport appropriately.

Aim: The aim of this study was to determine the prevalence, selected risk factors and types of injuries that amateur pole sport athletes experience, as well as the impact of the musculoskeletal injuries and the level of care used.

Methodology: A quantitative, descriptive, cross-sectional method was utilised with the distribution of online questionnaires to five pole studios in the eThekwini municipality, KwaZulu-Natal, South Africa. The questionnaire consisted of the following sections: demographics; training history; risk factors; musculoskeletal injuries; consequence of injury on sport and performance, quality of life and the management approaches and impact thereof. The data was analysed using the IBM SPSS version 28.

Results: A total of 59 female participants over the age of 18 years old were included in this study. A high prevalence of musculoskeletal injury was found, with a lifetime prevalence of 49.2% (n=29), and period prevalence over 12 months of 40.7% (n=24). The majority of injuries were found to affect the upper limb but injuries to the spine and lower limb were still common. The most commonly reported location of injuries was the shoulder (64.3%, n=18), followed by the hand and wrist (46.4%, n=13), and then the neck (35.7%, n=10) and thoracic back (35.6%, n=10). The most common type of injury was a strain type injury (48.1%, n=14), followed by contusions (11.1%, n=3). Significant risk factors included high skill level (p value of 0.005), increased strength (p value of 0.010), performing warm-ups for longer than 10 minutes (p value of 0.053) and performing static stretching cool-downs (p value of 0.005). The impact of pole sport injuries on the participants' pole performance demonstrated that despite the athletes' recovery from injury taking more than six weeks, the majority of the athletes either stopped pole sport and other activities for one week or less or did not stop the activities at all. The impact of pole sports injuries on the participants' quality of life was significant, especially affecting their ability to perform daily activities, decreasing their ability to sleep and decreasing their mood as a result of injury. Various management approaches, including self-medication, home remedies and complementary healthcare were utilised by participants. Self-medication and home remedies were found to be utilised more commonly compared to seeking help from healthcare professionals.

Conclusion: This study demonstrated that musculoskeletal injuries are largely present in pole sport athletes for which various management approaches were utilised. The injuries impacted multiple aspects of the participants' lives. The uniqueness of this sport provides an interesting platform for new research, especially with regard to musculoskeletal injuries, as shown in this study.

Key words: pole sport, pole sport athletes, risk factors, prevalence, musculoskeletal injury, impact of injury, quality of life, healthcare professionals

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ABBREVIATIONS

CAM	Complementary and alternative medicine
BMI	Body mass index
MSK	Musculoskeletal
MSKI	Musculoskeletal injury
kg	Kilogramme
cm	Centimetre
SPSS	Statistical Package for the Social Science
GP	General practitioner
n	Number
SD	Standard deviation
%	Percentage
OR	Odds ratio
CI	Confidence interval

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Sport is defined as an activity that involves physical exertion or skill in order to achieve a result, which is often competitive (Eime *et al.* 2013). Sport was originally a male-dominated entity as men were deemed bigger and stronger than women due to their changes during puberty, mainly via the hormone testosterone (Hilton and Lundberg 2021). Although there have been active changes to allow for more female-participation in sports that were previously deemed male-sports, there is still a gender discrepancy in sport due to a larger interest by the public to support men's teams and, therefore, increase the amount of money invested into men's sports (Winslow 2021). Sports such as artistic gymnastics, circus arts and pole dancing have allowed for the female advantage of increased flexibility (Yu *et al.* 2022) which is an essential component to succeed in these sports and increases the number of female athletes in these sports.

Pole dancing was originally an exotic activity used by dancers but has been picked up by amateur athletes as a form of exercise (Donaghue, Kurz and Whitehead 2011). "Pole sport" is defined as a form of acrobatics combined with aerial stunts (Lee, Lin and Tan 2020). The majority of commentators consider the origin of pole dancing to be in Vancouver, USA, between 1970 and 1980 (Whitehead and Kurz 2009). Katie Coates, the president of the International Pole Sports Federation coined the term pole sports in 2008 to transform the physical activity into an international sport. Pole sports is a physically demanding activity that requires a combination of strength and flexibility (Donaghue, Kurz and Whitehead 2011). Both globally and locally, the sport is predominantly represented by women, with only 2% of South African athletes being men (Kukard 2019). With the increase of these physical demands, there has also been an increase in the musculoskeletal injuries experienced.

Risk factors in sport are essential to determine as they assist in identifying what factors may increase the chance of injury as well as assist in injury prevention strategies (Ruddy *et al.* 2019). Due to the risk factors not being well defined in pole athletes, the sport has been likened to the sport of artistic gymnastics due to the similarities in body positions of athletes from both pole sports and artistic gymnastics (Fédération Internationale De Gymnastique 2020; International Pole and Aerial Sports Federation 2021).

A risk factor that is unique to pole sports would be the biomechanics surrounding pole sports. The biomechanics of pole activity differs from traditional sport in that dancers utilise alternate regions of their bodies for grip, namely their palms, popliteal and cubital fossae and the soles of their feet to withstand frictional forces to optimise poses (Lee, Lin and Tan 2020; Naczk 2020; Kukard 2019). The uniqueness this brings to the activity means that extrinsic factors such as sweat, humidity, temperature and material of the pole play a role in both the performance and subsequent injuries which could be sustained (Lee, Lin and Tan 2020; Kukard 2019).

Determining the prevalence of injuries in sport is a critical tool in order to tailor intervention strategies. The global prevalence of musculoskeletal injuries in pole dancing indicated that the upper limb, specifically the shoulder region, is the most affected (Soini and Laine 2018). Lee, Lin and Tan (2020) reported more recently that while the shoulder was the most commonly affected with a prevalence of 54.5%, injuries to the wrist was also prevalent (34.2%) and injuries to the back region (24.7%). Comparatively, Mitrousias, Halatsis and Bampis (2017) identified the low back and hip as the highest prevalence of injury (29.4%). Ruscello (2013) also proposed that moderate to highly intensive physiological effort is directly correlated with the number of injuries sustained by pole athletes. In South Africa, one study showed that a prevalence of 41.6% of musculoskeletal injuries in pole athletes were from the upper limb region and other injuries included the foot (7.2%), rib or chest (6.4%), low back (5.6%), neck (4.8%), knee (4.8%), ankle (4%), hip (2.4%), head (1.6%) and upper back (1.6%) (Kukard 2019). There is conflicting data regarding prevalence and, therefore, further clarity is needed, particularly in a South African context where studies are limited.

Furthermore, due to the increase in the popularity of pole sports, it is important to identify risk factors and the impact of musculoskeletal injuries in order to create tailored prevention and management strategies for injuries caused by pole sports.

1.2 AIM AND OBJECTIVES OF THE STUDY

1.2.1 Aim

The aim of this study was to determine the prevalence, selected risk factors and types of injuries that amateur pole sport athletes experience and the level of care used.

1.2.2 Objectives

The following objectives were identified:

- To estimate the period and lifetime prevalence of musculoskeletal injuries in pole sport athletes in eThekwini, South Africa.

- To determine the selected risk factors (age, weight, skill level, frequency of training and the duration of training) associated with musculoskeletal injuries in pole sport athletes in eThekwini.
- To assess the impact that pole injuries have on participants' performance and quality of life.
- To determine whether pole sport athletes seek treatment or management for their injuries and the outcome thereof.

1.3 BENEFITS OF THE STUDY

There is currently little information on the injuries and management protocols detailed for this sport globally. Therefore, this study will provide information on the injury profile of pole sport athletes in South Africa, and more specifically in the eThekwini municipality. This will consequently provide necessary education to the pole instructors regarding guidelines and preventative measures to assist with the prevention, reduction and management of injuries for their students. This study will additionally provide healthcare practitioners with information of the prevalence, risk factors, impact of injuries and treatments that have been used to treat such injuries. This study encourages further research to be done to identify effective management of injuries using evidence-based care.

1.4 FLOW OF DISSERTATION

Chapter One is an introduction to the study and provides insight into the background of the study, the aims and objectives and the benefits of the study. This chapter provides brief information on pole sports and justifies the necessity for the study.

Chapter Two provides the review of the current literature obtainable. The topic of musculoskeletal injuries in pole sports will be discussed and analysed. This chapter will also liken pole sports to artistic gymnastics in order to acquire the relevant information needed to assist in an injury profile. The chapter will compare the data acquired from the research topic when the data collection is completed.

Chapter Three describes the methodology of the study including in-depth information about the study procedure. It will provide information about the research design implemented, the research tools used and the methods that were used to gather the data for this study.

Chapter Four describes the results of the study. There will be graphs, tables and charts used to present the data and give a brief description of the data in order to increase understanding and avoid any misinterpretation of the study.

Chapter Five provides a discussion of the results compared to the current literature. The results detailed in Chapter Four will be discussed in comparison to the literature detailed in Chapter Two. The results will also be correlated to the aims and objectives found in Chapter One of the study.

Chapter Six provides a conclusion and the limitations found during the study. Recommendations for further research will also be included.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION TO POLE SPORT

Sport is made up of movements which increase the physical ability, health and overall performance of an athlete, whether amateur or professional (Ermįş, İmamoğlu and Satici 2019). During these sporting activities, athletes are at risk of injury. Injury is defined as a loss of function or structure in the body due to an isolated exposure to physical harm during sports training, competition or other lifestyle activities that is usually diagnosed by a medical professional as an injury following examination (Timpka *et al.* 2014). Healthcare is moving away from invasive care towards a more non-invasive, therapeutic and preventative approach to manage injuries (Pugazhendi *et al.* 2020).

Complementary and alternative medicine (CAM) has become widely used throughout the world (Phutrakool and Pongpirul 2022; Peltzer and Pengpid 2018). This is due to three main reasons which include the expectation perceived to benefit from CAM, discontent with conventional medicine as well as the patient's belief in the safety of using CAM (Tangkiatkumjai, Boardman and Walker 2020). Patients were seen to have a high satisfaction following using CAM (Peltzer and Pengpid 2018) CAM includes chiropractic care.

Chiropractors are practitioners who diagnose, treat and prevent musculoskeletal disorders and the effects these have on the function of the nervous system, musculoskeletal system and general well-being (World Federation of Chiropractic 2001). Chiropractors are popularly used in sport to assist with acute pain, chronic injury and preventative care, and those with a postgraduate qualification known as the International Chiropractic Sport Science Practitioner, have been included in amateur, professional and Olympic level sports (Nelson *et al.* 2021).

Pole sport is a combination of aerobatic, gymnastic and dance elements that are performed on a vertical pole (Cole 2021; Gołuchowska and Humka 2021). Pole sports combines strength, flexibility and cardiovascular training (Cole 2021). The origin of pole sport is ambiguous but seems to have originated in Canadian strip clubs during the 1980s and has since developed into a fitness exercise (Fennell 2018). Pole sport training improves an athlete's fitness and causes strengthening of the spine and muscles, which has led to it becoming a notable sport amongst athletes and fitness enthusiasts (Gołuchowska and Humka 2021).

2.1.1 Popularity

Pole sport has become popular globally, with studios opening across the world including Asia and Africa (Fennell 2018), Europe (Cole 2021), the Americas and Australasia (Nicholas *et al.* 2019). It is unclear as to when pole dancing transformed into being offered as an exercise but it grew rapidly as such since 2010 (Dimler, McFadden and McHugh 2017). Pole sports commonly takes place at private pole studios and the classes held are usually small averaging between 5 and 10 athletes in each class (Jensen and Thing 2022).

2.1.2 Associations/Organisations

Pole sport is one of the most newly recognised sports by the Global Association of International Sports Federation (GAISF) where it achieved observer status in 2017, which makes it possible that pole sport may become an Olympic discipline (Lee, Lin and Tan 2020; Naczk, Kowalewska and Naczk 2020). There are several international associations such as the International Pole Sports Federation and International Pole Dance Fitness Association which host organised international pole sport competitions (Naczk, Kowalewska and Naczk 2020).

2.1.3 Equipment

Pole sport utilises a vertical pole which is standardised by the International Pole Sports Federation at a height of four meters (Lee, Lin and Tan 2020) so athletes may perform different positions and exercises (Ballarin *et al.* 2021). Pole sport athletes utilise their palms, cubital fossa, popliteal fossa and the plantar aspect of their feet to grip the pole by way of friction (Lee, Lin and Tan 2020). As the difficulty level increases, the amount of contact points between the body and the pole decreases (Lee, Lin and Tan 2020). Grip aids, such as body chalk and wax, are often incorporated to enable adhering to the pole more easily (Lee, Lin and Tan 2020).

2.1.4 Athletic Components of Pole Sport

Pole sport is considered a moderate-intensity cardiorespiratory exercise as per the American College of Sports Medicine Guidelines (Ballarin *et al.* 2021; Lee, Lin and Tan, 2020) and may lead to a substantial increase in aerobic capacity and flexibility, resistance and coordination (Naczk, Kowalewska and Naczk 2020). A pole sport class typically includes a warm-up, strengthening exercises, practising the positions of varying difficulty level depending on the participant and finishes with a cool-down (Ballarin *et al.* 2021; Nicholas *et al.* 2019; Fennell 2018).

There are three athletic components to pole sports which are important to discuss. First, strength is used to climb the pole and sustain the body in certain positions (Jensen and

Thing 2022). Second, flexibility is essential as certain pole movements require the body to be flexible, for example backbends and twisted arm grips (Jensen and Thing 2022). The third component are the qualities of grace, poise and effortlessness, which are essential to make the pole athlete's movement's look elegant and beautiful (Jensen and Thing 2022).

Pole sport includes physical risks due to the demands of the pole sport athlete (Fennell 2018). It should be seen as an acrobatic sport that has a potential for serious injury, especially to the musculoskeletal system which are intrinsic in both amateur and professional athletes (Gołuchowska and Humka 2021) rather than being a dance sport (Dittrich *et al.* 2020).

2.1.5 Pole Sport Movements and Positions

There are several categories of pole tricks which demonstrate strength, flexibility and dynamic movements, such as flips and a combination of different movements (Lee, Lin and Tan 2020). Appendix K demonstrates a small variety of these positions showing spins, inverts, shoulder mounts, strength and flexibility movements which are commonly combined into routines. There are a multitude of positions and movements which have a specific definition to allow for them to be scored based on accuracy and execution during the pole performance (Garcia-Falgueras 2022). There are often variations and adaptions for each position or movement to make them more or less challenging and to allow for different levels of athlete to perform (Szopa *et al.* 2022).

2.1.6 Comparison to Artistic Gymnastics

Pole sport is a combination of strength and flexibility which is similar to gymnastics and other circus arts (Lee, Lin and Tan 2020). The differences between circus arts and pole sport include that non-contact mechanisms are the cause of most pole sport injuries whereas direct or indirect contact is the main cause of injury in circus arts (Nicholas *et al.* 2022), and that there are also less acrobatic movements which are performed in a shorter height in pole sports as opposed to circus sports (Nicholas *et al.* 2022). However, there are many similarities, as demonstrated in Appendix L, making it a comparable sport for injury analysis.

2.2 MUSCULOSKELETAL INJURIES

2.2.1 Types of Musculoskeletal Injuries

For the purpose of this study, the musculoskeletal injuries that will be discussed include fractures, contusions, sprains, strains and musculoskeletal pain.

2.2.1.1 Musculoskeletal Pain

Musculoskeletal pain is defined as pain affecting muscles, bones, ligaments, tendons and nerves, which may be acute or chronic; musculoskeletal pain affects over 30% of the general population (El-Tallawy *et al.* 2021; Puntillo *et al.* 2021). Musculoskeletal pain is normally widespread, and clinically described as dull, aching and throbbing pain which often causes referred pain, hyperalgesia and/or allodynia (Ren 2020). Musculoskeletal pain is common in sport and has a negative impact on athletes' health and their performance due to training difficulties from pain (Goes *et al.* 2020). There are often psychological and psychosocial comorbidities in patients with musculoskeletal pain, especially when the pain is chronic in nature and, thus, it is imperative for these to be addressed along with the physical implications (Crofford 2015).

2.2.1.2 Contusions

Contusions are when skeletal muscles are compressed between a bone and an external object which leads to direct and non-penetrated muscle trauma. The clinical presentation can include pain, swelling, decreased function, decreased range of motion, inflammation and oedema. Contusions are common in sport (Barnes *et al*. 2022).

2.2.1.3 Strains

A strain is defined as a distraction injury to a muscle or tendon and is commonly known as a muscle tear (Mueller-Wohlfahrt *et al.* 2012). A tendon is described as a dense connective tissue which joins bone to muscle (Yang, Rothrauff and Tuan 2013). There are multiple grading systems that have been developed throughout the years to describe a muscle strain.

The British Athletic Classification is commonly used to describe the clinical grading of a strain describing a grade 1 to 4 system (Pollock *et al.* 2014). Grade 1 injuries are small muscle tears which often lead to pain during or following activity. There is often pain during contraction of the muscle but strength is usually intact and there is normal range of motion (Pollock *et al.* 2014). Grade 2 muscle tears are described as moderate, leading to pain during activity, that normally leads to the activity being halted. There will be pain during contraction and weakness of the muscle and the range of motion may be limited (Pollock *et al.* 2014). Grade 3 is when there are extensive muscle tears causing a sudden onset of pain. There will be weakness in contraction and strength and range of motion is significantly decreased. There may be pain during walking if the tear occurs in the lower limb (Pollock *et al.* 2014). Grade 4 injuries are complete tears of the muscle or tendon causing sudden onset pain. There will be pain on contraction, but often less pain than grade 3 but there is often a palpable gap in the muscle that can be felt (Pollock *et al.* 2014).

2.2.1.4 Sprains

A sprain is defined as injury to the passive ligaments in the body. A ligament is described as a fibrous connective tissue which connects bone to bone (Yang, Rothrauff and Tuan 2013). Damage to a ligament can lead to hypermobility between the bones where the ligament connects (Hubbard and Wikstrom 2010). Lateral ankle sprains are one of the most common sport injuries, specifically the anterior talofibular ligament, and the calcaneofibular and posterior talofibular ligament (Hubbard and Wikstrom 2010).

2.2.1.5 Fractures

Fractures are defined as a crack or break in the continuity of a bone, caused by a combination of biomechanical forces, which can include compression, sheer or tensile stress (Coleman 2018). Fractures usually occur from trauma but can be spontaneous and clinically present as pain, soft tissue swelling, and decreased movement of the affected limb or deformity (Ralston *et al*. 2018). Fractures comprise up to 10% of sport injuries (Robertson and Wood 2015).

2.2.2 Selected Risk Factors

There are certain risk factors that may be associated with increased prevalence of musculoskeletal injuries. Identifying risk factors for a sport is an essential component as it enables the prediction and, therefore, prevention of injury (Amirshaghaghi, Pournemati and Zandi 2019). The risk factors of age, body composition, skill level, frequency of training and duration of training will be discussed relative to pole sport.

2.2.2.1 Age

The musculoskeletal system consists of multiple types of tissues, such as bone, cartilage, tendons, discs and muscles, and the interaction of these tissues is important for the musculoskeletal system to function. Therefore, alterations in one type of tissue affects all other tissues (Roberts *et al*. 2016). Age is linked to an increased risk for musculoskeletal injury due to the changes in tissue function (Green and Pizzari 2017). These changes include a decline in bone density, a reduction in muscle cell size, an increase in rigidity and inelasticity, and a reduction in skeletal muscle strength (Bajpai, Li and Chen 2022). Additionally, fibrosis of the joint cartilage can occur due to aging, which can cause pain and decreased range of motion which can result in complications such as osteoporosis (Sözen, Özışık and Başaran 2017), muscle degradation (Eby *et al*. 2015), osteoarthritis and a decreased capacity for the musculoskeletal system to adapt (Bajpai, Li and Chen 2022). Age was seen as a risk factor for injury by Nicholas (2019) but, according to Lee, Lin and

Tan (2020) and Soini and Laine (2018), age was not a significant factor in the incidence of pole sport injuries.

2.2.2.2 Weight

Both weight and body mass index (BMI) have been found to be risk factors for musculoskeletal injury (Amirshaghaghi, Pournemati and Zandi 2019).

An abnormal body composition may include extremes in weight, such as largely increased or decreased weight or BMI measurements. An increased body weight is associated with musculoskeletal disorders commonly due to increased mechanical load, which leads to repeated micro-trauma to the tissues. This can lead to acute or chronic tissue damage. If the body composition is abnormal due to decreased fitness and neuromuscular control, the risk of injury also increases (Amirshaghaghi, Pournemati and Zandi 2019; Taanila *et al*. 2015).

Muscle mass contributes to the risk of injuries. An increased muscle mass produces more power, and increases the strength in the limbs. In contrast, a decreased muscle mass may also contribute to injuries (Amirshaghaghi, Pournemati and Zandi 2019; Taanila *et al*. 2015).

In contrast, according to Kukard (2019), weight did not show statistical relevance when it was compared to the occurrence of injury in pole sport.

2.2.2.3 Skill Level

Increased skill level may be due to an increase of the length, frequency and intensity of skill-specific sports' training. This may lead to a lack of basic conditioning and strength training which can increase the risk of overuse injuries (LaBella and Myer 2017).

There are contradictions in the literature regarding skill level in pole sports. Szopa *et al.* (2022) found that lower levels of pole sport experience lead to a slightly increased risk of injuries and those with higher levels of pole sport skills have a lower chance of re-injury occurrence compared to beginner pole sport athletes. Kukard (2019) also found that those in the beginner skill level have the most injuries compared to the higher levels of pole sports. However, Nicholas *et al.* (2022) found that as the skill level of the pole sports athlete increased, so too did the proportion of injuries.

2.2.2.4 Frequency of Training

Despite health benefits from sport training, there is also an increase of musculoskeletal injuries when there is excessive frequency of training, especially when this frequency of training is performed in excess of the individual's capacity of their locomotor system (Gołuchowksa and Humka 2021; Lamoyne *et al*. 2017). Excessive frequency of training is also known as Overtraining syndrome which is when athletes train in a way that puts an excessive amount of strain on their body without having sufficient rest and recovery time resulting in maladaptions and a higher risk of injury (Armstrong *et al*. 2022).

Increased frequency of dance type training has been associated with an increased amount of injuries (Lee *et al.* 2017). The frequency of additional training activities outside of pole-specific training also increased the occurrence of musculoskeletal injuries (Szopa *et al*. 2022).

2.2.2.5 Duration of Training

The duration of training is closely linked to the frequency of training. Many hours of vigorous exercise have a significant correlation to overuse injuries (Lamoyne *et al*. 2017). According to Gabbett (2016), there were negative effects of increased training load in exercises, including the highest incidence of injury when the training load was highest.

Kukard (2019) found that participating in pole sport training for any longer than one hour a day led to a significant increase in the likelihood of an injury developing.

2.2.2.6 Intensity of Training

An increase in intensity of training leads to an increase in injuries when the training prescribed is inappropriate. Non-contact soft tissue injuries may be caused by a rapid increase in training load and intensity (Gabbett 2016). There were no published data on whether the increase in intensity of pole-specific sport training increased the risk of injury.

2.2.3 Prevalence of Injuries in Pole Sport

Nicholas *et al.* (2022) performed a yearlong prospective injury surveillance study where pole sport athletes were followed via self-reports via a daily online training diary. A total of 25 participants completed the study. Of the 103 injuries that occurred, the shoulder accounted for 20.4% of them, with the majority occurring from loaded internal shoulder rotation. The thigh accounted for 11.7% of injuries, mainly from hamstring injuries. The rest of the injuries were accounted for in order of the neck, low back and wrist.

Szopa *et al.* (2022) performed a cross-sectional retrospective survey on pole sport athletes and found that of a total of 276 participants, there were 1050 pole sport-related injuries: 59% of these injuries affected the lower extremity and 39% of the injuries affected the upper extremity, with 10% of the injuries affecting the back. Of these injuries, the most common injured were the muscles and tendons (25%) and then the joints and ligaments making up 23% of the injuries.

Gołuchowska and Humka (2021), found that the shoulder joint had the highest occurrence of injuries among both amateurs and professional pole sport athletes. Amateur pole sport athletes also sustained injuries in the biceps femoris muscle, ankle and wrist joints.

Cole (2021) performed a quantitative online questionnaire looking at the prevalence and magnitude of injuries within pole sports. This study found that 45% of the injuries occurred to the shoulders which meant it was the most frequently injured joint, followed by the wrists (19%).

Lee, Lin and Tan (2020) performed a cross-sectional online survey with 158 total participants in pole sports and reported the shoulder to make up the majority of injuries with 54.5% of the participants reporting a shoulder injury. These injuries were made up of 23.4% strains, 12% rotator cuff injuries, 4.4% impingement, 2.5% biceps tendinitis and 1.9% SLAP (superior labrum from anterior to posterior) injuries. The wrist followed as the next most common injures site affecting 34.2% of the population and back injuries affected 24.7% of participants.

Kurkard (2019) performed a questionnaire-based quantitative study assessing injury patterns in pole sport athletes in Gauteng, South Africa. In the 100 participants, the most commonly injured region of the body was the upper limb (41.6%), with the shoulder being the most commonly injured (15.2%). The wrist accounted for 12% of injuries, the hand accounted for 7.2% of the injuries and the elbow accounted for 7.2% of the injuries. The lower limb accounted for 18.4% of the injuries which was distributed between the foot at 7.2%, the knee at 4% and the hip at 2.4%. The spine and ribs accounted for 13.6% of the total injuries. These injuries were made up of strains accounting for 58%, followed by sprains accounting for 29%, contusions accounting for 7.6%, fractures accounting for 4.2% and concussions accounting for 0.8%.

