The epidemiology of musculoskeletal injuries in competitive lifesavers in KwaZulu-Natal

By

Carmel Beth Billson

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

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

Carmel Beth Billson — Date

Approved for Final Submission

Dr Laura O'Connor — Date
M.Tech: Chiropractic

Dr Stuart Clifton — Date
M.Tech: Chiropractic

DEDICATION

This is dedicated to the sports practitioners out there who are making a difference and to the people of the ocean.

ACKNOWLEGEMENTS

I would like to thank my parents, Patrick and Terry Billson, and my sisters Lauren and Natalie Billson. I am what I am because of you. Words cannot describe my gratitude for everything you have done for me.

To my incredible fiancé, Russell Sadler, for being there for me at every curve ball, late night and emotional episode. Being there with your cool calm attitude, being the voice of reason when I need it most and always having my back. I sincerely appreciate everything you do for me and thank you for tolerating me through this time. I would not have got this far without you.

My supervisor, Dr Laura O'Connor, for your support and guidance through this dissertation.

My co-supervisor, Dr Stuart Clifton, for your guidance and honest opinion.

To Dr Amanda Ardain, Carrie Tudor, Tam Sneyd, Bianca Von Bargen, Teegan Hardwick and Dr Joyline Kufandirori. You ladies helped me momentously and I will be forever grateful for everything that you did to help me get through this.

To IT WORKS, Andrew and Tony Bath, for tending to every computer crisis I threw at you, with speed and patience.

To the members at Marine Surf Lifesaving club for your support and encouragement
To Lifesaving KwaZulu-Natal for granting me permission to access information.

To Assistant Professor Nick Marshall for your guidance and assistance, thank you for giving me the opportunity to present this research at World Lifesaving Championships 2018.
To Professor Neil Roos for your mentoring and support through this process. I cannot thank you enough for everything you have done for me.

To all the participants who dedicated their time to participate in this study, thank you for making this study possible.

ABSTRACT

Background: Lifesaving is a multidimensional sport which can lead to injury and a high likelihood of overuse-related injuries. The environment within which lifesaving occurs is unique, with the soft beach sand and unpredictable nature of the ocean. It is difficult to assess the effects that injuries may have on the training and competitive performance of lifesavers as the incidence and severity of these injuries have not previously been studied in South Africa. Thus, this study investigated the epidemiology of lifesaving induced musculoskeletal (MSK) injuries in competitive lifesavers in KwaZulu-Natal.

Lifesavers are under-investigated, yet the growth and development of the sport requires that athletes are assessed for injury. This study could aid in educating federations, coaches and athletes regarding MSK injuries sustained by lifesavers, thereby assisting athletes to be more competitive at national and international competition levels.

Method: A quantitative, descriptive, cross-sectional epidemiological survey was used to collect data from 100 competitive lifesavers in KwaZulu-Natal. The questionnaire was pre-validated and hand delivered to the lifesaving clubs that agreed to participate, where the lifesavers self-selected to participate. Informed consent was obtained. The survey contained questions related to demographics, activity participation, psychosocial factors and the occurrence of lifesaving related musculoskeletal pain.

Results: The respondents were male (65%, n=65) and had a mean age of 28.6 years (±SD 14, range 16-73). The lifetime prevalence of MSK injury from lifesaving was 72% (n=72), with a total of 177 injuries being reported with shoulder pain being the most prevalent (38%). The 12-month prevalence showed 133 injuries were sustained whereas for current prevalence there were 86 injuries. Lower back pain was most frequently reported over these periods (26% and 22% respectively). The board race was the most popular event participated in at 76% (n=76), followed by surf ski 69% (n=69) and thirdly surf swim 67% (n=67). Seventy-four percent (74%) of board paddlers, 68% of surf ski paddlers and 67% of beach sprint and flags participants had experienced MSK pain related to lifesaving. Of the 72 competitors that experienced lifesaving MSK injuries more than half reported that it negatively affected them psychologically either in training, competition or overall. Injuries cause athletes to miss training sessions, which result in loss of fitness and falling behind the other athletes, this could cause a lack of confidence, lack of self-belief and lack of motivation to continue training and competing. The worst injury that the respondents had sustained occur mostly due to running (44%), was overuse related (43%), occurring in season (70%) and was described as a sharp, shooting severe pain with a constant and recurrent nature. It affected the athlete’s participation in the sport (75%) and required them to seek medical attention (89%). The only factor found to be related to MSK injuries was the number of rest days, which was significantly lower in those who suffered injuries ($p=0.04$). All other demographic, health, lifestyle and lifesaving activity participation factors were not associated with MSK lifesaving injuries ($p < 0.05$).

Conclusion: This is the first study to document MSK injuries in lifesaving athletes in South Africa. The high prevalence of injuries necessitates that mechanisms are put in place to prevent injury. In addition, the mechanics of running on sand requires further investigation to understand its impact on injury.