Mitrousias *et al.* (2017) performed a retrospective, case-series examining the epidemiology of injuries in pole sport athletes who were referred to an emergency hospital and discovered that 29.4% of patients sustained low back injuries, hip strains and contusions; 20.6% of patients sustained wrist sprains; 14.7% sustained ankle sprains; 5.9% sustained cervical spine strains; 5.9% sustained a concussion; 2.9% presented with a disc herniation and 2.9% presented with a fractured fifth metatarsal bone.

As stated previously, there is a limited amount of information published on pole sports and, thus, it has been likened to artistic gymnastics due to their similarities (Appendix L).

2.2.3.1 Upper Limb

The upper limb includes the shoulder joint, elbow joint and wrist joint. It is used as a weight bearing structure in artistic gymnastics which makes it susceptible for injuries (Wolf, Avery and Wolf 2017). In pole sports, the upper limb is also used for weight bearing in order to sustain positions of the body onto the pole, use different parts of the shoulder and elbow joints as points of contact and needing flexibility in this joints to achieve certain positions therefore increasing its susceptibility to injury (Lee, Lin and Tan 2020).

2.2.3.1.1 Shoulder Joint

Anatomy

The shoulder girdle is made up of the clavicle, scapula and the proximal humerus. It attaches the upper limb to the skeleton by means of the sternoclavicular joint (Miniato, Anand and Varacallo 2022).

The shoulder girdle is made up of four joints, including the major articulation being the glenohumeral joint, and the minor articulations including the acromioclavicular, sternoclavicular and scapulothoracic joints (Miniato, Anand and Varacallo 2022).

The glenohumeral joint is a synovial joint which connects the humeral head and the glenoid fossa of the scapula (Miniato, Anand and Varacallo 2022). This joint is a ball-and-socket joint and the humeral head is four times the size of the glenoid fossa which, therefore, allows for expansive movement compared to other joints in the body (Miniato, Anand and Varacallo 2022). The glenoid fossa has a labrum made of fibrocartilaginous material which joins to the glenoid fossa increasing the stability of the glenohumeral joint (Miniato, Anand and Varacallo 2022). There are also bursae surrounding the joint capsule which all increase the mobility of the joint (Miniato, Anand and Varacallo 2022). These include the subacromial bursa, which is found between the deltoid muscle and joint capsule, which minimises the friction underneath the deltoid muscle increasing its range of motion, and the subcoracoid bursa, which is found between the subscapularis and coracoid process and the subscapular bursa, which is found between the subscapularis muscle tendon and capsule, which minimises friction on the subscapularis muscle when the glenohumeral joint moves (Miniato, Anand and Varacallo 2022).

The acromioclavicular joint is a synovial joint which joins the clavicle to the acromion of the scapula (Miniato, Anand and Varacallo 2022). The sternoclavicular joint is a synovial joint which connects the upper limb to the axial skeleton (Miniato, Anand and Varacallo 2022). The scapulothoracic joint is where the scapula articulates with the posterior thoracic cage and is not a true joint (Miniato, Anand and Varacallo 2022).

The coracoacromial arch is made of the coracoid process, acromion and coracoacromial ligament which inhibits a superior humeral head dislocation (Rothenberg 2017).

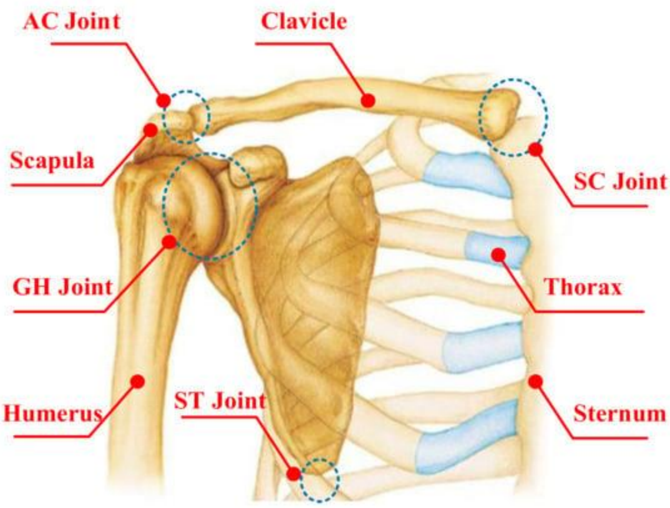

Figure 2.1: Anterior view of the shoulder

(Source: Zhang *et al.* 2020)

Muscles, tendons and ligaments also provide support for the shoulder girdle. The most important muscles in the shoulder girdle are known collectively as the rotator cuff muscles. The rotator cuff is made up of four muscles including the supraspinatus, infraspinatus, subscapularis and teres minor (Vosloo, Keough and De Beer 2016).

Table 2.1: Anatomy of the rotator cuff muscles

Muscle	Proximal Attachment	Distal Attachment	Innervation	Muscle Action
Supraspinatus	Supraspinatus fossa of scapula	Greater tubercle of humerus	Suprascapular nerve (C5, C6)	Abduction of arm; stabilises head of humerus in the glenoid cavity
Infraspinatus	Infraspinatus fossa of scapula	Greater tubercle of humerus	Suprascapular nerve (C5, C6)	External rotation of arm; stabilises head of humerus in the glenoid cavity
Subscapularis	Subscapular fossa of scapula	Lesser tubercle of humerus	Upper and lower subscapular nerves (C5, C6)	Internal rotation of arm; stabilises head of humerus in glenoid cavity
Teres Minor	Axillary border of scapula	Greater tubercle of humerus	Axillary nerve (C5, C6)	External rotation and adduction of arm; stabilises head of humerus in glenoid cavity

(Source: Moore, Dalley and Agur 2017)

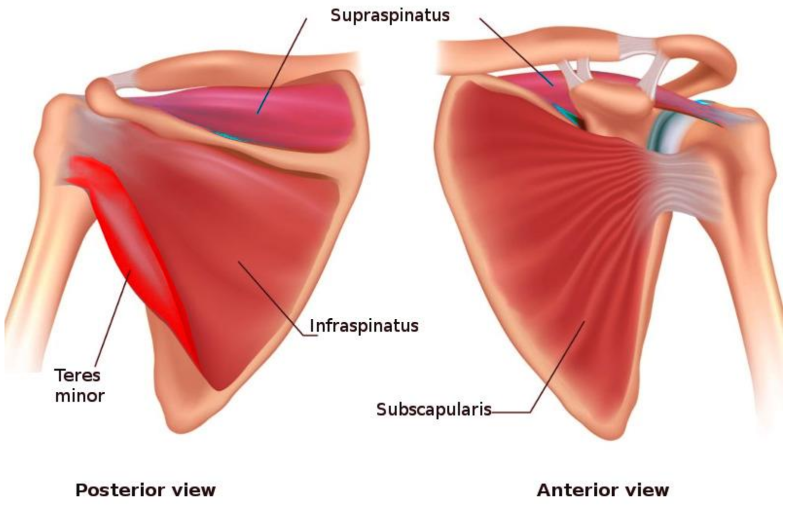

Figure 2.2: Anterior and posterior view of the rotator cuff muscles

(Source: Maruvada, Madazo-Ibarra and Varacallo 2022)

The ligaments are static stabilisers of the shoulder girdle and include glenohumeral ligaments, coracoclavicular ligament and coracohumeral ligament. The glenohumeral ligaments form the joint capsule which joints the humeral head to the glenoid fossa. These ligaments are primary stabilisers of the glenohumeral joint and glenoid fossa and assist the glenohumeral joint from anterior dislocation. The coracoclavicular ligament is made up of the trapezoid and conoid ligaments and joins the coracoid process and the clavicle which functions to keep the clavicle in alignment with the acromioclavicular ligament. The coracohumeral ligament joins the greater and lesser tuberosities of the humerus to the coracoid process (Chang, Anand and Varacallo 2022).

The coracoacromial ligament and acromioclavicular ligaments also make up components of the shoulder girdle. The coracoacromial ligament connects the coracoid process to the acromion which inhibits the dislocation of the humeral head superiorly (Rothenberg 2017). The acromioclavicular ligament connects the acromion to the clavicle and is essential for stability of the acromioclavicular joint (Kiel, Taqi and Kaiser 2022).

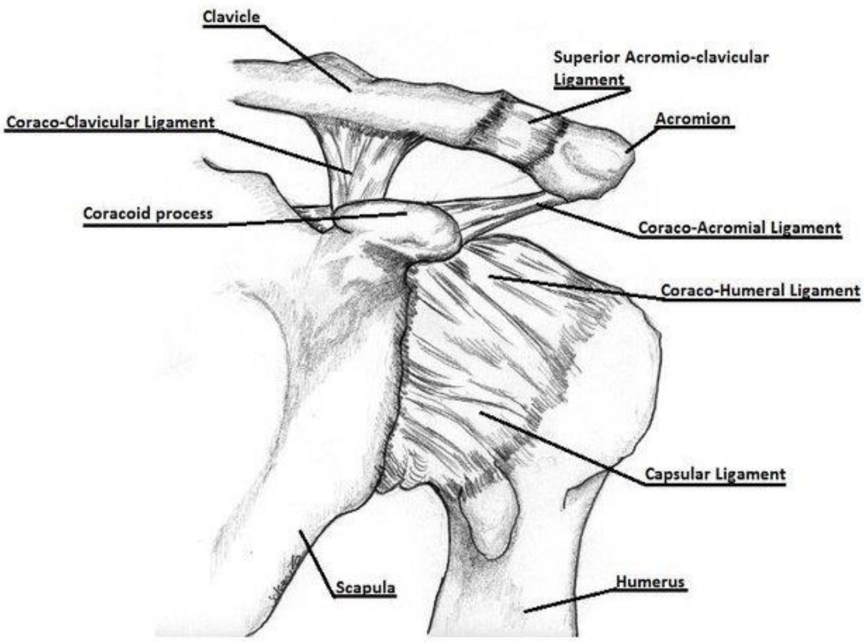

Figure 2.3. Ligaments of the shoulder girdle

(Source: Solomito 2015)

Shoulder Joint Injuries

In pole sports, the upper limb is used to raise and sustain the entire body off the floor for the majority of the pole routine (Kukard 2019). The glenohumeral joint has a large range of motion, including flexion, extension, abduction, adduction, internal rotation and external rotation, but due to its structure, it also has very little stability, thus making it susceptible to injury (Miniato, Anand and Varacallo 2022). The rotator cuff muscles are pertinent to assist with the movements of the glenohumeral joint which means they are highly susceptible to overuse injuries. This is due to the shoulder and musculature being evolved in such a way which is not load bearing. Putting the shoulder joint in positions where the musculotendinous tissues are put under immense strain while in a lengthened position may increase the incidence for soft-tissue injuries (Nicholas *et al.* 2022).

2.2.3.1.2 Elbow Joint

Anatomy

The elbow joint is a synovial joint which is composed of the articulations between the distal humerus and proximal radius and ulna. These form three joints known as the radiaohumeral and ulnohumeral joints, which allow for flexion and extension of the elbow, and the proximal radioulnar joint, which allows for supination and pronation of the wrist. As the elbow joint is a hinge joint, there is limited range of motion (Card and Lowe 2022).

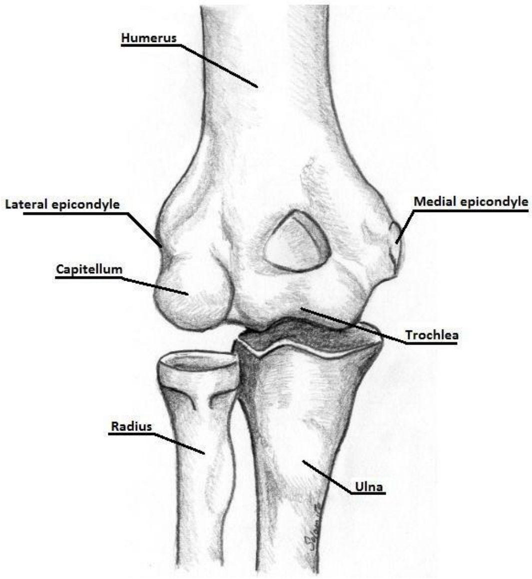

Figure 2.4: Elbow joint

(Source: Solomito 2015)

There are two ligaments which provide stabilisation which include the medial and lateral collateral ligaments. The medial collateral ligament originates from the anteroinferior aspect of the medial epicondyle and connects the ulna to the humerus which assists in an overload in valgus force (Tribst *et al.* 2012). The lateral collateral ligament is made of the radial collateral ligament, the lateral ulnar collateral ligament, the annular ligament and the accessory lateral collateral ligament (Mica, Caekebeke and van Riet 2016). The ligament originates from the lateral epicondyle of the elbow and inserts at the tubercle of the ulna (Islam *et al.* 2020).

The elbow joint is a much more stable joint in comparison to the shoulder joint due to the congruent articulation of the joints, especially between the olecranon of the ulna and the trochlea of the humerus, the anterior bundle of the medial collateral ligament and the lateral collateral ligament (Islam *et al.* 2020).

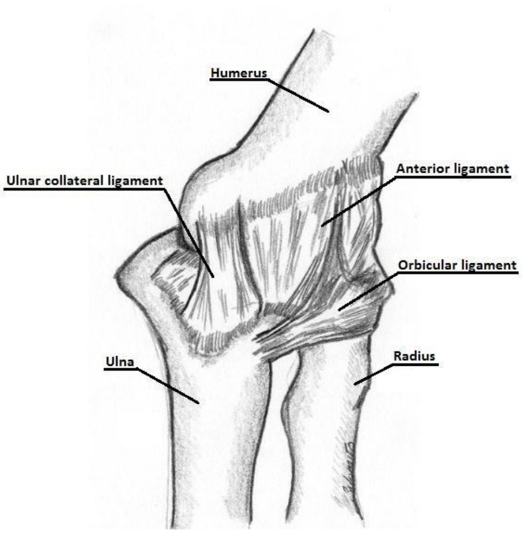

Figure 2.5: Ligaments of the elbow joint

(Source: Solomito 2015)

The elbow joint capsule is another stabiliser of the elbow joint and is made up of a tough fibrous membrane separated from the synovial membrane by fat pads (Aquilina and Grazette 2017).

The muscles of the elbow can be divided into extensors and flexors of the elbow. Medially, the forearm consists of the wrist and hand flexors and the forearm pronator and laterally, the forearm consists of the wrist and hand extensors and forearm supinator (Islam *et al.* 2020).

There are multiple muscles which attach to the elbow joint, which allow for secondary stabilisation of the elbow joint. The muscles that originate from the elbow joint cause flexion and extension to the wrist, hand and fingers. The flexors are the biceps brachii, brachialis and brachoradialis. The biceps brachii is also a supinator muscle. The extensors of the elbow are mainly caused by the triceps brachii and a small action from the anconeus. The muscles contributing to elbow stability include the flexors and extensors. The flexors prevent valgus forces on the elbow including the flexor digitorum superficialis, flexor carpi radialis and ulnaris and the pronator teres. The extensors prevent varus forces on the elbow include extensor digitorum, extensor carpi brevis, extensor carpi longus, extensor carpi ulnaris and anconeus (Card and Lowe 2022).

Table 2.2: Anatomy of the arm muscles

Muscle	Proximal Attachment	Distal Attachment	Innervation	Muscle Action
Biceps brachii	Short head: coracoid process of scapula Long head: supraglenoid tubercle of scapula	Radial tuberosity and bicipital aponeurosis	Musculocutaneous nerve (C5, C6, C7)	Supination of forearm; flexion of forearm when supine; stabilises shoulder
Brachialis	Distal half of anterior surface of humerus	Conoid process and tuberosity of ulna	Musculocutaneous nerve (C5, C6, C7) Radial nerve (C5, C7)	Flexion of forearm
Brachioradialis	Lateral supracondylar ridge of humerus	Styloid process of radius	Radial nerve (C5, C6)	Flexion of forearm when slightly pronated
Triceps brachii	Long head: infraglenoid tubercle of scapula Medial head: posterior surface of humerus, inferior to radial groove Lateral head: posterior surface of humerus, superior to radial groove	Olecranon of ulna and fascia of forearm	Radial nerve (C6, C7, C8)	Extension of forearm; long head stabilizes humeral head
Anconeus	Lateral epicondyle of humerus	Olecranon and posterior surface of elbow	Radial nerve (C7, C8, T1)	Assists in extension of forearm; stabilises elbow joint

(Source: Moore, Dalley and Agur 2017)

Elbow Joint Injuries

In artistic gymnastics, stress on the elbow is due to weight bearing including abduction stress and axial compression forces leading to injury (Bonazza *et al.* 2021). In pole sports, the elbow is often used as a stabiliser and a point of contact to hold the upper limb (Slater, 2022). The elbow is anatomically not designed for weight bearing and therefore is at risk for injury (Card and Lowe 2022). The elbow has a limited range of motion where flexion lies between 130˚ and 154˚, extension lies between -6˚ and 11˚, pronation lies between 75˚ and 85˚ and supination between 80˚ and 104˚ (Zwerus *et al.* 2019). This limited range of motion also increases the elbow joints risk to injury if the range of motion is exceeded past the anatomical limits (Card and Lowe 2022). Sports athletes are also prone to decreased elbow range of motion which can cause an increased load to the shoulder and wrist joint (Zwerus *et al.* 2019).

The most common injuries of the elbow include medial and lateral epicondylitis. Medial epicondylitis is when there is injury at the flexor-pronator origin at the medial epicondyle which often causes pronator teres and flexor carpi radialis pain. Lateral epicondylitis is more common than in the medial epicondylitis and it is when there is injury at the common extensor origin at the lateral epicondyle which often causes extensor carpi radialis pain (Lin, Ellenbecker and Safran 2022).

2.2.3.1.3 Wrist Joint

Anatomy

The wrist is made up of the eight carpal bones consisting up of a proximal row, which includes the scaphoid, lunate, triquetrum and pisiform, and the distal row, which includes the trapezium, trapezoid, capitate and hamate. These carpal bones are found between the radius and ulna and the metacarpal bones. The midcarpal joint is a functional unit and is formed by the articulation between the proximal and distal carpal bones. The radiocarpal joint is made up of the radius and the radioulnar disc. This forms a section of the triangular fibrocartilage complex, which is a load-bearing structure (Eschweiler *et al.* 2022).

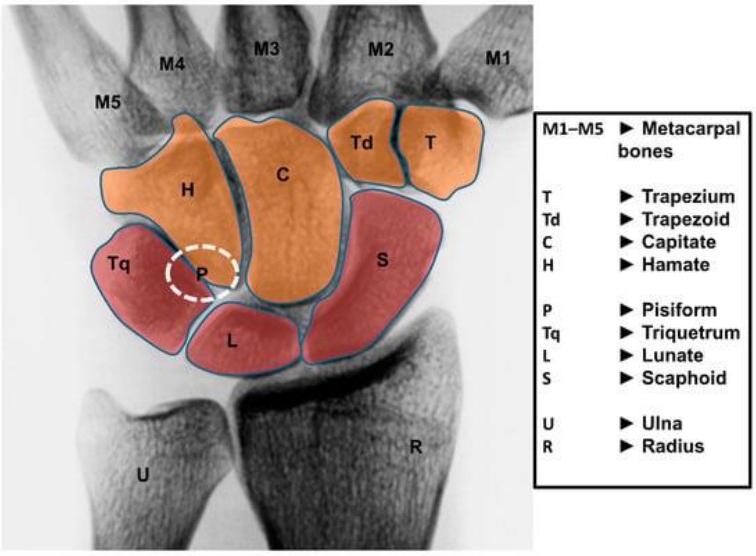

Figure 2.6: Wrist bones

(Source: Eschweiler *et al.* 2022)

There are multiple ligaments which stabilise the wrist joint including both extrinsic and intrinsic ligaments. The extrinsic ligaments are found between the carpal bones and the metacarpals or radius. They include the dorsal intercarpal ligament, dorsal radiocarpal ligament, radioscaphocapitate ligament, long and short radiolunate ligament, ulnolunate and ulnocapitate ligament.

The intrinsic ligaments origin and insertions are within the carpus. These include the scapholunate interosseous ligament, lunotriquetral interosseous ligament, trapeziotrapezoid ligament, trapeziocapitate ligament, capitohamate ligament, scaphotrapeziotrapezoid ligament, scaphocapitate ligament, triquetralcapitate ligament and triquetralhamate ligament (Eschweiler *et al.* 2022).

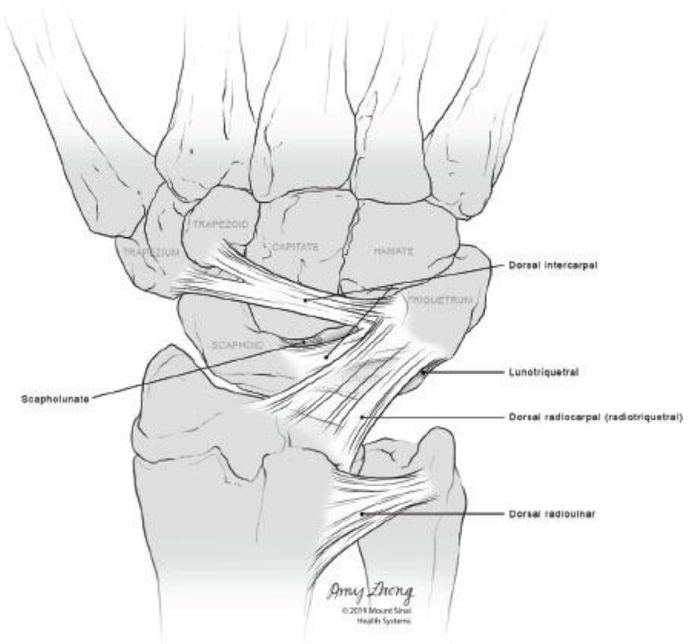

Figure 2.7: Dorsal ligaments of the wrist joint

(Margulies *et al.* 2021).

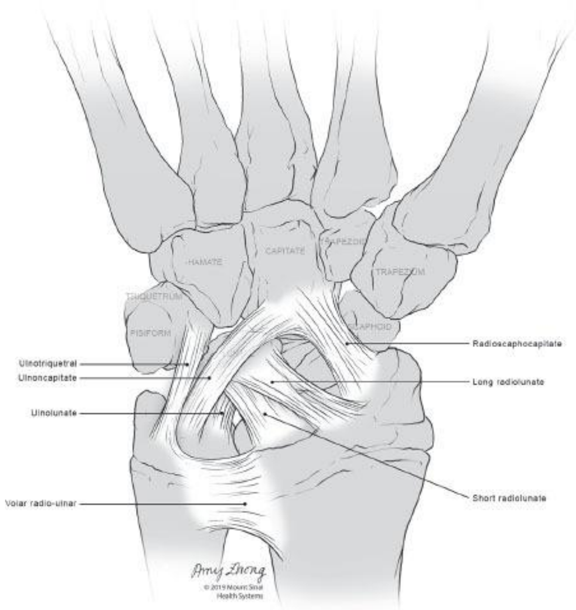

Figure 2.8: Volar ligaments of the wrist joint

(Margulies *et al.* 2021).

The muscles that attach to the wrist include the volar muscles including the palmaris longus, flexor carpi radialis and flexor carpi ulnaris and the dorsal muscles, which include the extensor carpi radialis longus and brevis and the extensor carpi ulnaris (Eschweiler *et al.* 2022).

Table 2.3: Anatomy of the primary wrist muscles

Muscle	Proximal Attachment	Distal Attachment	Innervation	Main Action
Palmaris longus	Medial epicondyle of humerus	Flexor retinaculum and palmar aponeurosis	Median nerve (C7, C8)	Flexion of hand at the wrist
Flexor carpi radialis	Medial epicondyle of humerus	2nd metacarpal base	Median nerve (C6, C7)	Flexion and abduction of hand at the wrist
Flexor carpi ulnaris	Humeral head: Medial epicondyle of humerus Ulnar head: Olecranon and posterior border of ulna	Pisiform, hook of hamate and 5th metacarpal	Ulnar nerve (C7, C8)	Flexion and adduction of hand at the wrist
Extensor carpi radialis longus	Lateral supra-epicondylar ridge of humerus	Dorsal aspect of 2nd metacarpal base	Radial nerve (C6, C7)	Extension and abduction of hand at the wrist
Extensor carpi radialis brevis	Lateral epicondyle of humerus	Dorsal aspect of 3rd metacarpal base	Deep branch of radial nerve (C7, C8)	Extension and abduction of hand at the wrist
Extensor carpi ulnaris	Lateral epicondyle of humerus	Dorsal aspect of 5th metacarpal base	Deep branch of radial nerve (C7, C8)	Extension and adduction of hand at the wrist

(Source: Moore, Dalley and Agur 2017)

Wrist Joint Injuries

In artistic gymnastics, the wrist is often subject to repetitive stresses, compression, distraction and torsional forces (Kukard 2019). Pole sports utilise the wrist for similar movements (Appendix K and L) and, thus, the wrist joint is also at risk for multiple stresses and, therefore, injury. The range of motion of the wrist is 73˚ of flexion, 71˚ of extension, 19˚ radial deviation, 33˚ ulnar deviation, 140˚ supination and 60˚ of pronation (Kim *et al.* 2014); pushing the wrist past its normal range of motion may lead to injuries (Polovinets, Wolf and Wollstein 2018).

The most common injuries to the wrist include wrist capsulitis, ligament tears, triangular fibrocartilage complex tears, carpus chondromalacia, grip lock injury and stress fractures; this injury spectrum has been termed gymnast's wrist (Wolf, Avery and Wolf 2017).

2.2.3.2 Lower Limb

The lower limb includes the hip joint, knee joint and ankle joint. In artistic gymnastics, the lower limb has been found to be the most susceptible to injuries in the body being the most reported location of the body (Campbell *et al.* 2019). The lower limb is often used in pole sports as a weight bearing structure during movements such as inversions (Appendix K). This makes it susceptible to injury.

2.2.3.2.1 Hip Joint

Anatomy

The hip joint is a ball and socket which is made up of the acetabulum which articulates with the head of the femur. The acetabulum is comprised of about 40% of the ileum, 40% of the ischium and 20% of the pubis (Zaghloul and Mohamed 2018).

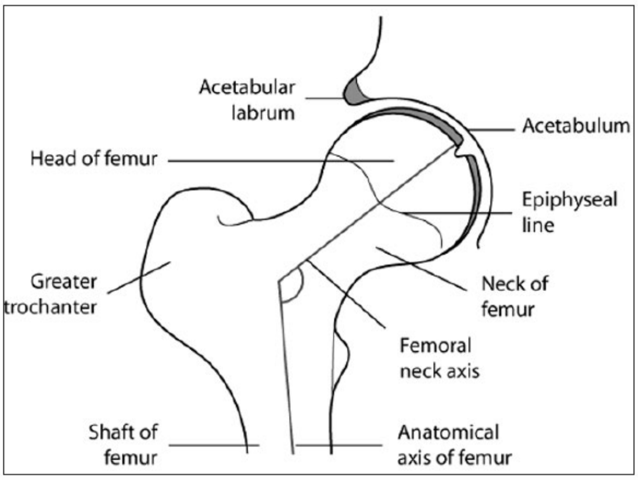

Figure 2.9: Hip joint

(Zaghloul and Mohamed 2018).

The hip joint is made up of three extracapsular ligaments which include the iliofemoral ligament which is the strongest and resists hyperextension of the hip; the pubofemoral ligament which resists hyperabduction of the hip; and the ischiofemoral ligament which stabilises the hip joint during extension. The hip joint is covered by a fibrous capsule in order to maintain stability of the hip (Zaghloul and Mohamed 2018).

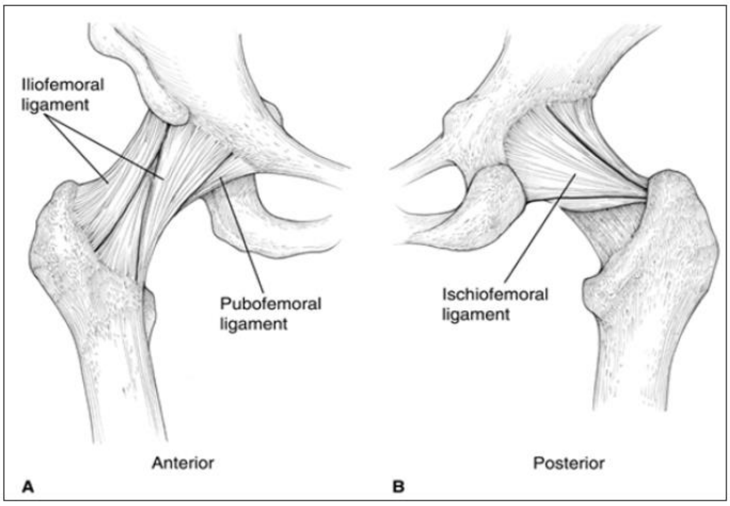

Figure 2.10: Ligaments of the hip joint

(Source: Zaghloul and Mohamed 2018)

There is an extensive amount of muscles which are active on the hip joint. The flexors include the iliopsoas, rectus femoris, tensor fascia latae and sartorius. The extensors include the gluteus maximus, biceps femoris, semimembranosus and semitendinosus. The adductors include the adductor magnus, longus and brevis. The abductors and internal rotators include the gluteus medius, gluteus minimus and tensor fascia latae. The external rotators include the obturator internus, obturator externus, superior gemellus, inferior gemellus, piriformis and quadratus femoris (Zaghloul and Mohamed 2018).

Table 2.4: Primary muscles of the hip joint: flexors

Muscle Iliopsoas	Proximal Attachment	Distal Attachment	Innervation	Main Action
Psoas major	T12-L5 vertebrae and discs; transverse processes of lumbar vertebrae	Lesser trochanter of femur	Anterior rami of lumbar nerves (L1, L2, L3)	Flexion of thigh at hip joint and stabilising hip
Psoas minor	T12-L1 vertebrae and discs	Pectineal line, iliopectineal eminence via iliopubic arch	Anterior rami of lumbar nerves (L1, L2)	Flexion of thigh at hip joint and stabilising hip
Iliacus	Iliac crest, iliac fossa, ala of sacrum and anterior sacro-iliac ligaments	Psoas major tendon, iliopecineal eminence via iliopubic arch	Femoral nerve (L2, L3)	Flexion of thigh at hip joint and stabilising hip
Rectus femoris	Anterior inferior iliac spine and ilium	Via quadriceps tendon; base of patella	Femoral nerve (L2, L3, L4)	Extension of leg at the knee; stability of hip joint; assists in thigh flexion
Tensor fasica latae	Anterior superior iliac spine; anterior part of iliac crest	Iliotibial tract, which attaches to lateral condyle of tibia	Superior gluteal nerve (L5, S1)	Adduction of thigh; medial rotation of thigh; stabilises pelvis when ipsilateral limb is weight bearing
Sartorius	Anterior superior iliac spine and superior part of notch	Superior part of medial surface of tibia	Femoral nerve (L2, L3)	Flexion, abduction and lateral rotation of thigh at hip joint; flexion of leg at knee joint

(Source: Moore, Dalley and Agur 2017)

Table 2.5: Primary muscles of the hip joint: extensors

Muscle	Proximal Attachment	Distal Attachment	Innervation	Main Action
Gluteus maximus	Ilium posterior to gluteal line; dorsal surface of sacrum and coccyx and sacrotuberus ligament	Iliotibial tract which inserts onto the lateral condyle of tibia	Inferior gluteal nerve (L5, S1, S2)	Extension of thigh and assists in lateral rotation; stabilises thigh
Biceps femoris	Long head: ischial tuberosity Short head: linea aspera and lateral supracondylar line of femur	Lateral fibula head, tendon is split by fibular collateral ligament of knee	Long head: tibial division of sciatic nerve (L5, S1, S2) Short head: common fibular division of sciatic nerve (L5, S1, S2)	Flexion of leg; extension of thigh; lateral rotation when knee flexed
Semimembr anosus	Ischial tuberosity	Posterior part of medial condyle of tibia	Tibial division of sciatic nerve part of tibia (L5, S1, S2)	Extension of thigh; flexion of leg; medial rotation when knee flexed
Semitendino sus	Ischial tuberosity	Medial surface of superior part of tibia	Tibial division of sciatic nerve part of tibia (L5, S1, S2)	Extension of thigh; flexion of leg; medial rotation when knee flexed

(Source: Moore, Dalley and Agur 2017)

Hip Joint Injuries

Often, extreme hip motion is needed in artistic gymnasts to perform certain motions and this can lead to injury from unstable joints and impingements (Weber *et al.* 2015). This is similar in pole sport athletes due to the positions the athletes need to put their hips into for certain pole movements. These can include movements such as the helix, the allegra half split 1, the outside knee hang closed fang, the cobra and many others as seen in Appendix K. The normal range of motion of the hip flexion is 95˚ and 107˚ and hip extension is usually 10˚ to 15˚ (Charbonnier *et al*. 2014). Normal internal rotation is found to be between 30˚ to 40˚, measured at roughly 34˚ (Beddows *et al.* 2020). Normal external rotation is found to be between 40˚ and 60˚, measured at roughly 50˚. The abduction of the hip measures between 30˚ and 50˚ and the adduction of the hip measures between 25˚ and 30˚ (Charlton *et al.* 2014).

The muscles attaching to the hip joint, specifically the biceps femoris, are often used as a point of contact and may, therefore, be more at risk to injury (Gołuchowska and Humka 2021; Cole 2021; Nicholas 2019).

The most common injuries of the hip in pole sports included joint overload and muscle tears (Gołuchowska and Humka 2021).

2.2.3.2.2 Knee Joint

Anatomy

The knee joint connects the femur, tibia and patella. The knee is made up of medial and lateral femoral condyles which articulate with corresponding tibial plateaus (Vaienti *et al.* 2017).

An important component of the knee are medial and lateral menisci. Menisci are fibro-cartilaginous in structure found between the femoral condyles and tibial plateaus. The medial meniscus is semi-circular in shape and is connected to the medial collateral ligament. The lateral meniscus is circular in shape and has increased movement compared to the medial meniscus. The function of the menisci is to absorb shock during movement by ensuring there is an even load between both the medial and lateral compartment of the knee (Vaienti *et al.* 2017).

Ligaments play a pertinent role in the stability of the knee. There are two groups of ligaments — the collateral and cruciate ligaments. The medial collateral ligament originates from the medial epicondyle of the femur and inserts into the medial condyle of tibia (Andrews *et al.* 2017). It is divided into two layers known as superficial and deep. The superficial layer functions to avoid valgus and external rotation stress to the knee. The deep layer functions as a stabiliser to the knee (Vaienti *et al.* 2017). The lateral collateral ligament originates from the lateral epicondyle of the femur and inserts on the fibula head (Yan *et al.* 2012). The function of this ligament is to prevent excessive varus and internal rotation of the knee (Vaienti *et al.* 2017). The cruciate ligaments are stabilisers primarily avoiding anterior and posterior movement of the tibia, but they also have a proprioceptive function. The anterior cruciate ligament originates at the lateral femoral condyle and inserts into the tibia plateau (Domnick, Raschke and Herbort 2016). Its primary function is to prevent anterior movement of the tibia on the femur when the knee is flexed and its secondary function is to resist varus and valgus stress (Vaienti *et al.* 2017).

The posterior cruciate ligament originates at the medial femoral condyle and inserts into the posterior tibial plateau (Logterman, Wydra and Frank 2018). The function of this ligament is to prevent posterior movement of the tibia on the femur (Vaienti *et al.* 2017).

The patellofemoral joint is an important component of the knee as it functions to increase stability, allows for the movement of force of the quadriceps onto the tibia and protects the femoral condyles (Vaienti *et al.* 2017).

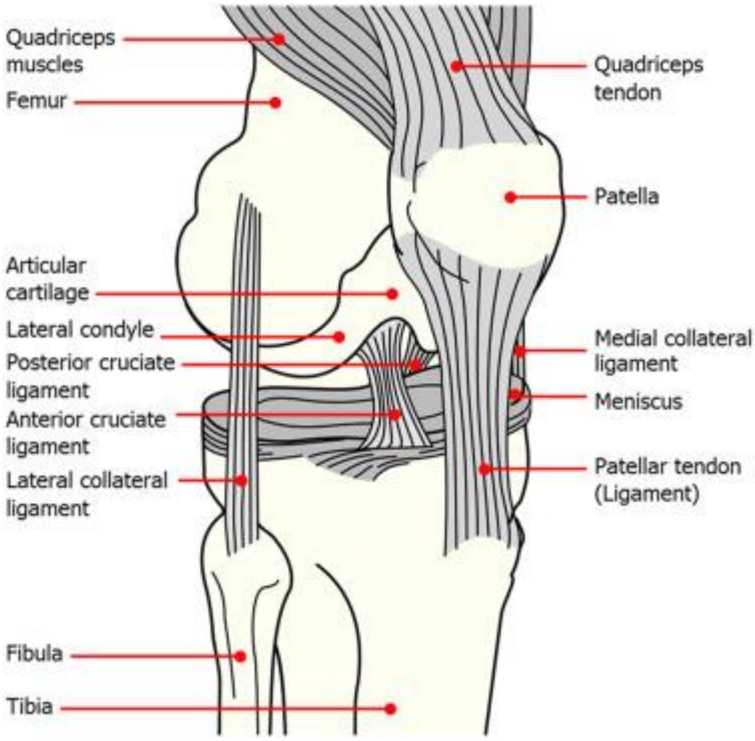

Figure 2.11: Knee joint

(Source: Innocenti 2022)

Most muscles found around the knee joint function to mobilise and stabilise the knee. However, certain muscles have dual actions and act on the hip and the knee. The anterior aspect of the knee contains the quadriceps muscle, which is made up of the rectus femoris, vastus lateralis, medialis and intermedius. The posterior aspect of the knee consists of the hamstring muscles made up of the biceps femoris, semimembranosus and semitendinosus. Medially, there are the sartorius and gracilis muscles and laterally there are the popliteus muscle and the iliotibial band (Abulhasan and Grey 2017).

Table 2.6: Primary muscles of the knee: flexors of knee

Muscle	Proximal Attachment	Distal Attachment	Innervation	Main Action
Biceps femoris	Long head: ischial tuberosity Short head: linea aspera and lateral supracondylar line of femur	Lateral fibula head, tendon is split by fibular collateral ligament of knee	Long head: tibial division of sciatic nerve (L5, S1, S2) Short head: common fibular division of sciatic nerve (L5, S1, S2)	Flexion of leg; extension of thigh; lateral rotation when knee flexed
Semimembranosus	Ischial tuberosity	Posterior part of medial condyle of tibia	Tibial division of sciatic nerve part of tibia (L5, S1, S2)	Extension of thigh; flexion of leg; medial rotation when knee flexed
Semitendinosus	Ischial tuberosity	Medial surface of superior part of tibia	Tibial division of sciatic nerve part of tibia (L5, S1, S2)	Extension of thigh; flexion of leg; medial rotation when knee flexed

(Moore, Dalley and Agur 2017)

Table 2.7: Primary muscles of the knee: extensors of knee

Muscle Quadriceps Femoris	Proximal Attachment	Distal Attachment	Innervation	Main Action
Rectus femoris	Anterior inferior iliac spine and ilium	Via quadriceps tendon; base of patella	Femoral nerve (L2, L3, L4)	Extension of leg at the knee; stability of hip joint; assists in thigh flexion
Vastus lateralis	Greater trochanter and lateral lip of linea aspera of femur	Via quadriceps tendon; base of patella	Femoral nerve (L2, L3, L4)	Extension of leg at the knee
Vastus medialis	Intertrochanteric line and medial lip of linea aspera of femur	Via quadriceps tendon; base of patella	Femoral nerve (L2, L3, L4)	Extension of leg at the knee
Vastus intermedius	Anterior and lateral surfaces of shaft of femur	Via quadriceps tendon; base of patella	Femoral nerve (L2, L3, L4)	Extension of leg at the knee

(Source: Moore, Dalley and Agur 2017)

Knee Joint Injuries

Knee joint injuries are not extremely common in gymnastics but they do sometimes occur (Greier, Drenowatz and Mairoser 2022). This is due to there being a lot of force used to take-off and land creating a force into the knees (Kirialanis *et al.* 2015). Pole sports athletes do utilise the back of the knee as a point of contact to hold the body onto the pole making it a potential site risk for injury (Appendix K). The knee is not a common site of injury and there are no current journal articles reporting on pole injuries to the knee, as per this literature search.

2.2.3.2.3 Ankle Joint

Anatomy

The ankle joint complex is comprised of the subtalar, talocrural and talocalcaneonavicular joint. The subtalar joint is made up of the talus and the calcaneous. The talocrural joint is the joint between the distal tibia and fibula and the talus. The talocalcaneonavicular joint is also known as Chopart's joint and combines the junction between the talus and the navicular and the calcaneocuboid joint which is made up of the calcaneous and the cuboid (Brockett and Chapman 2016).

There are a multitude of ligaments found in the ankle joint which can be seen in Figure 2.12 and Figure 2.13.

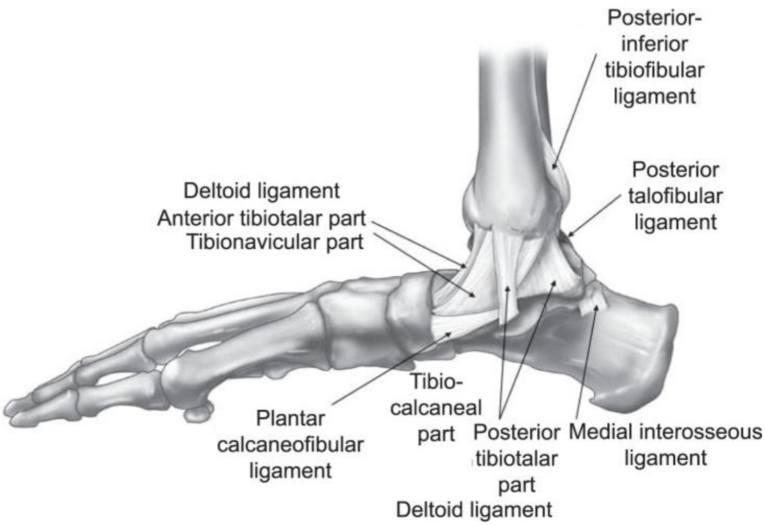

Figure 2.12: Medial ligaments of the ankle joint complex

(Source: McKeon and Hoch 2019)

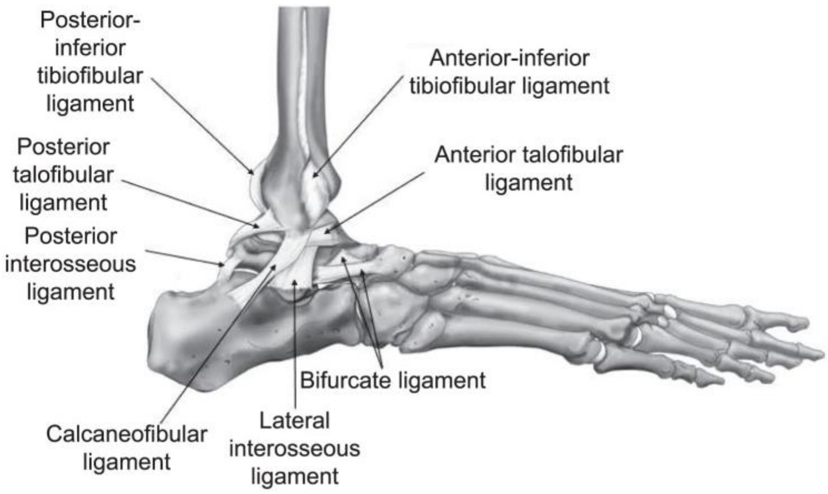

Figure 2.13: Lateral ligaments of the ankle joint complex

(Source: McKeon and Hoch 2019)

The muscles of the ankle are divided into four compartments. The anterior compartment is made up of the tibialis anterior, extensor digitorum longus, extensor hallucis longus and the peroneus tertius. The lateral compartment is made up of the peroneus longus and brevis. The posterior compartment is made up of the gastrocnemius, soleus and plantaris. The deep posterior compartment is made up of the tibialis posterior, the flexor digitorum longus and the flexor hallucis longus (Brockett and Chapman 2016).

Table 2.8: Anterior muscles of the ankle joint

Muscle	Proximal Attachment	Distal Attachment	Innervation	Action
Tibialis anterior	Lateral condyle and superior half of lateral surface of tibia and interosseous membrane	Medial cuneiform and 1st metatarsal base	Deep fibular nerve (L4, L5)	Dorsiflexion of ankle; inversion of foot
Extensor digitorum longus	Lateral condyle of tibia; superior ¾ of medial surface of fibula and interosseous membrane	Middle and distal phalanges of lateral four digits	Deep fibular nerve (L4, L5)	Extension of lateral four digits; dorsiflexion of ankle
Extensor hallucis longus	Middle part of anterior surface of fibula and interosseous membrane	Dorsal aspect of base of hallux	Deep fibular nerve (L4, L5)	Extension of great toe; dorsiflexion of ankle
Peroneus tertius	Inferior third of anterior surface of fibula and interosseous membrane	Dorsum of 5th metatarsal base	Deep fibular nerve (L4, L5)	Dorsiflexion of ankle; eversion of foot

(Source: Moore, Dalley and Agur 2017)

Table 2.9: Posterior muscles of the ankle joint

Muscle	Proximal Attachment	Distal Attachment	Innervation	Action
Gastrocnemius	Medial head: popliteal surface of femur Lateral head: lateral aspect of lateral condyle of femur	Via the calcaneal tendon to the posterior surface of calcaneus	Tibial nerve (S1, S2)	Plantarflexion of the ankle during extension of knee; raises heel while walking; flexion of leg at the knee joint
Soleus	Posterior aspect of head of fibula; middle third of tibia	Via the calcaneal tendon to the posterior surface of calcaneus	Tibial nerve (S1, S2)	Plantarflexion of ankle; stabilisation of the leg on the foot
Plantaris	Lateral supracondylar of femur; oblique popliteal ligament	Via the calcaneal tendon to the posterior surface of calcaneus	Tibial nerve (S1, S2)	Assists gastrocnemius in ankle plantarflexion

(Source: Moore, Dalley and Agur 2017)

Table 2.10: Lateral muscles of the ankle joint

Muscle	Proximal Attachment	Distal Attachment	Innervation	Action
Peroneus longus	Fibula head and superior two thirds of lateral surface of fibula	1st metatarsal base and medial cuneiform	Superficial fibular nerve (L5, S1, S2)	Eversion of foot; mild plantarflexion of ankle
Peroneus brevis	Inferior two thirds of lateral surface of fibula	Dorsal surface of tuberosity of 5th metatarsal base	Superficial fibular nerve (L5, S1, S2)	Eversion of foot; mild plantarflexion of ankle

(Source: Moore, Dalley and Agur 2017)

Table 2.11: Deep muscles of the ankle joint

Muscle	Proximal Attachment	Distal Attachment	Innervation	Action
Tibialis posterior	Interosseous membrane, posterior surface of tibia and fibula	Navicular tuberosity, cuneiform, cuboid, calcaneus, base of 2nd-4th metatarsals	Tibial nerve (L4, L5)	Plantarflexion of ankle; inversion of foot
Flexor hallucis longus	Inferior part of posterior surface of fibula and interosseous membrane	Base of distal phalanx of hallux	Tibial nerve (S2, S3)	Flexion of great toe; weak plantarflexion of ankle; stabilises medial longitudinal arch of foot
Flexor digitorum longus	Medial part of posterior tibial surface by a tendon to fibula	Base of distal phalanges of lateral four digits	Tibial nerve (S2, S3)	Flexion of lateral four digits; plantarflexion of ankle; stabilises longitudinal arches of foot

(Source: Moore, Dalley and Agur 2017)

Ankle Joint Injuries

The ankle joint is a common site for injury due to its ability to injure when gymnasts land on their feet following their routines (Hart *et al.* 2018). This is similar in pole sports as dismounting from the pole may lead to injuries to the ankle.

Gołuchowska and Humka (2021) found that the ankle was a common site of injury, accounting for 19% of the injuries in their study for amateur pole sports athletes. The most common reported injury type included joint sprains and contusions.

2.2.4 Impact of Injuries

Injuries to the musculoskeletal system impact pole sports athletes' ability to train and therefore performance and their overall quality of life.

2.2.4.1 On Pole Performance

The main consequence from injuries is loss of time from pole sports practice. The length of time off from the sport that the athlete has to take directly correlates with decreased fitness in the sport and psychological disorders, such as depression, which may affect the overall performance in the sport (Malm, Jakobsson and Isaksson 2019).

Cole (2021) found that of 400 total responses from injured pole sports athletes, 101 athletes had to take two to four weeks off of pole sport participation, 99 lost over a month off of pole sport participation, 39 lost over 6 months and 15 athletes had to take over 1 year off of pole sports participation.

Szopa *et al.* (2022) reported that more than 30% of the pole sport athletes who experienced injuries influenced their current level of activity, both in pole sports and other activities; 50% of the participants in the study constantly experience pain and discomfort.

2.2.4.2 On Quality of Life

Sport is linked to a multitude of health benefits such as physical fitness which includes psychosocial development, personal development and decreased alcohol consumption (Malm, Jakobsson and Isaksson 2019). Inactivity is a risk factor for cardiovascular disease and chronic diseases such as type 2 diabetes mellitus, hypertension, obesity, bone and joint diseases (Gonzàlez, Fuentes and Màrquez 2017).

Exercise is seen as a tool for mental health improvements in depression, anxiety, cognition, neurodegenerative disease, alcohol and drug abuse (Ruegsegger and Booth 2018). Therefore, not training may lead to decreased overall activity causing a negative impact on a pole sport athlete's health (Malm, Jakobsson and Isaksson 2019).

2.2.5 Management of Musculoskeletal Injuries

The management of pain and musculoskeletal injuries has seen a recent shift from mainstream pharmacological and surgical care to non-invasive care with a large emphasis on preventative medicine (El-Tallawy *et al.* 2021). Mainstream care includes pharmacological management which is made up of analgesic medication, injection therapy and surgery, which is the most recommended treatment for most musculoskeletal injuries (Pugazhendi *et al.* 2020). Surgery is expensive, and often leads to post-surgical side effects.

Injectable steroids are used which only provide short-term pain relief (Pugazhendi *et al.* 2020).

Complementary, holistic and preventative treatment has been more recently incorporated as a management protocol for musculoskeletal injuries. This often includes multiple disciplines to treat the injury in a holistic manner in which the biological, psychological and social aspects of the injury are addressed (Pugazhendi *et al.* 2020). The prevalence of CAM has shown to be between 25.9% and 26.9% in 32 countries with a satisfaction rate between 71% and 72.7% (Peltzer and Pengpid 2018). CAM includes physical modalities, rehabilitative exercises, psychology and other alternate therapies (El-Tallawy *et al.* 2021).

The main practitioners used to manage musculoskeletal injuries are discussed as follows.

2.2.5.1 General Practitioner

A general practitioner is often the first line of contact for patients with musculoskeletal injuries. The general practitioner plays an important role deciding whether the injury is minor and can be managed by the practitioner or whether further management such as referral for special tests and/or to specialists is necessary for the injury (Margham 2011). Patients who have sports injuries often see general practitioners first, but this often leads to non-specific diagnoses, which results in patients receiving only education and advice regarding their injury, rather than referral to physicians who can assist in physical treatment and rehabilitation of an injury (Baarveld *et al.* 2011).

2.2.5.2 Chiropractor

A chiropractor is an alternative healthcare profession who focuses on the management of musculoskeletal pain via a biopsychosocial approach. Chiropractors use spinal manipulative therapy, manual therapy, modalities, rehabilitation and education in order to address patients with musculoskeletal injury and pain (Hawk *et al.* 2020). Chiropractors have the opportunity to register with the International Federation of Sports Chiropractic (FICS). FICS provides the opportunity for chiropractors to obtain an International Certificate in Sports Chiropractic, which is a course that further trains chiropractors on how to best manage and treat sports injuries (The International Federation of Sports Chiropractic n.d.). This certificate also allows chiropractors to provide care at both national and international sport events (Nook, Nook and Nook 2016).

2.2.5.3 Physiotherapist

Physiotherapists are involved in preventing and managing injuries arising from sport participation. They work with patients to rehabilitate them to preinjury state both physically and emotionally. They also work to prevent reoccurrences of the injury (Dhillon, Dhilllon and

Dhillon 2017). This is done by improving strength and flexibility of muscles, improve coordination, assisting with pain management and educating the patient on their injury (Samuel 2021). The current evidence shows that there are advantages of early physiotherapy over a delayed start for musculoskeletal injuries, especially the recovery in early phases after the onset of injury. This benefits long-term mental health and decreases the need for invasive healthcare interventions (Campbell *et al.* 2022).

2.2.5.4 Acupuncture

An acupuncturist is an alternative healthcare professional, which is a part of the ancient practice of traditional Chinese medicine. It is the practice of penetrating the skin with a thin needle into a specific pressure point in order to stimulate the immune system to assist with improved circulation and pain modulation. It is based on the philosophy that there is a force called *qi* in the body which, when flowing correctly, leads to health but, when disrupted, may lead to illness or injury (Kawakita and Okada 2014).

Acupuncture has been shown to be effective for pain relief in various conditions including reducing traumatic pain (Chen and Wang 2014). Acupuncture is used to treat sport injuries, both as a primary intervention and an adjunctive therapy (Lee, Lee and Kim 2020). There have been previous randomised control trials that demonstrate acupuncture as being effective to control pain in spots injuries. Conditions such as shin splints, plantar fasciitis, and rotator cuff tendonitis and shoulder impingement syndrome have been improved via acupuncture (Lee, Lee and Kim 2020).

2.2.5.5 Homeopathy

Homeopathy is a non-invasive alternate healthcare profession which utilises holistic medicine to produce similar symptoms of illness as the one the patient is experiencing in order to treat the illness. Certain sports athletes utilise homeopathy to improve their performance and accelerate their recovery from both illness and injury (Mittelstadt, Issat and Duckworth 2013). Homeopathic medication is individualised and specific to the person. Homeopathic remedies give the patient the ability to regain a vital force, allowing the body to heal from the inside out. Homeopathic remedies are used to support the recovery from sports injury by decreasing pain, and lessening the recovery and rehabilitation process (Nayak *et al.* 2019).

2.2.5.6 Traditional African Healer

A traditional African healer is someone who is acknowledged by the community as competent to provide primary health care (Semenya and Potgieter 2014). African traditional medicine is an integral part of about 80% of the South African population as a substitute for western medicine. Traditional healers are usually divided into two categories: diviners and healers or herbalists. Diviners are experts at applying diagnostic criteria and they define the illness and the origin in terms of the African belief system and they provide a plant or animal-based treatment via spiritual means (Semenya and Potgieter 2014). Diviners regard themselves as ancestral servants. Herbalists practice the art of healing and is a profession that is freely accessible to anyone (Semenya and Potgieter 2014). It has been documented that certain sports athletes use traditional medicine as their primary source of health care (Mulungwa *et al.* 2019).

2.2.5.7 Ayurveda Doctor

Ayurveda is an ancient Indian medicine system in which each cell in the human body is believed to be an expression of intelligence and therefore this practice uses self-healing science. They also use herbal treatments which are immunomodulators as a part of this medical practice (Chauhan *et al.* 2015). More recent development in Ayurveda science suggest that various medicines are needed for the management of physical and mental health, which is necessary for athletes. Ayurveda is used to treat various sports injuries with the incorporation of exercises and Yoga (Anantkumar and Borkar 2018).

2.2.5.8 Psychology

Psychology has shown an association between sports injuries and emotional status, social support, vulnerability, personality and coping abilities (Li, Wu and Chen 2020). Andersen and Williams (1988) defined a concept known as pressure-dependent damage which explains that stressful events can affect the performance of athletes and, thus, increase the risk of sports injuries. The negative impact of injury can be related to the length of time someone has been participating in their sport.

Those who are high performers and have a high athletic identity often experience negative effects when injured, such as mood changes and feelings of loss, but also usually react better to the injury due to having a larger access to psychological resources to assist in coping with the injury. Therefore, those who are injured may benefit from psychological intervention in order to facilitate recovery. It is also beneficial to reduce fear of returning to play following an injury (Santi and Pietrantoni 2013).

2.3 SUMMARY

Pole sport has become a popular sport that is still growing worldwide. Due to the nature of the sport, which incorporates many different types of athletic skills, pole sport athletes are predisposed to injury. The review of literature reveals that, although there is only limited research done on pole sports, musculoskeletal injuries are still highly prevalent.

The risk factors have not been well defined and there is conflicting evidence across all the studies for the factors that have been proposed. The impact of pole sport injuries on athletes has a large significance. There are many management interventions available for sport injuries but there is very little research done on management for pole sports specific injuries. The efficacy for many of the management approaches is also insufficient and needs further research.

CHAPTER THREE: METHODOLOGY

3.1 RESEARCH DESIGN

The study utilised a descriptive cross-sectional survey design in order to provide numerical data on a portion of the population at one point in time. The study was conducted in a quantitative paradigm which is an objective and systematic process in which numerical data were used to obtain information about a specific population to provide clarity on what influences and affects that population (Allen 2017). In this study, the specific population refers to amateur pole sport athletes.

3.2 LOCATION OF STUDY

The study adopted an online questionnaire which was sent to the owners of five pole studios in the eThekwini municipality to forward to their students to complete.

3.3 POPULATION

The study population were amateur pole sport athletes in the eThekwini municipality of KwaZulu-Natal, South Africa. The population was determined by the number of members belonging to the pole sports studios who were willing to participate in this study. Male and female individuals over the age of 18 years who are actively participating in pole sports training were invited to participate in the study.

3.4 PERMISSION TO CONDUCT RESEARCH

Full ethical approval was granted to conduct research by the Institutional Research Ethics Committee (Appendix Q) at the Durban University of Technology. This was granted following the completion of a focus group, pilot study and gatekeeper's approval. The gatekeeper's approval consisted of permission from the owners of the pole studios (Appendix P).

3.5 SAMPLING STRATEGY

This subsection details the methods used to recruit participants, the sample size and the sample characteristics which includes the inclusion and exclusion criteria for this study.

3.5.1 Participant Recruitment

The participants were made aware of the research study by means of advertisements (Appendix A) which were sent to the owners of the studios to place at their respective pole studios in the eThekwini municipality. The owners of the studios were also asked to send the advertisement (Appendix A) via WhatsApp messenger to their pole studio groups. Additionally, with permission (Appendix I), the researcher was allowed to speak to the various classes to inform the pole sport athletes of the study. The link to the questionnaire (Appendix M), a letter of information (Appendix B), and an informed consent form (Appendix C) was sent to the students via the pole instructor to be signed and dated for the students to complete if interested and if they met the inclusion criteria.

3.5.2 Sample Size

The participants who met the requirements for the study according to the inclusion and exclusion criteria were allowed to participate in the study. Based on the average number of pole sport athletes at each pole studio in the eThekwini municipality, which is a total of 147 from five pole studios, and an estimated population prevalence of musculoskeletal injuries of 50%, with a 10% precision (half-width of the 95% confidence interval), this study aimed to recruit 59 participants (Estherhuizen 2022).

3.5.3 Sample Characteristics

The participants who met the criteria, and who volunteered to participate in the study were sent the link to the questionnaire (Appendix M), a letter of information (Appendix B), and an informed consent form (Appendix C) via the pole instructor to be signed and dated.

3.5.3.1 Inclusion Criteria

- Participants must be over the age of 18 years old.
- Participants must currently be participating in pole sports.
- Participants will only be accepted into the study if they give their informed consent.

3.5.3.2 Exclusion Criteria

- Patients who wish to no longer participate in the study will be automatically excluded and their data will not be used.
- Participants included in focus group and pilot group will be excluded.

3.6 MEASUREMENT TOOLS

QuestionPro was utilised for the questionnaire. The questionnaire was adapted from more than one validated questionnaire and included reviewing the work of Lee, Lin and Tan 2020 and Kukard 2019. The Nordic Musculoskeletal Questionnaire developed by Kuorinka *et al.* (1987) was adapted to have questions regarding musculoskeletal pain. Table 3.1 reflects the relevant references applied in each section of the questionnaire.

Permission to utilise and adapt research in the above studies was obtained via email correspondence (Appendix J). This resulted in the development of the pre-focus group questionnaire (Appendix M). This questionnaire was reviewed by a focus group and then by a pilot study to enhance its reliability and validity and to apply relevant corrections where necessary.

Table 3.1: Questionnaire reference list

Demographics (age, gender, race, height, weight, body type and occupation)	Kukard (2019) Soini and Laine (2018) Section A
Training history	Kukard (2019) Soini and Laine (2018) Section B
Risk factors	Lee, Lin and Tan (2020) Kukard (2019) Section A and B
Musculoskeletal injury/pain	Kukard (2019) Kuorinka *et al*. (1987) Section C
Injury consequence on sport and performance	Kukard (2019) Soini and Laine (2018) Section C
Injury consequence on quality of life	Lee, Lin and Tan (2020) Kukard (2019) Section D
Management of injuries	Kukard (2019) Soini and Laine (2018) Section E

3.7 FOCUS GROUP DISCUSSION

A focus group was selected to have an organised discussion regarding views, attitudes and experiences towards the topic to ensure internal validity of the questionnaire (Nyumba *et al.* 2018). A focus group reviews the questions included in the questionnaire in their entirety and establishes the relevance and applicability of the questions to the aims and objectives of the study.

The focus group was constructed as follows:

- A date and time was determined for the focus group meeting.
- An appropriate venue was secured which was online via a Zoom meeting.

- Participants included the student researcher, researcher supervisor, two chiropractic staff members or clinicians and two to three participants who met the inclusion criteria for the study.
- Participants were required to read a letter of information (Appendix D) and sign a letter of informed consent (Appendix F) and a confidentiality agreement (Appendix E).
- The focus group commenced with discussion of the questionnaire (Appendix M).
- The researcher read questions to the group with discussion of the relevance of the question to the aims and objectives of the study.
- The response of the focus group to each question could be in agreement of, disagreement or undecided on whether the question should be included in the questionnaire. If there was indecision, a vote by the majority decided on the fate of inclusion of the question.
- The focus group concluded its discussion once all questions were addressed.
- The participants were thanked for their participation.
- The researcher ensured that the discussion was recorded on Zoom and kept a written version of the changes.
- Alterations were made to the questionnaire which developed a new post-focus group questionnaire.

3.7.1 Changes to the Focus Group Questionnaire

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

Section A

- Q2
  - Group ages into 5 year categories
- Q5 and 6
  - Added "please type unsure if you do not know"
- Q7
  - Add images to explain body type
  - Add explanation for each body type

Section B

- Q9
  - Categorise the years

- Q12
    - Add in amateur as a skill level
- Q13
    - Add explanation for dominant side
    - Added “unsure” as an option
- Q17
    - Categorise length of time in 5 minute intervals
    - Added “N/A” as an option
- Q18
    - Explain the types of stretches
    - Added “N/A” as an option
- Q20
    - Added “N/A” as an option
- Q22
    - Add in additional options to the question “the warmer/more humid, the easier it is to grip the pole” and “the cooler/less humid, the harder it is to grip the pole”
    - Added “N/A” as an option
- Q24
    - Added “N/A” as an option
- Q26
    - Add in additional options to the question “the warmer/more humid it is, the slower I become fatigued” and “the cooler/less humid it is, the quicker I become fatigued”
    - Added “N/A” as an option
- Q27 and 28
    - Additional questions added “Does the temperature affect your muscle fatigue (tiredness) in a pole class?”
    - Added “N/A” as an option
- Q30
    - Categorise the types of activities: “Endurance/Aerobic; Strength/Resistance; Flexibility” with explanations and examples for each activity
    - Added “N/A” as an option
- Q31
    - Added “N/A” as an option

- Q32
    - Elaborate that dancing being questioned is a sport
- Q33
    - Added question: “Did you participate in gymnastics/circus arts prior to starting pole sports?”

Section C

- Add the word “musculoskeletal” in front of injury for all questions
- Q46
    - Added question: “What hand grip were you using when you sustained this musculoskeletal injury” with reference images
- Q50
    - Correct the categorisation of weeks so there is no overlap
- Q51
    - Add option of “did not stop”
- Q52
    - Additional question: “How long did you stop other exercise besides pole sport”

Section E

- Add in “orthopedic surgeon” as an option

3.8 PILOT GROUP

The fundamental purpose of conducting a pilot study is to examine the feasibility of an approach that is intended to ultimately be used in a larger scale study (Leon *et al.* 2012).

The pilot study group commenced as follows:

- The researcher sent an email to the owners of the pole studios to forward to the pole sport athletes asking one from each studio to participate in the pilot study. The first three participants who consented to this were chosen to participate and were thus excluded from the main study (Appendix I).
- The pilot participants were required to read and complete the letter of information (Appendix G) and a letter of informed consent (Appendix H) online.
- Thereafter, the participant was required to complete the questionnaire online (post-focus group) (Appendix M) before participation in the study was granted.
- Participants were then asked to complete the post-focus group questionnaire and fill out the pilot group feedback form (Appendix N) online.

- Comments produced in the pilot study were incorporated into the post-focus group questionnaire.
- This resulted in the production of the final questionnaire for the main study.

3.8.1 Changes to the Pilot Group Questionnaire

There were no changes to the pilot group questionnaire as the pilot group did not recommend any changes.

3.9 ETHICAL CONSIDERATIONS

The ethical considerations were as follows:

- The Institutional Research and Ethics Committee (IREC) at Durban University of Technology granted full ethical approval to conduct this research (IREC number: 216/22).
- The gatekeepers (Appendix I) gave permission to email the study to them before questionnaire administration began.
- Participation in the study was on a voluntary basis.
- All participants were given a letter containing information (Appendix B) about the study.
- Participants were required to sign a letter of informed consent (Appendix C) before partaking in the questionnaire (Appendix M), in line with autonomy of each participant.
- Participants were chosen at random, in line with justice, with no bias shown towards gender, race, religion or socioeconomic status.
- Beneficence was accounted for as the results provided valuable information with regards to both the prevalence and impact of musculoskeletal injuries in pole sport athletes, provided understanding for current management sought out by sufferers and explored the knowledge and role of complementary therapy in treatment of pole sport injuries.
- Non-maleficence was accounted for by ensuring no harm was done to the participants during the administration of questionnaires.
- Confidentiality was maintained as the participants were not required to provide identification details on the questionnaires and the completed questionnaires were placed in ballot boxes to ensure anonymity.
- Data will be kept for five years after study completion. “Raw” data will be stored in the chiropractic department and shredded after five years. All data transcribed from

raw data in spreadsheets on a computer, will be kept for five years on a computer and external storage device before deletion.

3.10 DATA COLLECTION

- Permission was sought from the relevant gatekeepers for access to the pole sport athletes (Appendix I).
- Once this permission was granted, the researcher travelled to the pole studios to advertise and inform the students of the study and answered any questions.
- The researcher sent an email to the owner of the pole studios with the letter of information (Appendix B), informed letter of consent (Appendix C) and link to the questionnaire (Appendix M) which was forwarded to the pole sport athletes.
- The questionnaires were anonymous.
- The participants were asked to respond to the email once the questionnaire was completed.
- If no response was received, the participants were sent a follow up email through the pole studio owner as a reminder.
- All data were coded for the purpose of data capture to ensure anonymity.

3.11 DATA ANALYSIS

Data from the questionnaire were collected and coded into a spreadsheet on Excel. It was then imported into IBM SPSS version 28 for analysis. Univariate analysis for factors associated with MSK lifetime injuries were achieved using Pearson's chi square tests where the assumptions were met, and Chi square exact tests where cell counts were low. Continuous factors were tested using t-tests. All tests were 2-sided and a p value of <0.100 was considered as statistically important for univariate testing. Those factors meeting the $p<0.1$ criterion were then taken into a multiple logistic regression model, where a more stringent p value criterion of $p<0.05$ was accepted. The final model includes all factors regardless of statistical significance, and odds ratios, 95% confidence intervals and p values are reported (Esterhuizen 2022).

CHAPTER FOUR: RESULTS

4.1 INTRODUCTION

This chapter includes the results and statistical data. This chapter outlines the following information: rate of participation, the demographics and anthropometrics of the participants, the period and lifetime prevalence of musculoskeletal injuries sustained, the risk factors for the sport, the impact of the injuries and the management used for the injuries.

4.2 RATE OF PARTICIPATION

There are five pole sport studios in the eThekwini municipality. Data collection occurred via an online questionnaire that was sent out to owners of all the studios to distribute to their pole sport athletes. Based on 147 total athletes from five pole studios, it was calculated that a reasonable sample size was 59 participants as it produced a two-sided 95% confidence interval with a precision (half-width) of 0,10 when the actual proportion is near 0,5. A total of 69 questionnaires were filled in, but 10 of those were incomplete and the data were not utilised in the study. A total of 59 questionnaires were completed, resulting in a completion rate of 85.51%.

4.3 DEMOGRAPHICS

The demographics in this study consisted of age, gender and ethnicity.

4.3.1 Age

Table 4.1 indicates the age distribution of pole sport athletes.

Table 4.1: Age of participants

Age Category (Year)	Count (*n*)	Percentage (%)
18–24	12	20.3%
25–29	18	30.5%
30–34	9	15.3%
35–39	10	16.9%
40–46	4	6.8%
45–49	3	5.1%
50–54	2	3.4%
55–59	1	1.7%
Total	**59**	**100.0%**

The age distribution indicated that most participants were in the 25–29 year age group (30.5%, *n*=18) followed by the 18–24 year age group (20.3%, *n*=12), the 35–39 year age group (16.9%, *n*=10) and then the 30–34 year age group (15.3%, *n*=9). There were a total of 17% (*n*=10) over the age of 40 years who participated in pole sports. This demonstrates that with regards to age, the highest proportion of pole sport athletes are in the 25–29 year age group (30.5%, *n*=18).

4.3.2 Gender

With regards to gender, 98.3% of the participants identified as female with only one participant identifying as non-binary (1.7%).

4.3.3 Ethnicity

The majority of participants were white accounting for 77.2%, followed by Asian (8.8%) and black (8.8%). The remaining participants were multi-ethnic (5.3%).

4.4 ANTHROPOMETRICS

The anthropometric data that were collected included the height, weight and BMI of the participants, that information which is indicated in Table 4.2.

Table 4.2: Anthropometrics of participants

	n	Mean	Standard Deviation	Minimum	Maximum
Weight (kg)	56	64.4	11.8	46.0	90.0
Height (cm)	55	163.9	6.5	151	177
BMI (kg/m²)	52	23.9	3.8	17.7	32.0

This table demonstrates that the average weight was 64.4kg and average height was 163.9cm. The BMI ranged from 18kg/m² to 32kg/m² with an average of 24kg/m². The participants were also asked to identify their body type as ectomorph, mesomorph and endomorph. Of a total of 59 participants, 32.2% (*n*=19) identified as an ectomorph, 30.5% (*n*=18) identified as a mesomorph and 37.3% (*n*=22) identified as an endomorph.

4.5 PREVALENCE OF MUSCULOSKELETAL INJURIES

The lifetime and period prevalence were determined in this study.

4.5.1 Lifetime Prevalence

The lifetime prevalence of musculoskeletal injuries from pole sports accounted for almost half of the participants at 49.2% (*n*=29).

Figure 4.1 demonstrates the percentage of lifetime prevalence of musculoskeletal injuries based on their anatomical location.

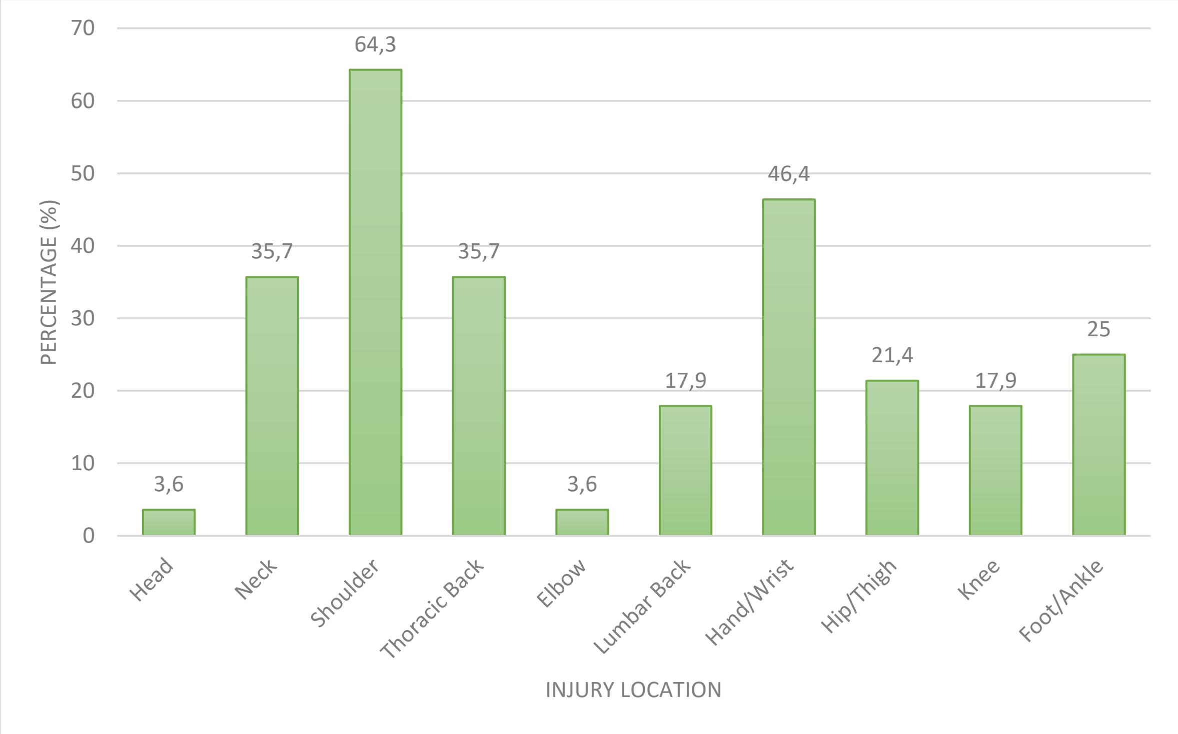

Figure 4.1: Percentage of lifetime prevalence of MSK injuries based on location

Of the 29 participants who experienced injuries and supplied information on their injuries, it was seen that the most common site of lifetime injury was the shoulder joint (64.3%, *n*=18) followed by the wrist (46.4%, *n*=13) and then the neck and thoracic back both accounting for 35.7% (*n*=10) respectively.

4.5.2 Period Prevalence

Period prevalence describes the prevalence of musculoskeletal injuries in the last 12 months. The prevalence of musculoskeletal injury in the last 12 months was 40.7% (*n*=24) overall. This means that 85.7% of those with a lifetime prevalence of musculoskeletal injuries had an injury in the last 12 months

Figure 4.2 demonstrates the percentage of period prevalence of musculoskeletal injuries based on anatomical location.

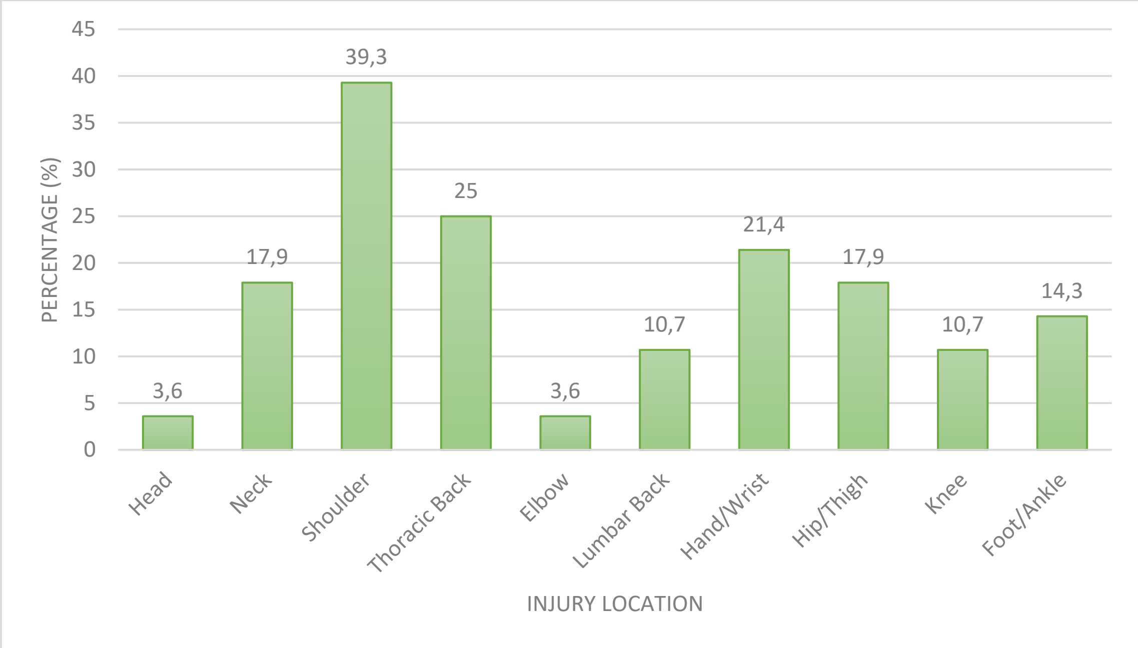

Figure 4.2: Percentage of period prevalence of MSK injuries based on location

For a 12-month period prevalence, the most common site injured was the shoulder (39.3%, *n*=11) followed by the thoracic back (25%, *n*=7), of the 28 with lifetime prevalence who answered this question (Figure 4.2).

4.6 TYPES OF INJURIES

Table 4.3 demonstrates the distribution of the types of injuries that occurred in participants.

Table 4.3: Type of injuries

	Fracture		Sprain		Strain		Contusion		Concussion		Other		N/A		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Head	0	0.0%	0	0.0%	2	14.3%	0	0.0%	0	0.0%	12	85.7%	0	0.0%	14	18.2%
Neck	0	0.0%	1	12.5%	4	50.0%	0	0.0%	0	0.0%	3	37.5%	0	0.0%	8	10.4%
Shoulder	0	0.0%	1	6.7%	11	73.3%	0	0.0%	0	0.0%	3	20.0%	0	0.0%	15	19.5%
Thoracic back	0	0.0%	2	20.0%	6	60.0%	0	0.0%	0	0.0%	2	20.0%	0	0.0%	10	13.0%
Elbow	0	0.0%	0	0.0%	2	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	2	2.6%
Lumbar back	0	0.0%	0	0.0%	3	60.0%	0	0.0%	0	0.0%	2	40.0%	0	0.0%	5	6.5%
Hand/Wrist	0	0.0%	3	37.5%	5	62.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	8	10.4%
Hip/Thigh	0	0.0%	1	12.5%	5	62.5%	2	25.0%	0	0.0%	0	0.0%	0	0.0%	8	10.4%
Knee	0	0.0%	1	33.3%	1	33.3%	1	33.3%	0	0.0%	0	0.0%	0	0.0%	3	3.9%
Foot/Ankle	0	0.0%	1	25.0%	0	0.0%	3	75.0%	0	0.0%	0	0.0%	0	0.0%	4	5.2%
Total	0	0.0%	10	12.99%	39	50.65%	6	7.79%	0	0.0%	22	28.57%	0	0.0%	77	100%

This table demonstrated that the most common types of injuries were strains representing a total of 50.65% (*n*=39). Sprains represented 12.99% (*n*=10) and contusions represented 7.79% (*n*=6) of pole sport injuries. It also demonstrates that the most common type of injuries affected the shoulder (19.5%, *n*=15), followed by head injuries (18.2%) and then the thoracic back (13%, *n*=10).

4.7 MOST SEVERE INJURY SITE

The participants were asked to report on their most severe injury site and which type has been demonstrated in Table 4.4.

Table 4.4: Most severe injury site

		Count (*n*)	**Percentage (%)**
Area causing the most severe MSKI	Ankle	1	3.6%
	Back	1	3.6%
	Costovertebral joint	1	3.6%
	Foot shin	1	3.6%
	Hand/Wrist area closer to arm	1	3.6%
	Hip/Thigh	2	7.1%
	Infraspinatus partial tear	1	3.6%
	Knee	1	3.6%
	Lumbar back injury	1	3.6%
	Lumbar, thoracic and shoulder	1	3.6%
	Neck	1	3.6%
	Rhomboid on the right	1	3.6%
	Rib just below shoulder blade	1	3.6%
	Rotator cuff	3	10.7%
	Shoulder	7	25.0%
	Spine and Ribs	1	3.6%
	Strained intercostal muscle causing a painful sharp shooting pain in shoulder and thoracic region	1	3.6%
	Wrist	1	3.6%
	Wrist and lower forearm	1	3.6%
	Total	28	100.0%
Type of injury causing the most severe MSKI	Contusion	3	11.1%
	Fracture	1	3.7%
	Impingement	1	3.7%
	Slipped rib and muscle strain	1	3.7%
	Spinal decompression and fusion	1	3.7%
	Sprain	2	7.4%
	Strain	13	48.1%
	Strain – pinched nerve	1	3.7%
	Strain or sprain, not sure	1	3.7%
	Strain resulting in pinched nerve	1	3.7%
	Tendon inflammation into rotator cuff	1	3.7%
	Torn rotator cuff	1	3.7%
	Total	27	100.0%

The most severe injury site was the shoulder (25%, *n*=7) followed by the rotator cuff of the shoulder (10.7%, *n*=3) demonstrating shoulder injuries as accounting for over 35% of the injury sites. The most common injury type was a strain accounting for 48.1% (*n*=13) of the injuries.

4.8 RISK FACTORS

The risk factors to the lifetime prevalence of musculoskeletal injuries in pole sport athletes in eThekwini which were investigated in this study included age, weight, skill level, frequency of training and duration of training. The statistical data showed that age, weight, frequency of training and duration of training were not statistically significant to musculoskeletal injury in pole sport athletes (tables 4.6.1 to 4.6.3).

Tables 4.6.1 to 4.6.3 show the crude univariate associations between each categorical factor and injury.

Table 4.5.1: Univariate analysis of factors associated with lifetime musculoskeletal injuries (*n*=59)

		MSK Injury in Lifetime						p-value
		No		Yes		Total		
		n	%	*n*	%	*n*	%	
Age category (year)	18–24	6	20.0%	6	20.7%	12	20.3%	0.700
	25–29	10	33.3%	8	27.6%	18	30.5%	
	30–34	4	13.3%	5	17.2%	9	15.3%	
	35–39	7	23.3%	3	10.3%	10	16.9%	
	40–46	2	6.7%	2	6.9%	4	6.8%	
	45–49	1	3.3%	2	6.9%	3	5.1%	
	50–54	0	0.0%	2	6.9%	2	3.4%	
	55–59	0	0.0%	1	3.4%	1	1.7%	
	Total	30	100.0%	29	100.0%	59	100.0%	
Skill level of pole sports	Beginner	15	50.0%	6	20.7%	21	35.6%	0.004
	Amateur	12	40.0%	10	34.5%	22	37.3%	
	Intermediate	1	3.3%	11	37.9%	12	20.3%	
	Advanced	2	6.7%	2	6.9%	4	6.8%	
	Total	30	100.0%	29	100.0%	59	100.0%	
Years participating in pole sports	<1 year	15	50.0%	8	27.6%	23	39.0%	0.122
	1–2 years	10	33.3%	8	27.6%	18	30.5%	
	3–4 years	3	10.0%	7	24.1%	10	16.9%	
	> 5 years	2	6.7%	6	20.7%	8	13.6%	
	Total	30	100.0%	29	100.0%	59	100.0%	
Participation in pole sports per week	1–2 times	25	83.3%	21	72.4%	46	78.0%	0.692
	3–4 times	4	13.3%	6	20.7%	10	16.9%	
	5–6 times	1	3.3%	1	3.4%	2	3.4%	
	7 times	0	0.0%	1	3.4%	1	1.7%	
	Total	30	100.0%	29	100.0%	59	100.0%	
Length of pole session on average	30 mins	1	3.3%	1	3.4%	2	3.4%	0.174
	45 mins	0	0.0%	0	0.0%	0	0.0%	
	1hr	29	96.7%	25	86.2%	54	91.5%	
	1.5 hr	0	0.0%	3	10.3%	3	5.1%	
	2 hr	0	0.0%	0	0.0%	0	0.0%	
	Total	30	100.0%	29	100.0%	59	100.0%	
Participation in other exercise	No	6	20.0%	9	31.0%	15	25.4%	0.330
	Yes	24	80.0%	20	69.0%	44	74.6%	
	Total	30	100.0%	29	100.0%	59	100.0%	
Frequency of participation in other exercise (week)	1–2 times	13	43.3%	8	27.6%	21	35.6%	0.406
	3–4 times	9	30.0%	7	24.1%	16	27.1%	
	5–6 times	3	10.0%	3	10.3%	6	10.2%	
	7 times	0	0.0%	1	3.4%	1	1.7%	
	N/A	5	16.7%	10	34.5%	15	25.4%	
	Total	30	100.0%	29	100.0%	59	100.0%	
Participation in dancing prior to starting pole	No	15	50.0%	13	44.8%	28	47.5%	0.691
	Yes	15	50.0%	16	55.2%	31	52.5%	
	Total	30	100.0%	29	100.0%	59	100.0%	
Participation in gymnastics/circus arts prior to starting pole	No	28	93.3%	27	93.1%	55	93.2%	1.000
	Yes	2	6.7%	2	6.9%	4	6.8%	
	Total	30	100.0%	29	100.0%	59	100.0%	

Table 4.5.2: Univariate analysis of factors associated with lifetime musculoskeletal injuries (*n*=59)

	MSK Injury in Lifetime						
	No		Yes		Total		*p*–value
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
Weight (kg)	65.4	12.0	63.4	11.7	64.4	11.8	0.532
BMI	24.1	3.8	23.7	4.0	23.9	3.8	0.722

Table 4.5.3: Univariate analysis of factors associated with lifetime musculoskeletal injuries (*n*=59)

		MSK Injury in Lifetime						
		No		Yes		Total		*p*–value
		n	%	*n*	%	*n*	%	
Body type	Ectomorph	13	43.3%	6	20.7%	19	32.2%	0.102
	Mesomorph	6	20.0%	12	41.4%	18	30.5%	
	Endomorph	11	36.7%	11	37.9%	22	37.3%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Fitness rank	Not fit at all	4	13.3%	1	3.4%	5	8.5%	0.178
	Below average	9	30.0%	4	13.8%	13	22.0%	
	Average	13	43.3%	15	51.7%	28	47.5%	
	Above average	4	13.3%	8	27.6%	12	20.3%	
	Very fit	0	0.0%	1	3.4%	1	1.7%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Strength rank	Not strong at all	2	6.7%	1	3.4%	3	5.1%	0.061
	Below average	13	43.3%	4	13.8%	17	28.8%	
	Average	9	30.0%	14	48.3%	23	39.0%	
	Above average	6	20.0%	8	27.6%	14	23.7%	
	Very strong	0	0.0%	2	6.9%	2	3.4%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Participation in warm–up before pole	No	0	0.0%	0	0.0%	0	0.0%	–
	Yes	30	100.0%	29	100.0%	59	100.0%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Length of warm up on average	< 5 mins	6	20.0%	1	3.4%	7	11.9%	0.027
	5–9 mins	17	56.7%	12	41.4%	29	49.2%	
	10–14 mins	7	23.3%	15	51.7%	22	37.3%	
	15–19 mins	0	0.0%	1	3.4%	1	1.7%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Participation in static stretching warm-up	No	17	56.7%	13	44.8%	30	50.8%	0.363
	Yes	13	43.3%	16	55.2%	29	49.2%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Participation in dynamic movement warm-up	No	7	23.3%	1	3.4%	8	13.6%	0.052
	Yes	23	76.7%	28	96.6%	51	86.4%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Participation in a cardiovascular warm-up	No	25	83.3%	21	72.4%	46	78.0%	0.312
	Yes	5	16.7%	8	27.6%	13	22.0%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Participation in a cool-down after pole	No	3	10.0%	1	3.4%	4	6.8%	0.612
	Yes	27	90.0%	28	96.6%	55	93.2%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Participation in a static stretching cool-down	No	13	43.3%	1	3.4%	14	23.7%	<0.001
	Yes	17	56.7%	28	96.6%	45	76.3%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	

Table 4.5.3/continued: Univariate analysis of factors associated with lifetime musculoskeletal injuries (*n*=59)

Participation in a dynamic movement cool-down	No	17	56.7%	20	69.0%	37	62.7%	0.329
	Yes	13	43.3%	9	31.0%	22	37.3%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Temperature affects grip on pole	No	2	6.7%	0	0.0%	2	3.4%	0.492
	Yes	28	93.3%	29	100.0%	57	96.6%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Warmer temperature increases difficulty to grip pole	No	8	26.7%	7	24.1%	15	25.4%	0.824
	Yes	22	73.3%	22	75.9%	44	74.6%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Warmer temperature decreases difficulty to grip pole	No	30	100.0%	26	89.7%	56	94.9%	0.112
	Yes	0	0.0%	3	10.3%	3	5.1%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Cooler temperature increases difficulty to grip pole	No	27	90.0%	22	75.9%	49	83.1%	0.181
	Yes	3	10.0%	7	24.1%	10	16.9%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Cooler temperature decreases difficulty to grip pole	No	20	66.7%	20	69.0%	40	67.8%	0.850
	Yes	10	33.3%	9	31.0%	19	32.2%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Temperature does not affect grip	No	27	90.0%	29	100.0%	56	94.9%	0.237
	Yes	3	10.0%	0	0.0%	3	5.1%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Use of grip aid	No	6	20.0%	2	6.9%	8	13.6%	0.254
	Yes	24	80.0%	27	93.1%	51	86.4%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Always uses grip aid	No	18	60.0%	18	62.1%	36	61.0%	0.871
	Yes	12	40.0%	11	37.9%	23	39.0%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Uses grip aid when pole is slippery	No	19	63.3%	16	55.2%	35	59.3%	0.524
	Yes	11	36.7%	13	44.8%	24	40.7%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Uses grip aid for moves difficult to sustain	No	22	73.3%	16	55.2%	38	64.4%	0.145
	Yes	8	26.7%	13	44.8%	21	35.6%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Does not use grip aid	No	24	80.0%	27	93.1%	51	86.4%	0.254
	Yes	6	20.0%	2	6.9%	8	13.6%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Temperature affects energy level fatigue	No	4	13.3%	4	13.8%	8	13.6%	1.000
	Yes	26	86.7%	25	86.2%	51	86.4%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Warmer temperature fatigues energy levels quicker	No	5	16.7%	8	27.6%	13	22.0%	0.312
	Yes	25	83.3%	21	72.4%	46	78.0%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Warmer temperature fatigues energy levels slower	No	30	100.0%	29	100.0%	59	100.0%	-
	Yes	0	0.0%	0	0.0%	0	0.0%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Cooler temperature fatigues energy levels quicker	No	30	100.0%	26	89.7%	56	94.9%	0.112
	Yes	0	0.0%	3	10.3%	3	5.1%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Cooler temperature fatigues energy levels slower	No	23	76.7%	21	72.4%	44	74.6%	0.708
	Yes	7	23.3%	8	27.6%	15	25.4%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Temperature has no effect on energy level fatigue	No	25	83.3%	25	86.2%	50	84.7%	1.000
	Yes	5	16.7%	4	13.8%	9	15.3%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	

Table 4.5.3/continued: Univariate analysis of factors associated with lifetime musculoskeletal injuries (*n*=59)

Temperature affects muscle fatigue	No	13	43.3%	16	55.2%	29	49.2%	0.363
	Yes	17	56.7%	13	44.8%	30	50.8%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Warmer temperature fatigues muscles quicker	No	14	46.7%	20	69.0%	34	57.6%	0.083
	Yes	16	53.3%	9	31.0%	25	42.4%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Warmer temperature fatigues muscles slower	No	30	100.0%	29	100.0%	59	100.0%	-
	Yes	0	0.0%	0	0.0%	0	0.0%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Cooler temperature fatigues muscles quicker	No	28	93.3%	27	93.1%	55	93.2%	1.000
	Yes	2	6.7%	2	6.9%	4	6.8%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Cooler temperature fatigues muscles slower	No	26	86.7%	26	89.7%	52	88.1%	1.000
	Yes	4	13.3%	3	10.3%	7	11.9%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	
Temperature does not affect muscle fatigue	No	18	60.0%	13	44.8%	31	52.5%	0.243
	Yes	12	40.0%	16	55.2%	28	47.5%	
	Total	**30**	**100.0%**	**29**	**100.0%**	**59**	**100.0%**	

4.8.1 Skill Level

Skill level was ranked between beginners, amateurs, intermediates and advanced. The data showed that beginners were less likely to get injured and that intermediates were more likely to get injured (37.9%, *n*=11, *p*=0.004) making this a significant risk factor as demonstrated (Table 4.5.1).

4.8.2 Strength

Strength in pole fitness was also statistically significant showing that those ranked as average, above average and very strong were more likely to get injured (*p*=0.061). 48.3% (*n*=14) ranked themselves as average, 27.6% (*n*=8) ranked themselves as above average and 6.9% (*n*=2) ranked themselves as very strong (Table 4.5.3).

4.8.3 Warm-Up

The length of an athlete's warm up showed statistical significance where warm-ups longer than 10 minutes were more likely to get injured (*p*=0.027). The type of warm-up was also investigated where those doing dynamic movement warm-up were more likely to get injured (*p*=0.052), compared to those who did static stretching or cardiovascular warm-ups (Table 4.5.3).

4.8.4 Cool Down

Those who performed static stretching type cool-downs were more likely to get injured ($p<0.001$) (Table 4.5.3).

Table 4.6 demonstrates the multiple logistic regression for factors associated with lifetime musculoskeletal injuries.

Table 4.6: Multiple logistic regression for factors associated with lifetime musculoskeletal injuries

Factor	Crude OR	95% CI	*p*-value	Adjusted OR	95% CI	*p*-value
Strength > average	4.8	1.445 – 15.940	0.010	1.87	0.369 – 9.449	0.451
Warm up length > 10 minutes	4.04	1.321 – 12.377	0.014	1.32	0.302 – 5.795	0.710
Skill level intermediate and above	7.31	1.804 – 29.636	0.005	15.85	1.208 – 208.017	0.035
Warm up dynamic movement	8.52	0.976 – 74.388	0.053	60.54	2.302 – 1592.2	0.014
Cool down static stretching	21.41	2.567 – 178.625	0.005	26.65	2.090 – 339.7	0.011

After adjusting for all factors in the model, strength and warm-up length ceased to be predictive factors of injuries. Skill level became a stronger predictor with its odds ratio increasing to nearly 16, and so did dynamic warm-ups (OR increasing to 60) and static stretching cool-down (OR increasing to 27). Therefore, after adjusting for strength and length of warm-up, the factors which were associated with lifetime MSK injuries were being average or above skill level, warming up using dynamic movement, and cooling down using static stretching (Table 4.6). It is important to note that these behaviours might have arisen as a result of the injury and not prior to the injury since we do not know with this study design which came first, the injury or the behaviour (a limitation of cross-sectional studies). There is just an association which is worth reporting but it does not imply causation.

4.9 IMPACT OF POLE SPORT INJURIES

The participants were questioned on how their musculoskeletal injuries impacted different aspects of their life (Table 4.7).

Table 4.7: Impact associated with lifetime musculoskeletal injuries

		Count (*n*)	Percentage (%)
Length of recovery time from the MSKI (week)	0–1 week	8	27.6%
	2–3 weeks	7	24.1%
	4–6 weeks	3	10.3%
	>6 weeks	11	37.9%
	Total	**29**	**100.0%**
Length of time pole sport was ceased (week)	0–1 week	8	27.6%
	2–3 weeks	2	6.9%
	4–6 weeks	4	13.8%
	>6 weeks	7	24.1%
	Did not stop	8	27.6%
	Total	**29**	**100.0%**
Length of time other exercise was ceased (week)	0–1 week	8	27.6%
	2–3 weeks	4	13.8%
	4–6 weeks	3	10.3%
	>6 weeks	2	6.9%
	Did not stop	12	41.4%
	Total	**29**	**100.0%**
MSKI affected ability to sleep	No	13	44.8%
	Yes	16	55.2%
	Total	**29**	**100.0%**
MSKI affected mood negatively	No	10	35.7%
	Yes	18	64.3%
	Total	**28**	**100.0%**
MSKI increased stress levels	No	16	59.3%
	Yes	11	40.7%
	Total	**27**	**100.0%**
MSKI affected ability to perform daily activities	No	3	10.7%
	Yes	25	89.3%
	Total	**28**	**100.0%**
MSKI affected job	No	17	60.7%
	Yes	11	39.3%
	Total	**28**	**100.0%**
MSKI affected wellbeing and/or quality of life	No	14	50.0%
	Yes	14	50.0%
	Total	**28**	**100.0%**

The majority of the participants took longer than six weeks to recover from their musculoskeletal injury (37.9%, *n*=11) but most of the athletes either did not stop pole sport (27.6%, *n*=8) or other activities (41.4%, *n*=12) or only stopped pole sport (27.6%, *n*=8) and other activities (27.6%, *n*=8) for one week or less; 89.3% (*n*=25) of the participants found their injury affected their daily activities. More than 50% of the participants reported having their sleep affected (55.2%, *n*=16), led to affecting their mood negatively (64.3%, *n*=18) and affected their quality of life and wellbeing (50%, *n*=14) (Table 4.7).

4.10 MANAGEMENT OF MUSCULOSKELETAL INJURIES

The participants were asked what their strategies to managing their injuries were, including the use of self-management and professional management and the effectiveness thereof.

4.10.1 Self-Management of Musculoskeletal Injuries

The participants were asked to report on their use of self-management approaches for their musculoskeletal injuries (Table 4.8).

Table 4.8: Self-management and relief thereof associated with lifetime musculoskeletal injuries

		Count (*n*)	Column N %
Remedy: no treatment	No	26	89.7%
	Yes	3	10.3%
	Total	**29**	**100.0%**
Remedy: no treatment provided relief	No	3	100.0%
	Yes	0	0.0%
	Total	**3**	**100.0%**
Remedy: self-medication	No	15	51.7%
	Yes	14	48.3%
	Total	**29**	**100.0%**
Remedy: self-medication provided relief	No	5	35.7%
	Yes	9	64.3%
	Total	**14**	**100.0%**
Remedy: home remedies	No	11	37.9%
	Yes	18	62.1%
	Total	**29**	**100.0%**
Remedy: home remedies provided relief	No	6	33.3%
	Yes	12	66.7%
	Total	**18**	**100.0%**

Table 4.8 outlines that self-medication was used in 48.3% (*n*=14) of the injury cases and was effective in 64.3% (*n*=9). Home remedies such as heat and ice were used in 62.1% (*n*=18) of the injury cases and were effective in 66.7% (*n*=12).

4.10.2 Professional Healthcare as Management of Musculoskeletal Injuries

Table 4.9 shows the professional consultations rate and success rates thereof which were utilised by pole sport athletes.

Table 4.9: Professional management and relief thereof associated with lifetime musculoskeletal injuries

		Count (*n*)	Column N %
Consulted a GP	No	23	82.1%
	Yes	5	17.9%
	Total	**28**	**100.0%**
Consulting a GP provided relief	No	4	80.0%
	Yes	1	20.0%
	Total	**5**	**100.0%**
Consulted a chiropractor	No	19	67.9%
	Yes	9	32.1%
	Total	**28**	**100.0%**
Consulting a chiropractor provided relief	No	4	44.4%
	Yes	5	55.6%
	Total	**9**	**100.0%**
Consulted a physiotherapist	No	23	85.2%
	Yes	4	14.8%
	Total	**27**	**100.0%**
Consulting a physiotherapist provided relief	No	2	50.0%
	Yes	2	50.0%
	Total	**4**	**100.0%**
Consulted an acupuncturist	No	27	100.0%
	Yes	0	0.0%
	Total	**27**	**100.0%**
Consulting an acupuncturist provided relief	No	0	0.0%
	Yes	0	0.0%
	Total	**0**	**0.0%**
Consulted a homeopath	No	27	100.0%
	Yes	0	0.0%
	Total	**27**	**100.0%**
Consulting a homeopath provided relief	No	0	0.0%
	Yes	0	0.0%
	Total	**0**	**0.0%**
Consulted a traditional African healer	No	27	100.0%
	Yes	0	0.0%
	Total	**27**	**100.0%**
Consulting a traditional African healer provided relief	No	0	0.0%
	Yes	0	0.0%
	Total	**0**	**0.0%**
Consulted an Ayurveda doctor	No	27	100.0%
	Yes	0	0.0%
	Total	**27**	**100.0%**
Consulting an Ayurveda doctor provided relief	No	0	0.0%
	Yes	0	0.0%
	Total	**0**	**0.0%**
Consulted an orthopedic surgeon	No	25	92.6%
	Yes	2	7.4%
	Total	**27**	**100.0%**
Consulting an orthopedic surgeon provided relief	No	0	0.0%
	Yes	2	100.0%
	Total	**2**	**100.0%**
Consulted someone not on the list (please specify)		32	54.2%
	(I just carried on with daily life)	1	1.7%
	0	23	39.0%
	1 (occupational therapist)	1	1.7%
	1 (Spoke to biokineticist and someone with hx of wrist injury)	1	1.7%
	1 (sports doctor)	1	1.7%
Consulting someone not on the list (please specify) provided relief	No	2	66.7%
	Yes	1	33.3%
	Total	**3**	**100.0%**

A general practitioner was consulted in only 17.9% (*n*=5) and of these only 20% (*n*=1) had relief. Chiropractors were consulted in 32.1% (*n*=9) of the injury cases and had a 55.6% (*n*=5) success rate. Physiotherapists were consulted 14.8% (*n*=4) of the injury cases and had a 50% (*n*=2) success rate. It should be noted that of the only two who consulted orthopedic surgeons, 100% had success.

4.11 SUMMARY

This chapter has outlined the results from the data collected from participants in this study. This study investigated the period and lifetime prevalence, details regarding musculoskeletal injuries due to pole sports, risk factors, the impact that musculoskeletal injuries have on participants and the management they used for the injuries obtained.

There was a total of 59 participants in this study. The lifetime prevalence of musculoskeletal injuries in pole sports was 49.2% (*n*=29) and the period prevalence was 40.7% (*n*=24) which demonstrates that injuries are fairly common in this sport. The most common types of injuries were strains (50.65%, *n*=39) and the most common anatomical region injured was the shoulder (19.5%, *n*=15).

The most severe musculoskeletal injuries occurred to the shoulder 35% (*n*=10), with the most severe injury type being strains (48.1%, *n*=13). The factors associated with these injuries were being average or above skill level, warming up using dynamic movement, and cooling down using static stretching. It is important to note that these behaviours might have arisen as a result of the injury and not prior to the injury since we do not know with this study design which came first, the injury or the behaviour (a limitation of cross-sectional studies). Although, even though there is evidently an association, this does not imply causation.

The results also demonstrated that athletes' injuries were severe and, in many cases, lasted longer than six weeks with large impacts on quality of life and functioning. The success rates of self-medication and home remedies showed to be higher compared with consulting healthcare professionals. This excluded the use of an orthopaedic surgeon; however, the choice of management may have been influenced by the severity of the injury and, thus, the success rates of management were also influenced by the severity of the injury.

CHAPTER FIVE: DISCUSSION

5.1 INTRODUCTION TO THE DISCUSSION IN POLE SPORT

This chapter will compare the results obtained in this study outlined in Chapter Four with the study objectives and the literature reviewed in Chapter Two. This discussion will include the rate of participation, demographics, prevalence of musculoskeletal injuries associated with pole sports, the risk factors, impact and management used for the injuries.

5.2 RATE OF PARTICIPATION

The total sample size required for this study was 59 participants and, although 69 responses were obtained, only 59 questionnaires were completed and thus utilised in this study.

This sample size was smaller than the study done by Kukard (2019) in Gauteng, South Africa, which had a total sample size of 100 participants from a total of eight pole sport studios. This study collected data from only five pole sport studios and was also conducted post COVID-19. The impact of the pandemic meant that many participants could not continue to partake in additional sporting activities due to financial issues from job loss and the subsequent loss of income (Grubben, Hoekman and Kraaykamp, 2023; Schotte and Zizzamia 2022).

This study achieved a sufficient response rate to add important information to the body of literature regarding pole sport injuries.

5.3 Demographics

5.3.1 Age

The majority of the participants who participated in pole sports were in the 25–29 year old age group followed by the 18–24 year old age group.

Lee, Lin and Tan (2020) found that of a total of 158 participants from five different countries. The majority of them were in the 30–39 yearold age group with a median age of 31, ranging from 19–60 years old. Nicholas *et al.* (2022) conducted a study using participants from social media and found a mean age of 32.3 +/- 8.9 years.

Cole (2021) used participants from social media and found a mean age of participants being 32 years old, ranging from 18–69 years old. Naczk, Kowalewska and Naczk (2020) did a study to compare competitive pole sport athletes and untrained women. They found a mean age of pole sport athletes to be 25.12 +/- 3.28 years.

5.3.2 Gender

The gender distribution showed that 98.3% of the participants were female and the remainder (*n*=1) identified as non-binary.

Nicholas *et al.* (2022) used 63 female participants and three male participants showing the predominance of females. Szopa *et al*. (2022), Gołuchowksa and Humka (2021) and Nawrocka *et al*. (2017) all performed studies on pole sport which included only female participants, which reiterates that pole sport is predominantly a female sport.

Jensen and Thing (2022) explored the trend of gender in pole sports. The female dominance in pole sport has been explained by many studios only allowing females to train. This was often based on the fact that this gives an increased sense of security for women, leading to a decrease in feelings of being sexualised. Some of the studios indicated that when men have been allowed to partake in pole sports, the women often act differently and worry about trying to prove themselves against men or looking good for the men.

As a result of the predominance of the gender being female, the effect of gender predisposing pole sport athletes to injury could not be investigated.

5.3.3 Ethnicity

The majority of the participants were white (77.2%) which meant that the effect of ethnicity predisposing pole sport athletes to injury could not be investigated.

5.4 ANTHROPOMETRICS

The participants in this study showed a BMI range between 18 to 32 and the participants identified as ectomorph, mesomorph and endomorph, which was relatively evenly distributed, which meant that anthropometrics predisposing pole sport athletes to injury could not be investigated.

Amirshaghaghi, Pournemati and Zandi (2019) examined the role that body composition had in predicting sports injuries and found that an abnormal body composition may be linked with injury prediction. However, from the current research, it seems that injury patterns are relative to different types of injuries and, thus, a larger study focusing on anthropometrics linked to pole sports would be needed to assess the link.

5.5 PREVALENCE OF MUSCULOSKELETAL INJURIES

This study addressed both lifetime and period prevalence associated with musculoskeletal injury of pole sport injuries.

5.5.1 Lifetime Prevalence

The lifetime prevalence of pole sport injuries in this study was 49.2% (*n*=29) revealing almost half of all the pole sport athletes who were currently participating in the sport had sustained at least one injury as a result of the sport. This was a lower percentage compared to the study done by Kukard (2019) on pole sport athletes in Gauteng, South Africa, which found that 58% of their participants had sustained an injury due to pole sports. This difference could be due to the lesser sample size of this study (*n*=59) compared to the larger study done by Kukard (2019) (*n*=100).

5.5.2 Period Prevalence

Period prevalence was defined as an athlete experiencing a musculoskeletal injury in the past 12 months and this study revealed this to be 40.7% (*n*=24).

5.6 PRESENTATION OF MUSCULOSKELETAL INJURIES

5.6.1 Number of Participants Who Sustained an Injury

Of the 59 study participants, 49.2% (*n*=29) indicated that they had sustained an injury as a direct result of pole sports. The remainder of this chapter will focus on these study participants.

5.6.2 Region of the Body Injured

This study's participants were asked to identify all the regions they had been injured from pole sports. According to the data, pole sport athletes sustained injuries in the following regions: shoulder (64.3%), hand/wrist (46.4%), neck (35.7%), thoracic back (35.7%), foot/ankle (25%), hip/thigh (21.4%), lumbar back (17.9%), knee (17.9%), head (3.6%) and elbow (3.6%).

The studies conducted by Nicholas *et al.* (2022), Gołuchowska and Humka (2021), Cole (2021), Lee, Lin and Tan (2020) and Kurkard (2019) on pole sport athletes all revealed similar results, where the upper limb was the most commonly injured region of the body, and the shoulder joint made up the majority of the upper limb injuries, followed by the hand and wrist region.

Nicholas *et al.* (2022) did a prospective cohort study on the incidence, mechanisms and characteristics of injuries in 66 pole dancers from 41 studios across Australia over one year and found that the shoulder accounted for a total of 20.4% of the injuries. Gołuchowska and Humka (2021) conducted a questionnaire online via social media which included 213 women who answered questions regarding their injuries to the locomotor system during training and revealed that the highest occurrence of injuries was the shoulder joint. Cole

(2021) recruited participants via social media who completed a questionnaire, which found 45% of the pole sport injuries were to the shoulders, followed by 19% wrist injuries. Lee, Lin and Tan (2020) did an online web-based survey via social media for pole sport athletes which revealed 54.5% of the participants had sustained a shoulder injury, with the wrist being the next most common at 34.2%. Kukard (2019) performed a questionnaire-based quantitative study on 100 pole sport athletes in Gauteng, South Africa, and found the upper limb accounted for 41.6% of the injuries, with the shoulder accounting for the majority of this (15.2%), followed by the wrist (12%), hand (7.2%) and elbow (7.2%).

The upper limb is most at risk of injury due to certain pole specific movements which load the upper limb substantially, leading to an overload of the musculoskeletal system (Szopa *et al.* 2022). Most shoulder injuries occur from movements that load internal shoulder rotation (Nicholas *et al.* 2022).

Many pole movements include placing the shoulder joint into an end range of motion position which then leads to having the musculature of the shoulder joint to support the rest of the body. The shoulder has evolved into performing tasks such as reaching and carrying which do not include weight bearing. Placing joints into positions which lengthen musculotendinous tissues whilst under large levels of strain can cause soft tissue injuries. This especially affects amateur athletes who have not built up the required strength and stability for these positions (Nicholas *et al.* 2022).

With regards to wrist joint injuries, many pole sport athletes perform manoeuvres which utilise a palm grip onto the pole while moving the rest of the body into positions so that majority of the weight of the athlete ends up directed into the wrist joint (Lee, Lin and Tan 2020). In artistic gymnastics, the wrist often undergoes repetitive stress and torsional forces, which is similar to pole sport athletes (Kukard, 2019).

Szopa *et al*. (2022) did a cross-sectional survey over four months using 50 pole dance schools in Poland and found that, of a total of 320 female pole dancers, 86% reported an injury occurrence throughout their participation in pole sport. Szopa *et al*. (2022) found that majority of the injuries occurred to the lower extremity (59%), followed by the upper extremity (39%), and then the spine (10%). This is in contrast with present study's results which shows that the upper extremity is the most injured region of the body during pole sport.

Another relevant find was that over 48% of athletes experienced a re-injury, and the majority of those were to the same area that the original injury occurred (Szopa *et al*. 2022). A previous injury has been suggested to be a risk factor for future injury (DiFiori *et al.* 2014). Re-injury commonly occurs due to deficits in the neuromuscular elements present post injury. An injury often causes changes in an individual's strength and proprioception which may decrease their motor function, leading to a higher susceptibility for injury (Fulton *et al*. 2014).

The data are significant from a clinical perspective because it allows healthcare professionals to understand which anatomical areas of pole sport athletes are most at risk to injury, which allows for the appropriate assessment and management to be applied to these athletes.

5.6.2.1 Comparison to Artistic Gymnastics

Pole sport has been likened to artistic gymnastics and other circus arts due to it combining strength and flexibility (Lee, Lin and Tan 2020). Paxinos *et al*. (2019) conducted a 10-year study examining 156 elite artistic and rhythmic gymnasts. They found a total of 2 390 injuries reported for a rate of 1,5 new injuries per year per athlete. The most common affected areas included the hip (18.5%), ankle (16.5%), lumbar spine (16%) and the foot (16%). The most frequent diagnosis was tendinitis (32%), followed by low back pain (20%), and sprains (12%); 15 athletes (9%) sustained serious injuries that required surgery. Rhythmic gymnasts had significantly more overuse type injuries compared to artistic gymnasts (p=0.049).

Sastre-Munar *et al*. (2022) conducted a study on injuries, pain and catastrophising levels in gymnasts. Of the 160 gymnasts, 50% experienced an injury. The most common injury location was the ankle, knee and lower back. A large proportion of the artistic gymnasts (50.8%) sustained an injury and this research found showed that artistic gymnasts suffered more frequent wrist pain. The high impact of injuries was caused by floor routines and landing, as well as common wrist extension positioning and hand grips, which explains these results. Wrist pain has been found to be a common area for musculoskeletal pain and injury due to the load applied to the upper extremity while weight-bearing.

The proportion of spinal injuries in pole sport athletes and artistic gymnasts is comparable. However, in contrast to my results, artistic gymnasts have a higher incidence of lower body and wrist injuries. This can be explained by unpacking the cause of injury in these injuries. In gymnasts, many injuries are caused by acrobatic and tumbling activities which lead to falls and incorrect landing (Bradshaw and Hume 2012). Injuries experienced by pole sport athletes, in contrast, are more likely due to intrinsic factors, such as the demand of pole movements on the musculoskeletal system, as well as insidious factors such as training volume (Nicholas 2019).

5.6.3 Most Severe Injury Site

In this study, the participants were asked to identify the region in their body that they experienced their most severe injury. According to the data, pole sport athletes sustained their most severe injury in the following regions: shoulder (25%), rotator cuff of the shoulder (10.7%), hip/thigh (7.1%), ankle (3.6%), back (3.6%), costovertebral joint (3.6%), foot/shin (3.6%), hand/wrist (3.6%), infraspinatus partial tear (3.6%), knee (3.6%), lumbar back (3.6%), lumbar, thoracic and shoulder (3.6%), neck (3.6%), rhomboid (3.6%), rib (3.6%), spine and ribs (3.6%), intercostal muscle (3.6%), wrist (3.6%) and wrist and lower forearm (3.6%).

This study's data demonstrated that the most injured region of the body was the upper limb accounting for 50.1% of the total injuries. This was followed by the spine, rib and their related muscles, accounting for 28.8%, and the lower limb accounting for 17.9%. A participant indicated the spine and the shoulder as their most severe injury site, accounting for the remaining 3.6%.

This further emphasised that there is a high demand on the upper limb during pole sports. This is clinically relevant for medical health professionals to be aware of as it helps understand the need for cross-training in order to adequately prepare the body to reduce the risk of injury. Cross-training usually involves training in other ways not directly involving the regular sport of the athlete. It can include training to increase flexibility, muscle endurance, power and strength (Durkalec-Michalski *et al*. 2021). An example of cross-training includes resistance training, which has become more popular due to its benefits of decreasing cardiovascular disease, improving blood pressure and bone density. Additionally, it has also been seen to improve muscle strength, power, endurance and hypertrophy.

For participants in pole sports, strength is an important aspect of the sport and participating in resistance training once a week can assist in building that strength and, thus, decreasing the likelihood of injuries (Townsend 2022).

Flexibility training is as important for pole sport athletes due to many of the movements requiring flexibility for them to be performed. Flexibility is a standard component of fitness and static stretching has demonstrated positive effects on muscle strength, power and hypertrophy, thereby decreasing the risk of injury (Bouguezzi *et al*. 2023).

5.6.4 Types of Injuries

The most severe injuries experienced by participants in this study were defined by type and were categorised as strain (48.1%), contusion (11.1%), strain leading to a pinched nerve

(7.4%), sprain (7.4%), fracture (3.7%), impingement (3.7%), slipped rib and muscle strain (3.7%), spinal decompression and fusion (3.7%), tendon inflammation into rotator cuff (3.7%), tear of the rotator cuff (3.7%) and one participant was unsure whether their injury was a strain or sprain (3.7%).

With strain being the majority type of injury (48.1%), the results of this study mirrored the results of the study done by Kukard (2019), who found 58% of their pole sport athlete participants had a strain injury, and a study by Mitrousias *et al.* (2017) that found that sprains, strains and contusions to be the most common injuries to occur in pole sport athletes. Muscle strain injuries are common injuries in sport and have a high recurrence rate in athletes (Bayer *et al.* 2021). They are frequently the result of the muscle being stretched beyond its resting length (Delos, Maak and Rodeo 2013), and often occur at the myotendinous junction (Jakobsen and Krogsgaard 2021). If there is an incomplete repair of the myotendinous junction after the injury, it may explain the reason for the high recurrence rate of injury (Bayer *et al.* 2021). Strains may be predominant in pole sport athletes due to the muscles playing a large role in supporting the joints during pole movements. As seen with the shoulder joint, the rotator cuff muscles are the main stabilisers of the shoulder and the fact that the most common injuries are in the shoulder correlates to the most common injury type being a strain (Nicholas *et al.* 2022).

Subsequent to strain, contusion was the next most common severe injury in this study's cohort, which, given the nature of the sport, is a foreseeable consequence. Contusion injuries are defined as direct, non-penetrative muscle trauma where the skeletal muscle is compressed between bone and an external object. They can lead to localised pain, inflammation, decreased function and range of motion, oedema and swelling (Barnes *et al.* 2022). Pole sport is a high-impact sport where an athlete changes from one movement to another and where numerous parts of the body may contact the pole. Contusion injuries may occur if there is a lack of muscular control leading to direct force of the pole onto the muscle (Kukard 2019). A contusion may also occur if the athlete slips off of the pole and lands onto the floor.

Sprains made up a total of 7.4% of the injuries. This is much lower than the percentage found in the Kukard's (2019) study, where it was found that 29% of the participants had suffered a sprain injury. Kukard (2019) suggested a reason that there were so many sprain injuries in their participants was a potential lack of warming up prior to participating in the sport. This may be a potential reason for the difference in the current study's results as 100% of the participants who had previous injuries did a warm-up prior to participating in the pole class. A sprain occurs when one or multiple ligaments are stretched or torn. This occurs when the range of motion of a joint is exceeded (Ortega-Avila *et al.* 2020), which is common in pole sports due to the level of range of motion an athlete needs to execute many of the pole sport movements. If an athlete's range of motion is limited, and they push their bodies into the position or movement, they may end up with a sprain.

The data are significant because knowing the types of injuries for which athletes are most at risk can guide a healthcare professional on how best to develop programs to decrease the risk of these injuries assisting in appropriate management of the injury so that the athlete can return to their pre-injury state.

5.7 RISK FACTORS

5.7.1 Age

This study found that there was no significant correlation between age and the incidence of pole sport injuries as seen in studies done by Lee, Lin and Tan (2020) and Soini and Laine (2018). In contrast, Nicholas (2019) did identify age as a risk factor for injury.

5.7.2 Weight

Despite weight and BMI having shown to be a risk factor for musculoskeletal injury (Amirshaghaghi, Pournemati and Zandi 2019), this study demonstrated that weight was not a risk factor for injury. This correlates with the results found by Kukard (2019). This may have been due to the sample size being too small to correlate weight and injury prevalence.

5.7.3 Skill Level

This study demonstrated that skill level had a significant impact on injury prevalence. Those who categorised themselves as beginners were less likely to be at risk of injury, whereas those who categorised themselves as intermediates were at a higher risk of injury (p=0.004). This correlated with the study done by Nicholas *et al.* (2022) where the higher skill level of pole sports increased the risk of injury. This could be because those who had a higher skill level of pole sports perform more difficult pole movements and, thus, have a higher risk of injury, whereas beginners perform more simplified and less dangerous movements. This phenomenon is known as the Dunning-Kruger effect, which states that people often tend to overestimate their ability. This may describe why those who ranked their skill level as higher may believe their skill level to be higher than their actual ability. It may lead to the athlete performing movements too advanced for their level which can increase the risk of potential injuries (Sullivan, Ragogna and Dithurbide 2019). Szopa *et al* (2022) also demonstrated that a lower level experience in pole sport training increased the risk of re-injury.

5.7.4 Frequency of Training

This study found no statistically significant data linking the frequency of training to the risk of injury. The American College of Sports Medicine Guidelines defines pole sport as a moderate-intensity cardiorespiratory exercise (Ballarin *et al.* 2021). Adults are encouraged to perform at least 150–300 minutes per week of moderate intensity activity (Yang 2019). Thus, with an average pole class being 60 minutes, anything more than five classes a week can be seen as excessive and not allowing the body enough rest (Yang 2019). Studies by Gołuchowksa and Humka (2021), Lamoyne *et al*. (2017) and Lee *et al.* (2017) all showed that excessive training was linked to an increased risk of injury. This study sample only found 6.8% of the participants who had a previous musculoskeletal injury to have been participating in pole sports more than four times a week which may be why there was no correlation found between frequency of training and injury prevalence.

5.7.5 Duration of Training

This study found no statistically significant data linking the duration of training to the risk of injury. A small number of those who had musculoskeletal injuries (10.3%) participated in sessions which lasted longer than one hour, whereas all those who had no previous musculoskeletal injury only participated in classes which were one hour or less. Kukard (2019) found that a duration of pole sports training lasting longer than one hour increased the likelihood of an injury developing. In the current study, the data suggest there may be a potential risk of a longer duration of training being linked to injury; however, a larger sample size would be needed to discover this.

5.7.6 Intensity of Training

This study found no statistically significant data linking the intensity of training to the risk of injury. There has been no identified published data on whether the intensity had an effect on musculoskeletal injuries, possibly because measuring the intensity of a pole workout is specific to each individual, making it difficult to assess.

5.7.7 Additional Risk Factors Identified

5.7.7.1 Strength

This study found that pole athletes who ranked as average and above were seen to more likely to get injured. The level of strength rated by participants was a subjective finding. This may be due to the Dunning-Kruger effect where participants believed they were stronger than they were and felt they could attempt more difficult movements that their bodies were not prepared for and result in injury (Sullivan, Ragogna and Dithurbide 2019).

5.7.7.2 Warm-up

This study found that pole athletes who participated in a warm-up longer than 10 minutes were more likely to get injured. Those who performed dynamic movement warm-up were more likely to get injured compared to those performing static stretching or cardio warm-ups. Previous research shows an opposite finding, that warming up prior to sport increases the blood flow in the muscles which can decrease the risk of injuries (Park *et al.* 2018). Dynamic stretching, specifically, has been shown to decrease stiffness in muscles and increase the range of motion of the surrounding joints and has been seen to prevent injuries (Iwata *et al.* 2019). The reason for the findings in this study are not yet understood and needs additional research.

5.7.7.3 Cool-down

This study found that pole athletes who performed static stretching type cool-downs were more likely to get injured. Studies have shown a benefit of static stretching to increase range of motion, but this benefit decreases 10 minutes post stretch (Sato *et al*. 2020). Afonso *et al.* (2021) found that post-exercise stretching has no data to support or disprove it being beneficial for recovery. A potential reason that static stretching type cool-downs were correlated to an increased risk of injury is that athletes participating in static stretching spend a lot of time at the end range of motion. Being at an end range of motion leads to pushing tissues to their extremes, which may increase the risk of injury but this would need to be further investigated.

5.8 IMPACT OF POLE SPORT INJURIES

5.8.1 On Pole Performance

This study found that the majority of those who experienced pole sport injuries took longer than six weeks to recover from their injury but most of these athletes did not stop pole sport or other activities or only stopped pole sport and other activities for one week or less. This finding was similar to Gołuchowska and Humka (2021), who found more than 80% of athletes continued training despite pain negatively affecting the locomotor system. This study showed that the majority of athletes continued training despite their injury which may have increased the stress on the injuries and led to more severe or permanent damage to the body.

The data are significant as it may indicate that pole sport athletes and their coaches are not educated appropriately regarding the importance of resting and returning to the sport at a lower intensity following injury rather than pushing through the pain which can lead to re-injury and permanent damage to the body. Thus, educating patients who partake in this sport is of vital importance to decrease the risk of further injury.

5.8.2 On Quality of Life

This study investigated the effect of injury on the athletes' sleep, mood, stress levels, ability to perform daily activities, job and overall well-being. This study showed that half of the participants found their injury affected their well-being, with 64.3% of the participants having had their mood affected negatively and 40.7% of the participants experiencing an increase in their stress levels. Psychological and sociocultural factors are both risk factors for injury and have an effect on the ability of an athlete to rehabilitate their injury (Chang *et al.* 2020). Injured athletes of all levels have been found to have had lower mental health scores with higher psychological disorders, such as anxiety and depression, increased distress, decreased social functioning and generally a lower quality of life (Furie, Park and Wong, 2023).

Athletes are at higher risk for mental health problems compared to the general population due to their athletic identity and that sport injuries can lead to a physical inability which may increase the likelihood of mental health disorders (Mohammed, Pappous and Sharma 2018). The way an athlete responds to their injury with regards to cognition, emotion and behaviour play a large role in the outcome of the injury (Chang *et al.* 2020). Common emotional responses to injury can be sadness, isolation, irritability, decreased motivation, anger or frustration, change in appetite, sleep difficulties and detachment. When these behaviours become persistent, worse or excessive, they can be problematic and lead to more severe psychological disorders (Putukian 2016).

A majority of 50% of the participants found that their injury affected their sleep. Sleep plays a large role in recovery from injury. Sleep and exercise have been found to influence each other in a reciprocal manner. Exercise improves overall sleep quality and sleep latency and this can then improve mood, and physiological effects on thermoregulation, autonomic and cardiac functioning, as well as hormone and immune responses (Chennaoui *et al*. 2021). When athletes over train, it can lead to a decrease in sleep quality and quantity (Chennaoui *et al*. 2021).

Research has shown that people having less than seven hours of sleep increases the risk of injury, and if this is sustained for at least two weeks, there is a 1.7 times increase in the risk of certain musculoskeletal injuries (Huang and Ihm 2021). Disrupted sleep is linked with an increase in physical stress, which can increase muscle tension, which can lead to a change in motor coordination and flexibility, thus leading to fatigue and potential injury (Hamlin *et al*. 2021). There is also a reciprocal relationship that exists between pain and sleep. When an injury causes pain, it can disrupt sleep and, without sleep, pain is seen to increase (Chennaoui *et al*. 2021).

Almost 90% of the participants found that their injury affected their ability to perform daily activities and 39.3% found that their injury affected their job. Work affords individuals a large amount of social and health benefits and increases overall quality of life (Venning *et al.* 2021). Both musculoskeletal and mental health disorders are a large cause of absence of work which can further exacerbate mental health due to personal and economic distress. This becomes a negative cycle as mental health issues from an injury and an inability to return to work may exacerbate mental illness (Joosen *et al.* 2022). In order to decrease this, it is important for workplaces to have return to work interventions in order to make integrating a previously injured patient back into work easier. This can include an early intervention of psychoeducation, goal setting, graded exposure, behavioural activation and problem-solving strategies and measuring the progress of the employee (Venning *et al.* 2021).

5.9 MANAGEMENT

5.9.1 Self-Management Approaches

Many people in South Africa attempt to treat their injuries at home rather than seeking professional assistance. Owolabi *et al.* (2023) did a study to find what determined the seeking for injury care in South Africa. The barriers they identified included access to healthcare and the quality of healthcare access. The participants identified that the unpleasant attitude of the healthcare workers often led to a negative experience. When family or friends have negative experiences, it may lead to the person needing help to think twice prior to seeking assistance for their injury.

The surrounding neighbourhood and environment also impacted people seeking healthcare. Living in high crime areas may lead to fear avoidance behaviours of seeking healthcare. Transportation was also a large determinant as those without cars or relying on public transport may delay a person's ability to get to a medical professional for assistance. The financial implication of receiving healthcare was also a large factor which led to people not seeking care (Owolabi *et al.* 2023).

For athletes specifically, there is a perception that getting assistance from a healthcare professional may lead to the recommendation of taking a rest from the sport or decreasing the athletes' frequency or duration of training, which often athletes do not want to do as it may inhibit their own success in the sport (Chen, Buggy and Kelly 2019). For these reasons, this study investigated commonly used self-management approaches.

The use of analgesic medication is a common practice when it comes to musculoskeletal injuries (de Sire *et al.* 2021). There are multiple types of pharmacological interventions that can be used, including paracetamol, non-steroidal anti-inflammatory drugs and opioids (de Sire *et al.* 2021). It is recommended that all pharmacological medications are monitored by a medical professional as the best approach is to have the lowest dose of medication for the shortest time to avoid any medication abuse (Melzer, Elbe and Strahler 2022). While this is the ideal, this study showed that almost half of the previously injured participants used self-medication and 64% of those found their self-medication to be effective.

Home remedies, such as hot and cold therapy, are quite popular amongst athletes. Heat and ice were used in 62% of the injury cases in this study, and according to participants, were effective in 67% of cases. Cold therapy or cryotherapy is often used in acute injuries as the cold decreases the inflammation and pain. Cryotherapy has been found to decrease pain and increase joint mobility at an optimal level of 20 minutes (Mutlu and Yilmaz 2020). Alternatively, heat therapy or thermotherapy is more commonly used for chronic injuries in order to decrease joint stiffness (Singh *et al.* 2018). Thermotherapy has been found to be effective at low levels to provide pain relief, improve flexibility and strength and help athletes function better. Both cryotherapy and thermotherapy are effective, safe and easy to use non-pharmacological options which may decrease the use of medication (Freiwald *et al.* 2021).

It is clinically relevant to understand the way athletes manage their injuries themselves in order to gain clarity on what has been effective and ineffective in their injury journey. This allows healthcare professionals to make more effective decisions in managing athletes appropriately.

5.9.2 Professional Healthcare Management

There has been a change in the approach patients have regarding musculoskeletal pain and injury where patients have moved from mainstream pharmacological and surgical care to non-invasive care (El-Tallawy *et al.* 2021). This study has has demonstrated similar findings in that chiropractors were consulted the most extensively of the professional healthcare management (32%), followed by general practitioners (18%) and physiotherapists (14.8%). Only 7.4% of the participants consulted an orthopaedic surgeon. The noteworthy part of the findings was that of those who consulted a chiropractor, 56% had relief from their injury and pain and those who consulted a physiotherapist had a 50% success rate in relief of pain. Those who consulted a general practitioner only had 18% relief from injury and pain. The two injuries which were severe and needed orthopaedic intervention led to 100% success rate.

General practitioners are the first-line health professionals who the general population go to for pain and injuries. However, general practitioners have faced challenges where musculoskeletal injuries need a biopsychosocial approach, which includes improving symptoms and functioning, incorporating rehabilitation and psychosocial support. This differs from the traditional model of medical diagnosis and treatment.

Research has shown that many general practitioners treat musculoskeletal injury and pain with medication, limited advice and prognostic information and prefer imaging and referral to surgeons, rather than referral to physiotherapists or chiropractors, to see if conservative management can assist the patient before surgical intervention is required (Foster, Hartvigsen and Croft 2012). Many general practitioners do not have an appropriate understanding of what musculoskeletal specialists, such as chiropractors and physiotherapists, may be able to offer patients nor do they value the treatment offered (Barnes, Janse van Rensburg and Raubenheimer 2021).

According to research, patients seeing musculoskeletal specialists, such as physiotherapists and chiropractors, do not have a risk of their other medical conditions being overlooked and that these types of practitioners also have extensive clinical diagnostic accuracy. Research has shown that if a nurse triages a patient to a physiotherapist for their primary assessment for musculoskeletal disorders, there are as many positive health effects as having the primary assessment done by a general practitioner (Bornhöft *et al.* 2019). Other benefits of seeing a musculoskeletal specialist include a decrease in medication use, referral for further investigations and referral for surgery, and decreasing the costs involved (Foster, Hartvigsen and Croft 2012).

General practitioners receive limited training in musculoskeletal conditions in medical school, during internship and in post-graduate training. The research also shows that general practitioners do not feel equipped to manage musculoskeletal disorders and rely on either using medication or referral in order to manage a patient. This contrasts to the training musculoskeletal specialists, such as physiotherapists, chiropractors and osteopaths, receive as their speciality, demonstrating they are more equipped to manage musculoskeletal pain and injury (Foster, Hartvigsen and Croft 2012).

It is important for athletes to receive psychosocial interventions following injury to assist in recovery. Gennarelli, Brown and Mulcahey (2020) found that the inclusion of counselling, relaxation and guided imagery, emotional or written disclosure, positive self-talk and setting goals have been shown to assist in improving mood, pain management and adherence to rehabilitation by female athletes. Mindfulness-based stress reduction has also been investigated and showed an improvement in injured athletes' mental health where athletes had an increased pain tolerance and were, therefore, less sensitive to pain (Mohammed, Pappous and Sharma 2018).

Thus, musculoskeletal injuries would be best approached in a multidisciplinary manner, in which different healthcare providers work together with the athlete and their family and coaches to produce the best outcome for the athlete (Edouard and Ford 2020).

5.10 IMPORTANCE OF RESEARCH IN FEMALE-DOMINANT SPORTS

As shown by research, pole sport is predominantly a female sport (Nicholas *et al.* 2022; Szopa *et al*. 2022; Jensen and Thing 2022; Gołuchowksa and Humka 2021; Nawrocka *et al*. 2017). According to the South African Constitution, women should have gender inclusion in sport. As a result, it has been decided to address the gender disparities that currently exist for girls and women in South Africa's sport ecosystem, particularly with relation to participation, competition, officiating, coaching, and leadership (South Africa, Department of Sports, Arts and Culture 2023: 28).

Women in sport face many barriers, which negatively affects the ability for participating, promoting and decision-making power in sport. These barriers include socio-cultural values, which stem from patriarchy, a lack of media advertising and coverage, a lack of role models, gender stereotyping and gender-based violence (Harris *et al*. 2015). There is an absence of resource access, such as to funding, scholarships and equitable remuneration. Other issues include a scarcity of opportunities to partake in different sports at a school level; priority scheduling for male participation; insufficient programmes which identify talent and assist in talent development; scarce opportunities for professional participation; and inadequate facilities and equipment (de Borja *et al*. 2022). Generally, there is an underrepresentation of women in leadership positions which demonstrates the reality in South African sport (Kane and Lavoi 2018).

Regarding injuries, women are considered to be at high risk for specific conditions in sport. These include, but are not limited to, sport-related concussions, bone stress fractures, patellofemoral pain syndrome, anterior cruciate ligament tears and sexual violence (de Borja *et al*. 2022). Younger athletes are also at risk of developing the female athlete triad, which has been classified under the syndrome of relative energy deficiency in sport. This triad originally included a syndrome of three conditions including disordered eating, amenorrhea and osteoporosis (Hilibrand *et al*. 2015). The Female Athlete Triad Coalition Consensus Statement updated the definition of the triad to involve any of the following components: decreased energy availability, which refers to an imbalance of caloric intake to energy expenditure, including excessive exercise, restriction in diet or both combined; menstrual dysfunction; and decreased bone mineral density (Skorseth *et al*. 2020, De Souza *et al*. 2014). It is important that the pathophysiology of these conditions is understood as it assists in decreasing the susceptibility to injury and helps improve the long-term health of the female athlete (Hilibrand *et al*. 2015). It is essential that research is done to address factors that specifically concern female athletes in order to prevent potential injuries (de Borja *et al*. 2022).

Additionally, there is a lack of female representation in sports medicine (Forsyth *et al*. 2019). Increasing the representation of female team physicians may impact care for female athletes in a positive way (de Borja *et al*. 2022). There are many benefits of gender equity in the physician workforce as it can optimise care for female athletes.

In a similar manner, female physicians have been shown to outperform men in certain areas, including screening patients for breast and cervical cancer. Female physicians are also more likely to engage in patient-centred communication compared to male physicians. Patients being able to identify with their physician based on sex allows for increased trust from the patient, improving the communication regarding injuries and medical history, and leads to better outcomes and higher patient compliance (de Borja *et al*. 2022).

5.11 IMPORTANCE OF RESEARCH IN POLE SPORT

Historically, pole sport has its roots in exotic dancing including having origins in “strip clubs” (Fennell 2018). Although having been established as a sport, which includes national and international pole competitions, there is still a stigma attached to the sport due to its origins (Fennell 2018). A stigma is defined as discrediting and humiliating an individual due to the characteristics they possess (Subu *et al*. 2021). This usually occurs when a person is labelled due to being associated with activities defined as deviant by those in society who believe in traditional social rules (Kim and Kwon 2019).

Pole sport athletes have faced judgement for partaking in a sport which may have the stigma of exotic dancing attached to it and it being transferred to them (Griffiths 2016). Nicholas *et al*. (2018) conducted a study on women’s motivation for participation in a stigmatised form of activity; pole sport athletes described that they were often stereotyped negatively which often led to judgement and misunderstanding or the lack of wanting to understand from society.

This research demonstrated that often this helped the pole sport athletes bond with each other and this motivated their continuation with the sport. However, this may not translate to feeling comfortable with gaining access to healthcare due to the societal judgement placed on pole sport athletes.

In a study on stigmatising with belly dancing (Kraus 2010), strategies used to avoid being stigmatised included secrecy and semantic manipulation, which may also be employed by pole sport athletes. This makes research surrounding pole sport, especially surrounding injuries and their subsequent management, imperative in order to ensure athletes receive the assistance they need, without being judged due to their choice of exercise.

5.12 SUMMARY

This chapter reviewed the results and compared these results to relevant studies on musculoskeletal injuries and pole sport athletes. Overall, musculoskeletal injuries were prevalent in pole sport athletes. This study showed that the upper limb, and specifically the shoulder, was the most affected area that was injured due to pole sports. This study identified skill level and strength to be risk factors associated with pole sport injuries. The impact of injuries on pole sport athletes' quality of life, specifically affecting their ability to perform daily tasks, sleep and mood were significant and demonstrated the need for more than just the athletes' injury to be dealt with, but also their psychosocial state as a result of the injury. Many pole sport athletes depend on self-management for their injuries and others seek professional healthcare. The outcomes of both forms of management varied for each participant but showed that more tailored management for pole sport athletes would be beneficial. This chapter also detailed the importance of research in female-dominant sports and in pole sport specifically.

CHAPTER SIX: CONCLUSION

6.1 INTRODUCTION

This chapter details the limitations identified in this study, provides recommendations for future research and concludes the study.

6.2 STRENGTHS

This is the first study done in eThekwini, South Africa, on the epidemiology of musculoskeletal injuries in pole sport athletes. The only other South African study, to our knowledge, that has investigated this topic is Kukard (2019) and, thus, a significant strength of this study is adding to the body of literature surrounding this sport in South Africa. A further strength includes the addition of knowledge regarding musculoskeletal injuries in pole sport athletes, which is beneficial to healthcare professionals to aid in managing injuries related to this sport.

6.3 LIMITATIONS

This study was done via an online questionnaire which had to be distributed via the owners of the pole sport studios as a result of the POPI Act. The POPI Act stands for the Protection of Personal Information Act and promotes the protection of personal information by all institutions, thus seeking to enforce the right to privacy for individuals (South African, Department of Justice 2013). This means that the personal information of the pole dance athletes could not be given to me to contact them directly. Therefore, the response rate was decreased as it was dependent on the distribution of the questionnaire via an external party.

The participants needed to be currently participating in pole sports which meant that those who had stopped pole sports recently, potentially due to injury, were not included in the study. However, their injuries may have still provided valuable data on musculoskeletal injuries.

This study had a minimum age requirement of 18 years old. There may have been pole sport athletes under 18 years old and were therefore excluded from participating.

Due to the limited amount of research surrounding this topic worldwide, a comparison of data had to be made to gymnastics and other circus arts. While this is beneficial due to similarities between the sports, it would be more beneficial to be able to compare the data to studies relating to pole sport only.

6.4 RECOMMENDATIONS

The following recommendations are made with regards to future research:

- A study completed on the same research problem in a different province or country to compare the data collected by each study.
- A study that includes participants with pole sport experience in the last five years to provide valuable data on lifetime prevalence of injury and to investigate whether those who stopped pole sports was due to injury.
- A study including adolescents as they make up a large number of those who participate in pole sports.
- A study determining injury profiles of professional pole sport athletes to compare them to amateur pole sport athletes.
- A study determining in-depth information about self-management used by the athletes (what type of medication and its effectiveness, what type of home remedies and their effectiveness).
- A quality-of-life study is recommended as the impact on the pole sports athletes were found to be significant.
- A study determining the level of re-injury that occurs in pole sport athletes.
- A study determining the barriers to accessing healthcare for pole sport athletes.

6.4 CONCLUSION

Pole sport is growing in popularity internationally, especially in South Africa. This study was guided by its aim and objectives to investigate musculoskeletal injury in pole sport athletes in eThekwini.

Pole sport athletes have had a high period and lifetime prevalence of musculoskeletal injuries. This study found that the distribution of injuries predominantly affected the upper limb, specifically the shoulder joint. Although fewer reports were noted, there were still multiple injuries affecting the spine and lower limb. Strain injuries were the cause of the majority of injuries.

The significant risk factors for injury found in pole sport athletes included high skill, increased strength, performing warm-ups for longer than 10 minutes and performing static stretching cool-downs.

Injuries had a large impact on participants' quality of life, especially affecting their ability to continue with their daily activities and affecting their mood and sleep negatively.

Management approaches varied among participants with the most frequently used strategy being self-medication and home remedies, both of which seemed to assist most participants with their injury. Participants who consulted healthcare professionals were in the minority; the participants mostly utilised chiropractors, general practitioners and physiotherapists.

This study also identified the importance of research being done in female predominant sports to custom management to the patient.

The importance of research being done on pole sport specifically has been emphasised to educate healthcare professionals on pole sport injuries and emphasise the psychological implication of these injuries that may extend further from the injury into the realm of stigma.

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APPENDICES

Appendix A: Advertisement

ARE YOU A POLE DANCE ATHLETE CURRENTLY PARTICIPATING IN POLE DANCING?

Participate in a research study today.

Contact Kim 0720851288

Appendix B: Letter of Information – Main Study

LETTER OF INFORMATION

Title of the Research Study: The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sports athletes in eThekwini municipality.

Principal Investigator/s/researcher: Kim Worth, BTech: Chiropractic

Co-Investigator/s/supervisor/s: Prof Julian Pillay, PHD

Brief Introduction and Purpose of the Study:

Good Day research participant

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

What is Research:

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

Outline of the Procedures:

The aim of this study is to determine the prevalence, selected risk factors and types of injuries that amateur pole sport athletes are prone to as well as the level of chiropractic care used and the influence this has on their participation in the sport, performance levels and their quality of life. Participants will be emailed and/or sent a WhatsApp with the link to the questionnaire to fill out. The expected time to complete the questionnaire is approximately 10 minutes. You will be expected to complete and sign Informed Consent (Appendix C) as well as the questionnaire (Appendix M). Once the questionnaire is completed, the process is complete and you will not be contacted further.

Risks or Discomforts to the Participant:

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

Explain to the participant the reasons he/she may be withdraw from the Study:

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

Benefits:

By volunteering to partake in this study, you will allow Chiropractors and other healthcare professionals to build our knowledge of the correlation between musculoskeletal injuries and pole sport athletes. This benefits you as the patient as we can provide improved healthcare in the future.

Remuneration:

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

Costs of the Study:

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

Confidentiality:

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

Results:

Once the information has been collected, the results from the study will be published in the dissertation section of the DUT Library which can be taken out through normal library protocol. There will also be an online copy available to you through the DUT online library system. There will also be a journal article that will be published shortly after the dissertation is completed. This may be shared with anyone interested in it.

Research-related Injury:

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

Storage of all electronic and hard copies including tape recordings:

All electronic data will be kept on an external storage device, will be kept in the Department of Chiropractic at DUT for five years after which all information will be deleted and the storage device will be destroyed.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (072 085 1288), my supervisor (031 373 2398) or the DUT-Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Acting Director: Research and Postgraduate Support on researchdirector@dut.ac.za

Appendix C: Consent Form – Main Study

CONSENT

Full Title of the Study: The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sports athletes in eThekwini municipality.

Names of Researcher/s: Kim Worth, BTech: Chiropractic

Statement of Agreement to Participate in the Research Study:

I hereby confirm that I have been informed by the researcher, Kim Worth about the nature, conduct, benefits and risks of this study – Research Ethics Clearance Number: 216/22

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

____________________	___________	________	_________________
Full Name of Participant	**Date**	**Time**	**Signature/Right Thumbprint**

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

____________________	___________	_________________
Full Name of Researcher	**Date**	**Signature**

______________________	____________	___________________
Full Name of Witness (If applicable)	**Date**	**Signature**

____________________	___________	_________________
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Appendix D: Letter of Information – Focus Group

LETTER OF INFORMATION

Focus Group

Title of the Research Study: The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sports athletes in eThekwini municipality.

Principal Investigator/s/researcher: Kim Worth, BTech: Chiropractic

Co-Investigator/s/supervisor/s: Prof Julian Pillay, PHD

Brief Introduction and Purpose of the Study:

Good Day focus group participant

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

What is Research:

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

Outline of the Procedures:

The aim of this study is to determine the prevalence, selected risk factors and types of injuries that amateur pole sport athletes are prone to as well as the level of Chiropractic care used and the influence this has on their participation in the sport, performance levels and their quality of life. Participants will be emailed and/or sent a WhatsApp the link to the questionnaire to fill out. The expected time to complete the questionnaire is approximately 10 minutes. You will be expected to complete and sign Informed Consent (Appendix C) as well as the questionnaire (Appendix M). Once the questionnaire is completed, the process is complete and you will not be contacted further.

Risks or Discomforts to the Participant:

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

Explain to the participant the reasons he/she may be withdraw from the Study:

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

Benefits:

By volunteering to partake in this study, you will allow Chiropractors and other healthcare professionals to build our knowledge of the correlation between musculoskeletal injuries and pole sport athletes. This benefits you as the patient as we can provide improved healthcare in the future.

Remuneration:

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

Costs of the Study:

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

Confidentiality:

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

Results:

Once the information has been collected, the results from the study will be published in the dissertation section of the DUT Library which can be taken out through normal library protocol. There will also be an online copy available to you through the DUT online library system. There will also be a journal article that will be published shortly after the dissertation is completed. This may be shared with anyone interested in it.

Research-related Injury:

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

Storage of all electronic and hard copies including tape recordings:

All electronic data will be kept on an external storage device, will be kept in the Department of Chiropractic at DUT for five years after which all information will be deleted and the storage device will be destroyed.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (072 085 1288), my supervisor (031 373 2398) or the DUT-Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Acting Director: Research and Postgraduate Support on researchdirector@dut.ac.za

Appendix E: Confidentiality Statement – Focus Group

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

CONFIDENTIALITY STATEMENT AND CODE OF CONDUCT: Focus group

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

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

Please print in block letters:

Focus Group Member: ___________________________ Signature: ___________________________

Witness Name: _________________________________ Signature: ___________________________

Researcher's Name: ____________________________ Signature: ___________________________

Supervisor's Name: ______________________________ Signature: ___________________________

Appendix F: Consent Form – Focus Group

CONSENT

Focus Group

Full Title of the Study: The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sports athletes in eThekwini municipality.

Names of Researcher/s: Kim Worth, BTech: Chiropractic

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Kim Worth about the nature, conduct, benefits and risks of this study – Research Ethics Clearance Number: 216/22
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

____________________	____________	_________	__________________
Full Name of Participant	**Date**	**Time**	**Signature/Right Thumbprint**

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

____________________	____________	__________________
Full Name of Researcher	**Date**	**Signature**

____________________	____________	__________________
Full Name of Witness (If applicable)	**Date**	**Signature**

____________________	____________	__________________
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Appendix G: Letter of Information – Pilot Study

LETTER OF INFORMATION

Pilot Study

Title of the Research Study: The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sports athletes in eThekwini municipality.

Principal Investigator/s/researcher: Kim Worth, BTech: Chiropractic

Co-Investigator/s/supervisor/s: Prof Julian Pillay, PHD

Brief Introduction and Purpose of the Study:

Good Day pilot study participant

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

What is Research:

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

Outline of the Procedures:

The aim of this study is to determine the prevalence, selected risk factors and types of injuries that amateur pole sport athletes are prone to as well as the level of chiropractic care used and the influence this has on their participation in the sport, performance levels and their quality of life. Participants will be emailed <u>and/or sent a WhatsApp</u> the link to the questionnaire to fill out. The expected time to complete the questionnaire is approximately 10 minutes. You will be expected to complete and sign Informed Consent (Appendix C) as well as the questionnaire (Appendix M). Once the questionnaire is completed, the process is complete and you will not be contacted further.

Risks or Discomforts to the Participant:

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

Explain to the participant the reasons he/she may be withdraw from the Study:

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

Benefits:

By volunteering to partake in this study, you will allow chiropractors and other healthcare professionals to build our knowledge of the correlation between musculoskeletal injuries and pole sport athletes. This benefits you as the patient as we can provide improved healthcare in the future.

Remuneration:

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

Costs of the Study:

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

Confidentiality:

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

Results:

Once the information has been collected, the results from the study will be published in the dissertation section of the DUT Library which can be taken out through normal library protocol. There will also be an online copy available to you through the DUT online library system. There will also be a journal article that will be published shortly after the dissertation is completed. This may be shared with anyone interested in it.

Research-related Injury:

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

Storage of all electronic and hard copies including tape recordings:

All electronic data will be kept on an external storage device, will be kept in the Department of Chiropractic at DUT for five years after which all information will be deleted and the storage device will be destroyed.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (072 085 1288), my supervisor (031 373 2398) or the DUT-Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Acting Director: Research and Postgraduate Support on researchdirector@dut.ac.za

Appendix H: Consent Form – Pilot Study

CONSENT

Pilot Study

Full Title of the Study: The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sports athletes in eThekwini municipality.

Names of Researcher/s: Kim Worth, BTech: Chiropractic

Statement of Agreement to Participate in the Research Study:

I hereby confirm that I have been informed by the researcher, Kim Worth about the nature, conduct, benefits and risks of this study – Research Ethics Clearance Number: 216/22

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

____________________	____________	________	__________________
Full Name of Participant	**Date**	**Time**	**Signature/Right Thumbprint**

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

____________________	____________	__________________
Full Name of Researcher	**Date**	**Signature**
____________________	____________	__________________
Full Name of Witness (If applicable)	**Date**	**Signature**
____________________	____________	__________________
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Appendix I: Gatekeepers Permission

17.06.2022

Request for Permission to Conduct Research

Dear XXX (owner of pole studio)

My name is Kim Worth, a chiropractic student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves “The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sports athletes in eThekwini municipality.”

I am hereby seeking your consent to access to your pole studio to inform your pole sport athletes about my research, put up an advertisement in the studio and to send the questionnaire to you to distribute to all your pole sport athletes.

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

If you require any further information, please do not hesitate to contact me on 0720851288 or by email on kworth2@gmail.com. Thank you for your time and consideration in this matter.

Yours sincerely,

Kim Worth

Durban University of Technology

Appendix J: Study Adaption Permission

DURBAN UNIVERSITY OF TECHNOLOGY — INSTITUTIONAL RESEARCH ETHICS COMMITTEE

3/7/22, 9:42 AM Gmail - Permission to utilize research

Gmail **Kim Worth <kworth2@gmail.com>**

Permission to utilize research
2 messages

Kim Worth <kworth2@gmail.com> Mon, Mar 7, 2022 at 9:18 AM
To: amberkukard@gmail.com

Good Day

I am conducting my Master's research on an investigation into the injury profile of musculoskeletal injuries and the impact thereof in amateur pole sports athletes in eThewkwini. I have referenced your study extensively thus far in my research.

I would like to obtain permission to utilize your study, The Injury Patterns in Poles Sport Athletes in Gauteng. I would like to adapt your questionnaire to use in the data collection process of my study which will be an online questionnaire.

Please advise if this permission is granted. Feel free to contact me if any additional information is required.

Thank you.

Kind Regards
Kim Worth

Amber Kukard <amberkukard@gmail.com> Mon, Mar 7, 2022 at 9:39 AM
To: Kim Worth <kworth2@gmail.com>

Good morning

You may use my questionnaire for adaption, provided my work is credited and recognition is given where it is due.

All the best with your study.

Kind regards
Dr Amber Kukard
[Quoted text hidden]

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Back to list

Permission to utilize research

Report message · Block user

Kim Worth 8 days ago

Good Day

I am conducting my Master's research on an investigation into the injury profile of musculoskeletal injuries and the impact thereof in amateur pole sports athletes in eThewkwini. I have referenced your study in my research.

I would like to obtain permission to utilize your study, Sports injuries in pole dancing: a quantitative survey (KARTOITUS TANKOTANSSIJOIDENURHEILUVAMMOISTA). I would like to translate your questionnaire into English and adapt it to use in the data collection process of my study which will be an online questionnaire.

Please advise if this permission is granted. Feel free to contact me if any additional information is required.

Thank you.

Kind Regards
Kim Worth

Jerry Soini to you 18 hours ago

Hello!

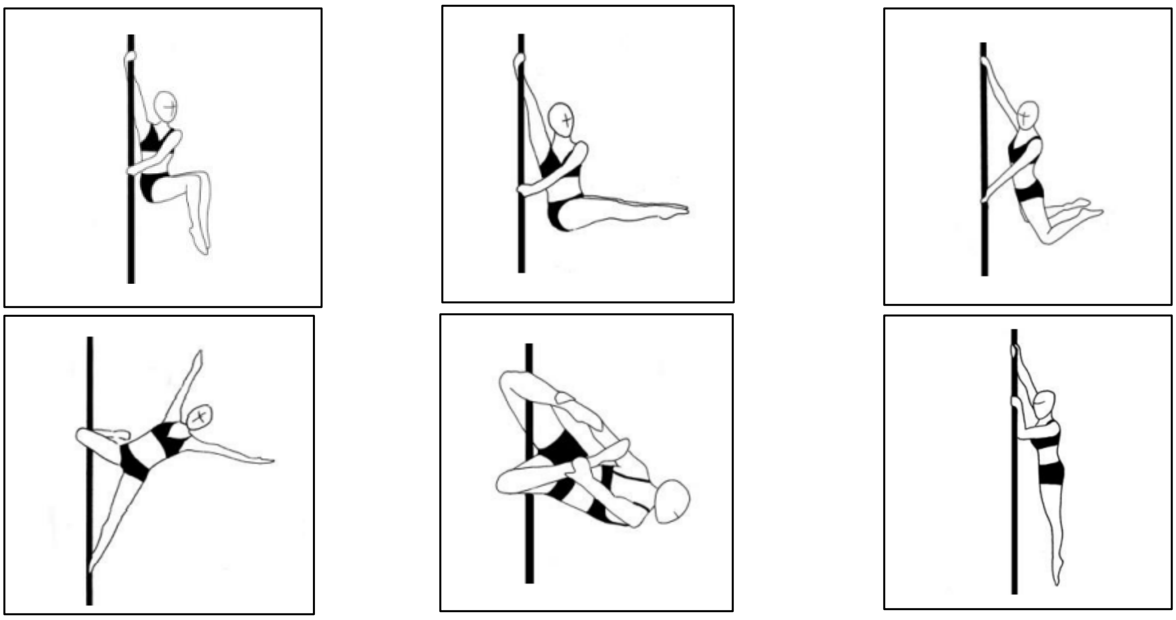
Permission is granted. I'd love to read your Master's research when you get it ready!

Best regards
Jerry Soini

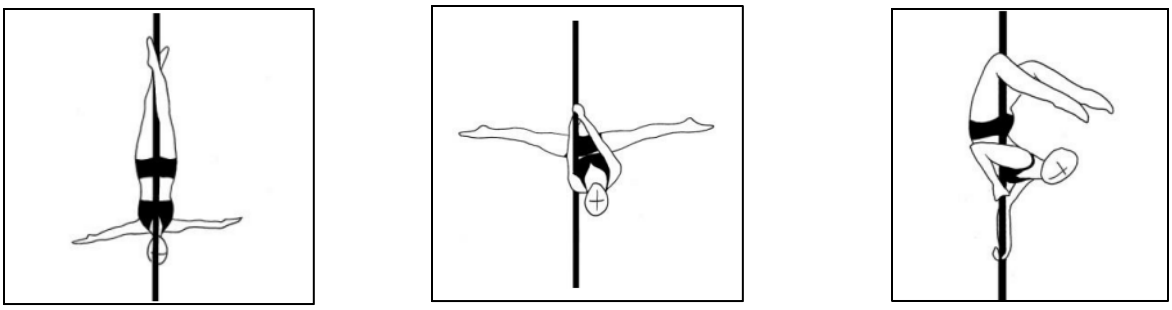
Appendix K: Types of Elements Performed in Pole Sport

Types of Elements Performed in Pole Sport

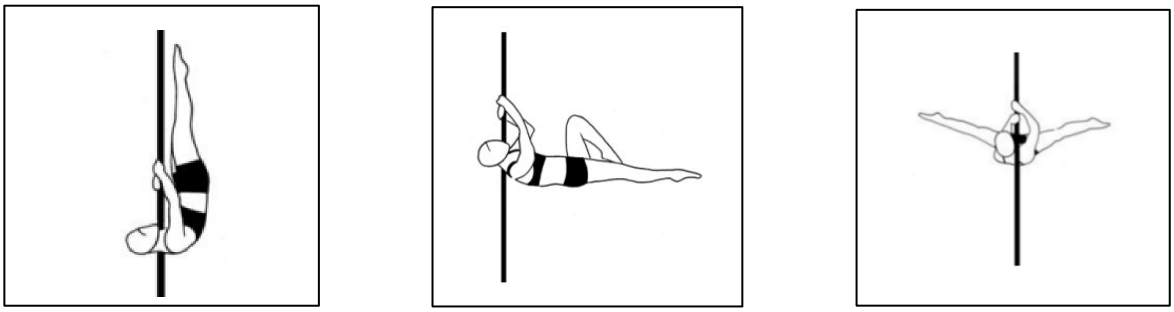
1. Spins (Most can be performed on static and spinning pole)



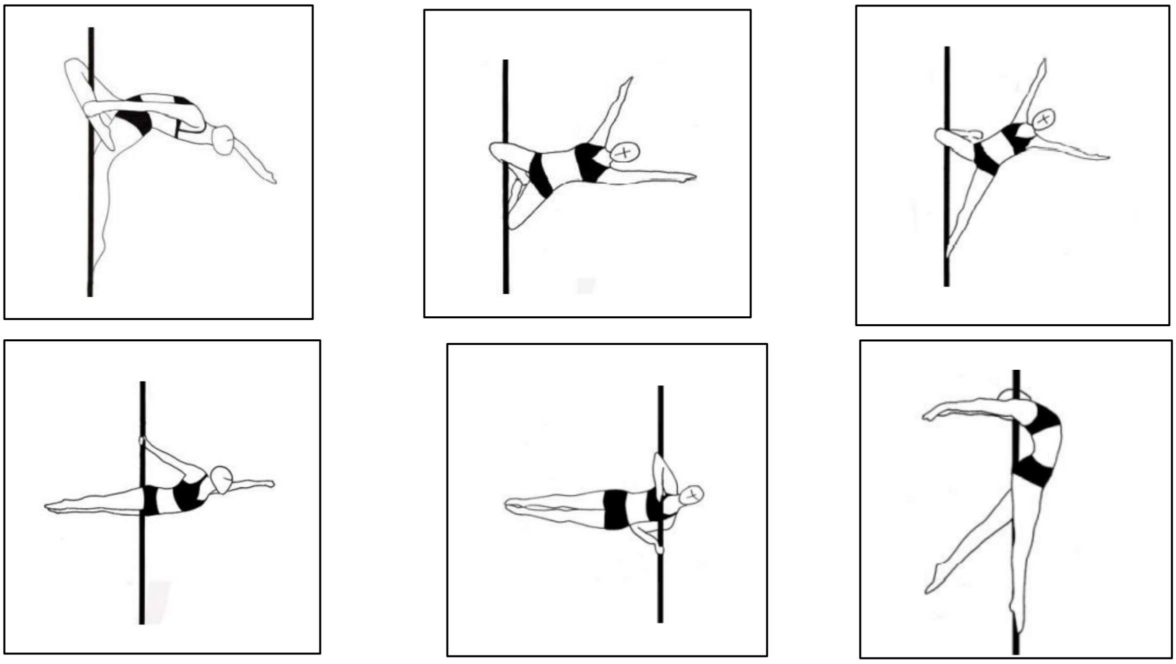
2. Inverts



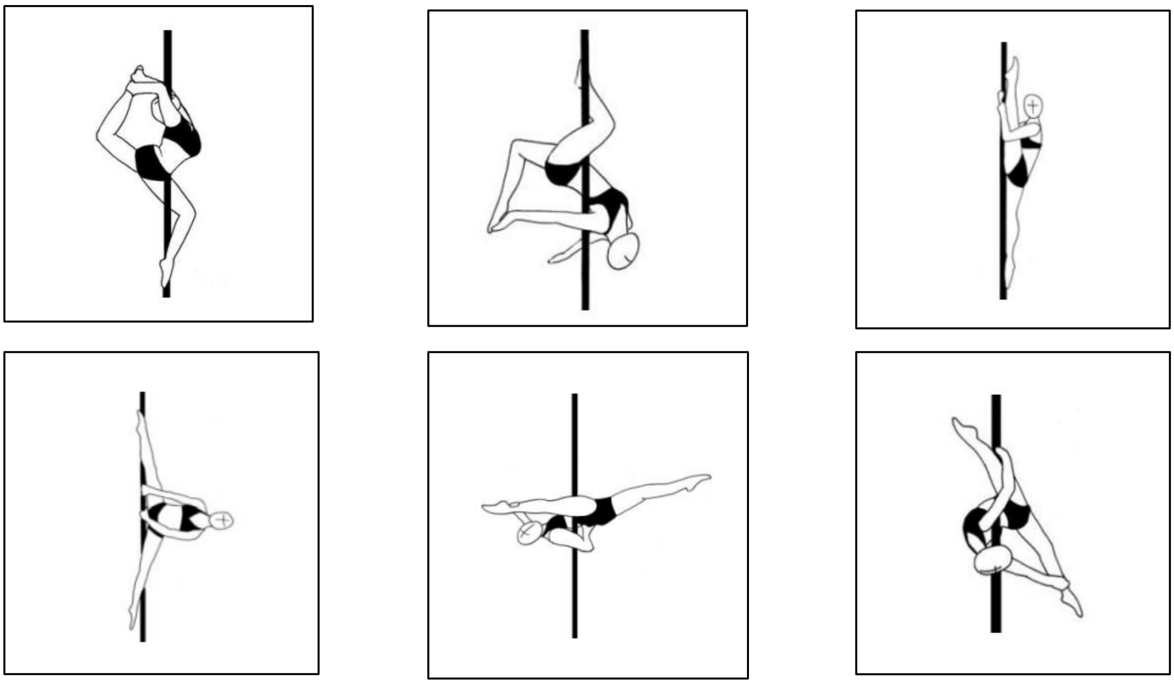
3. Shoulder Mount



4. Strength



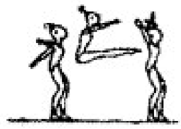
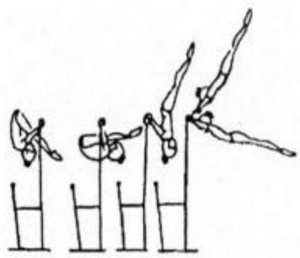
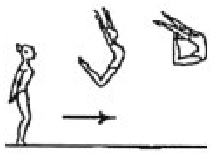
5. Flexibility

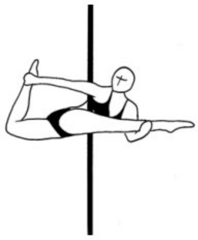
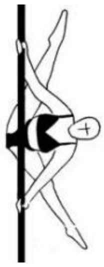
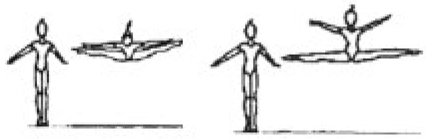


Appendix L: Comparison Between Pole Sport and Gymnastics

Comparison between Pole Sport and Gymnastics

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

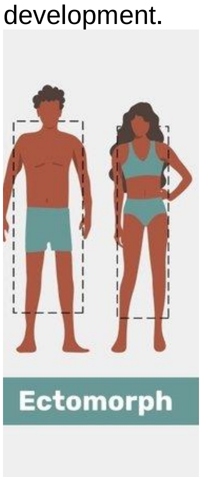
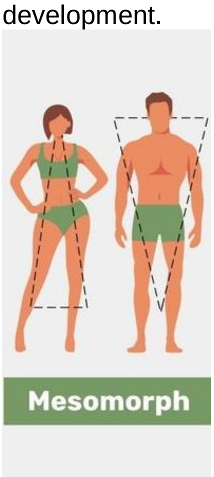
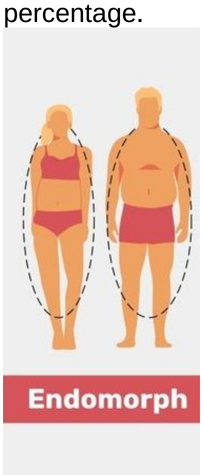
Position	Pole Sport	Gymnastics
Hyperflexion of the spine	 Underarm Hold Pike	*Pike jump (hip < 90°)* 
Hyperflexion of the spine with upper limb weight bearing	 Elbow Hold Hang	*Underswing bwd (inverted pike swing), dislocate (Schleudern) to hang on HB* 
Hyperextension of the spine	 Half Back Split on Pole	*Jump with upper back arch and head release with feet almost touching head (sheep jump)* 

Hyperflexion and hyperextension of the hips	 Chopsticks half split	*Split jump to ring position (180° separation of legs)* 
Hyperabduction of the hip joint with associated hyperflexion of the spine	 Cross Bow 2 Hands on Pole	*Straddle pike jump (both legs above horizontal), or side split jump (leg separation 180˚)* 

Appendix M: Questionnaire

Note: This questionnaire was put into QuestionPro and completed as an online questionnaire.

1. Letter of Information

Section A									
Demographics: (Please fill in or select where relevant)									
2. Age (in years)	18-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	>60
3. Gender	Female			Male			Other (specify)		
4. Race	Asian		Black	Multiracial or Multi-ethnic		White		Other (specify)	
5. Weight (in kgs)					Unsure				
6. Height (in cm)					Unsure				
7. Body Type	**Ectomorph (slim)** Categorised as a lean slender body build with slight muscular development. 			**Mesomorph (muscular)** Characterized by more than average muscular development. 			**Endomorph (curvy)** Characterized by a soft round body build with a high fat percentage. 		
8. Occupation									

Section B

Training History: (Please fill in or select where relevant)

9. For how many years have you been participating in pole sports?	Less than 1 year	1-2 years	3-4 years	More than 5 years			
10. How often do you participate in pole sports per week?	1-2x	3-4x	5-6x	7x			
11. How long are your pole sports sessions on average?	Less than 30 minutes	30 minutes	45 minutes	1 hour	1 hour, 30 minutes	2 hours	More than 2 hours
12. What skill level of pole sports are you part of?	Beginner	Amateur	Intermediate	Advanced			
13. Which side is dominant when it comes to pole sports? i.e. your dominant side is determined by your hand position (the side you invert or do spins on)	Left	Right	Ambidextrous (using both hands)	Unsure			
14. How would you rank your fitness in pole sports?	Not fit at all	Below average	Average	Above average	Very Fit		
15. How would you rank your strength in pole sports?	Not strong at all	Below average	Average	Above average	Very Strong		
16. Do you warm up before a pole sports session?	Yes	No					
17. How long do you warm up for on average?	Less than 5 mins	5-9 mins	10-14 mins	15-19mins	20 mins or more	N/A	
18. What type of warm up do you perform? You may select more than one option.	Static stretching i.e. holding a single position for a period of time.	Dynamic movement i.e. performing movements which allow you to move through a full range of motion.	Cardio i.e. movement that occurs at a fast pace to increase your heart rate	N/A			
19. Do you cool-down after a pole sports session?	Yes	No					
20. If yes, what type of cool-down do you perform? You may select more than one option.	Static stretching i.e. holding a single position for a period of time.	Dynamic movement i.e. performing movements which allow you to move through a full range of motion.	N/A				
21. Does the temperature affect how well you are able to grip the pole?	Yes	No					

22. If yes, in what way? You may select more than one option.	The warmer/more humid, the harder it is to grip the pole	The warmer/more humid, the easier it is to grip the pole	The cooler, less humid, the harder it is to grip the pole	The cooler, less humid, the easier it is to grip the pole	N/A
23. Do you use any form of grip aid?	Yes		No		
24. If yes, when do you use it? You may select more than one option.	Always	When pole is more slippery (usually on warmer days)	For moves I find difficult to sustain		N/A
25. Does the temperature affect your energy level fatigue (tiredness) in a pole class?	Yes		No		
26. If yes, in what way? You may select more than one option.	The warmer/more humid it is, the quicker I become fatigued	The warmer/more humid it is, the slower I become fatigued	The cooler/less humid it is, the quicker I become fatigued	The cooler/less humid it is, the slower I become fatigued	N/A
27. Does the temperature affect your muscle fatigue (tiredness) in a pole class?	Yes		No		
28. If yes, in what way? You may select more than one option.	The warmer/more humid it is, the quicker my muscles become fatigued	The warmer/more humid it is, the slower my muscles become fatigued	The cooler/less humid it is, the quicker my muscles become fatigued	The cooler/less humid it is, the slower my muscles become fatigued	N/A
29. Do you currently participate in any other form of exercise?	Yes		No		
30. If so, please indicate what activities you participate in? You may choose more than one option.	Endurance/Aerobic i.e. exercise which increases your heart rate e.g. dancing, jogging, cycling, sports training (tennis, swimming, soccer etc.)	Strength/ Resistance i.e. exercises to increase muscle strength e.g. weight lifting, cross-fit	Flexibility i.e. exercise which encourages stretching your body and increasing range of motion e.g. yoga, tai chi, pilates		N/A
31. How often do you participate in the above activities per week?	1-2x	3-4x	5-6x	7x	N/A
32. Did you participate in dancing as a sport prior to starting pole sports?	Yes		No		
33. Did you participate in gymnastics/circus arts prior to starting pole sports?	Yes		No		

<u>Section C</u>

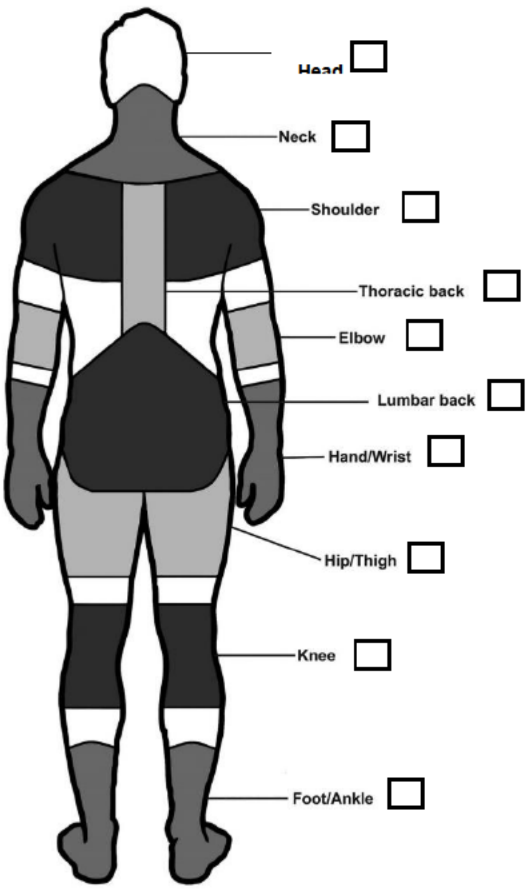
Musculoskeletal Injury: (Please fill in or select where relevant)

34. Musculoskeletal Injury is discomfort, pain, or damage to the bones, muscles, ligaments, nerves, or tendons resulting in pain which may or may not cause cessation of training.

35. Have you suffered any musculoskeletal injuries as a direct result of pole sports in your <u>lifetime</u>?	Yes	No

If you answered "Yes" to the above question, please complete the section below. If you answered "No", the rest of this questionnaire may be left blank, however, please proceed to the end of the survey and select done so that your responses are recorded.

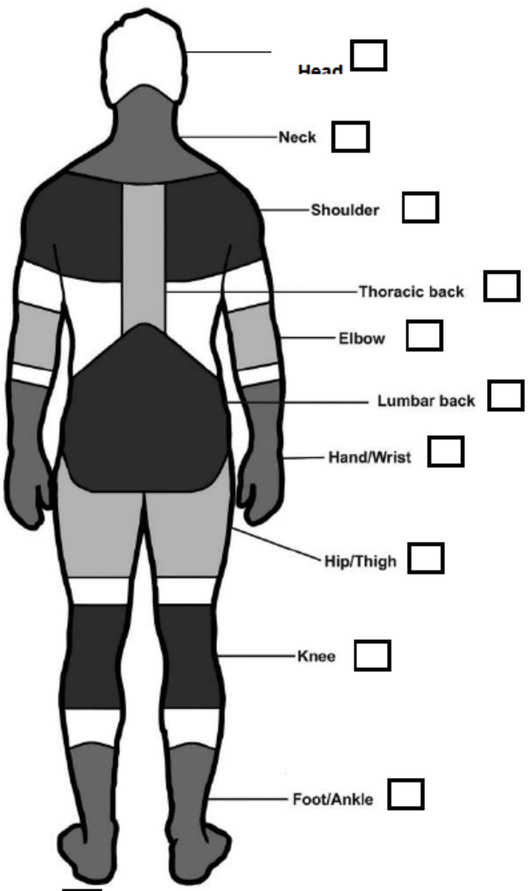
36. Please see image below to identify where you have had a musculoskeletal injury in your lifetime and select the areas in the next question.



(Monnier *et al.* 2015)

37. Please tick if you have had a musculoskeletal injury in any of the

- ☐ Head
- ☐ Neck
- ☐ Shoulder
- ☐ Thoracic back (mid back)

following areas in your lifetime? **Should you need to refer to the diagram, you may revert to the previous question.**	☐ Elbow ☐ Lumbar back (low back) ☐ Hand/Wrist ☐ Hip/Thigh ☐ Knee ☐ Foot/Ankle	
38. Have you suffered any musculoskeletal injuries as a direct result of pole sports in the <u>past 12 months</u>?	Yes	No
39. Please see image below to identify where you have had a musculoskeletal injury in the past 12 months and select the areas in the next question.	 N/A ☐ (Monnier *et al.* 2015)	
40. Please tick if you have had a musculoskeletal injury in any of the following areas in the past 12 months?	☐ Head ☐ Neck ☐ Shoulder ☐ Thoracic back (mid back) ☐ Elbow ☐ Lumbar back (low back) ☐ Hand/Wrist	

Should you need to refer to the diagram, you may revert to the previous question.	☐ Hip/Thigh ☐ Knee ☐ Foot/Ankle

41. What type of musculoskeletal injury was it? Leave this question blank if you have not suffered from a musculoskeletal injury in the past 12 months.

Area	**Fracture**	**Sprain (ligaments)**	**Strain (muscles and tendons)**	**Contusion (severe bruise)**	**Concussio n**	**Other**
Head						
Neck						
Shoulder						
Thoracic/mid back						
Elbow						
Lumbar/low back						
Hand/wrist						
Hip/thigh						
Knee						
Foot/ankle						

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

43. Please write down the area of the body that caused the most severe musculoskeletal injury.

____

Please write down the type of musculoskeletal injury which occurred when you had the most severe musculoskeletal injury.

e.g. fracture, sprain, strain, contusion, concussion ____________________________

44. What pole activity were you performing when you sustained your worst musculoskeletal injury?

Activity	**Please select one option**
Spin	
Invert	
Shoulder mount	
Mounting pole	
Dismounting pole	
Flexibility position	
Strength position	
Other	

45. If your previous selection was "other" please specify what pole activity you were performing.

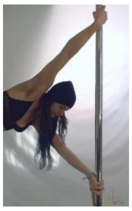
____

46. What hand grip were you using when you sustained this musculoskeletal injury?

(Reference for images: Hall 2022)

Activity	**Image for reference**	**Please tick**
Cup grip		
Baseball/crush grip		
Stronghold		

Anchor/brace grip			
Split/bracket grip			
Half bracket grip			
Elbow grip			
Forearm grip			
Armpit hold			
Princess grip			
Tabletop hold			

Twisted grip			
Goofy grip			
Other (specify)			
Unsure			

47. If your previous selection was "other" please specify what grip was used.

____

48. How severe was the musculoskeletal injury?	Very mild	Mild	Moderate	Severe	Very severe
49. What setting was the pole on?	Static		Spinning		
50. How long did it take to recover from the musculoskeletal injury?	0-1 week	2-3 week	4-6week	More than 6 weeks	
51. How long did you stop pole sport?	0-1 week	2-3 week	4-6week	More than 6 weeks	Did not stop
52. How long did you stop sport other exercise besides pole sport?	0-1 week	2-3 week	4-6week	More than 6 weeks	Did not stop

<u>Section D</u>		
Influence on personal life: (Please fill in or select where relevant) **53.** Did the injury:		
Affect your ability to sleep	Yes	No
Affect your mood negatively	Yes	No
Increase stress levels	Yes	No
Affect your ability to perform daily activities	Yes	No
Affect your job	Yes	No
Affect your wellbeing and quality of life	Yes	No

Section E

Management: (Please fill in or select where relevant)

54. What treatment approach did you use and did it provide relief from your pain?

You may select more than one answer.

	Please tick if you used this treatment approach	Please tick if this treatment method provided relief.
No treatment		
Self-medicate		
Home remedies (Ice, Heat, Rest etc.)		
Consulted a General Practitioner		
Consulted a Chiropractor		
Consulted a Physiotherapist		
Consulted an Acupuncturist		
Consulted a Homeopath		
Consulted a Traditional African Healer		
Consulted a Ayurveda doctor		
Consulted an Orthopaedic surgeon		
Other		

55. If you chose "other" in the previous question, please specify.

____

Appendix N: Pilot Group Feedback Form

Pilot Group Feedback Form

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

Section	Feedback	
A	Demographics	
B	Training History	
C	Musculoskeletal Injury	
D	Influence on personal life	
E	Management	

Appendix O: Institutional Research Ethics Committee Clearance

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

11 November 2022

Ms K M S C Worth
26 David Mclean Drive
Westville
Durban

Dear Ms Worth

The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sport athletes in eThekwini municipality
Ethical Clearance number IREC 216/22

The DUT-Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

In addition, the DUT-IREC acknowledges receipt of your gatekeeper permission letter.

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

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

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

Yours Sincerely

Prof J K Adam
Chairperson: DUT-IREC

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Appendix P: Editor's Certificate

Helen Bond

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25 September 2023

CERTIFICATE

Kim Worth

Dear Kim

Thank you for using Impela Editing Services to edit your Master's dissertation entitled "***The injury profile of musculoskeletal injuries, and the impact thereof, in amateur pole sports athletes in eThekwini municipality***".

I have proofread for errors of grammar, punctuation, spelling, syntax and typing mistakes. I have formatted your work and checked the references (this means checking the formatting). I believe your work to be error free.

PLEASE NOTE: Impela Editing accepts no fault if an author makes changes to a document after a certificate has been issued.

I wish you the very best in your submission.

Kind regards

Helen Bond (Bachelor of Arts, HDE)

Appendix Q: Plagiarism Report

Turnitin Originality Report

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