Key words: lifesaving, musculoskeletal, pain, epidemiology, prevalence

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List of Symbols and Abbreviations

=	Equals
>	Greater than
%	Percentage
<	Less than
±SD	Standard Deviation
Kg	Kilograms
m	Meters
N	Number of participants (total sample)
n	Number of participants (sample sub-group)
p	*p*-value showing statistical significance
BMI	Body Mass Index
B.Tech	Bachelor of Technology
DUT	Durban University of Technology
et al.	and others
GP	General practitioner
IREC	Institutional Research Ethics Committee
LSA	Lifesaving South Africa
LBP	Low Back Pain
LKZN	Lifesaving KwaZulu-Natal
LOIC	Letter of Information and consent
MSK	Musculoskeletal
M.Tech	Master of Technology
N. Dip	National Diploma
SASCOC	South African Sports Confederation and Olympic Committee
SD	Standard deviation

Definitions

Amateur: in the context of this study; a person who engages in a pursuit, especially a sport, on an unremunerated basis (Avramidou, Avramidis and Pollman 2007).

Athlete: in the context of this study; A person who is proficient in sports and other forms of physical exercise.

Competitive Lifesaver: in the context of this study; a person who takes part in lifesaving contests (Reilly, Wooler and Tipton 2005).

Code/coding/coded: in the context of this study: each questionnaire will have a unique number in order to keep the participants' personal details confidential.

Duty/ voluntary lifesaver: in the context of this study; a person who voluntarily serves the community in patrols and water safety (Reilly, Wooler and Tipton 2005).

Lifesaving: the action or process of saving another person's life, especially from drowning (Carter, Marshall and Abbott 2015).

Lifesaving Sport: in the context of this study; an amateur sport in which participants take part in races in various disciplines on the beach and in the ocean (Herbert 2017)

Lifetime prevalence: Refers to the experience of a condition at some point in an individual's life (Webb and Bain 2016).

Overuse: Refers to excessive or repetitive use of a body part (Quinn 2008).

Period prevalence: Refers to the number of individuals in a population affected by a condition during a specific period of time i.e 12 months (Gerstman 2003).

Point prevalence: Refers to the number of individuals in a population affected by a condition at a specific point in time (Gerstman 2003).

Professional Lifeguard: in the context of this study; a trained individual employed to guard/ ensure safety of swimmers/ members of the public in return for monetary remuneration (Herbert 2017).

Risk factor: Refers to any variable, exposure or characteristic associated with an increased likelihood of developing a condition, injury or disease (Collins English Dictionary 2015).

Musculoskeletal pain: a sensation of agony that inhibits the individual from participating in lifesaving or practice for a minimum of twenty-four hours (Longmore *et al.* 2012).

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Injuries can negatively impact the progression, mentality and performance of an athlete, regardless of the level of competition (Powell 2009; Mitchell 2012). There are very few studies investigating the prevalence of musculoskeletal (MSK) injuries and their associated risk factors in lifesavers. This chapter will describe the background, aims and objectives, rationale, delimitations and flow of the dissertation.

1.2 Background to the study

The sport of lifesaving, a globally recognised sport (Avramidou, Avramidis and Pollman 2007), comprises four major sporting disciplines: swimming, running, surf ski/kayak and board paddling (Carter, Marshall and Abbott 2015). It is one of few sports that serve primarily as a community-based service with athletes having to complete a number of hours of voluntary service guarding beaches in order to be able to participate in the competitive aspect of the sport. This ensures the physical fitness and ability of the lifeguard to effectively perform their rescue duties (Avramidou, Avramidis and Pollman 2007; Erby, Heard and O'Loughlin 2010).

The multi-disciplined nature of the sport, as well as the inherently dangerous surf, sand and weather conditions experienced in the beach environment may result in various injuries to the musculoskeletal system in the athletes (Meir *et al.* 2011). Competitive lifesavers are exposed to racing conditions which are often unpredictable. The size of the waves, surf conditions, sandbanks, hidden obstacles, injury from a competitors or the athletes' craft may result in injuries (Meir *et al.* 2011). There is limited literature nationally or internationally documenting MSK injuries suffered by these athletes. Irrespective of the level of competition; injuries in athletes, can negatively affect the progression, mentality and performance of an athlete (Powell 2009; Mitchell 2012). In an email communication on the 5th of June 2017, the General Manager of Lifesaving South Africa (LSA) indicated that funding from government or private sector to support lifesaving in South Africa is limited, and that if the literature around lifesaving were increased, budgets could then be re-assessed and re-allocated to better assist these athletes.

Due to the limited literature on lifesaving injuries, it is necessary to look at the activities which constitute lifesaving to acquire a better understanding of the potential risk involved. Lifesaving requires the athletes to swim in a pool or in the ocean. Swimming in a pool provides a controlled environment and has a decreased risk of injury when compared to swimming through the surf, where athletes must negotiate rip currents, waves and sand banks (Fitzgerald and Harrison 2003). Injuries to pool swimmers will include more overuse syndromes, and in general are less abrasive with less bruising compared to surf swimmers (Erby, Heard and O'Loughlin 2010). Injuries involved in board paddling include: overuse of shoulder, knee, lower back and neck, as well as hyper extension of cervical and lumbar spine (Mendez-Villanueva and Bishop 2005). Paddling in a controlled flatwater environment gives rise to overuse syndromes and less incidences of abrasions, or collisions with other craft when compared to Malibu board/ surf ski paddling through the surf and over waves (Powell 2009). Injuries for surf craft paddling include sprains, tendinopathies, dislocations, fractures and chronic muscle pain (Mallac 2015). Injuries such as extensor tenosynovitis and tendinitis, shoulder bursitis and back strain are often seen (Wernicki and Northfield 2014).

It has been hypothesised that beach running will predispose an athlete to lower extremity injury, while the aquatic race components (swim, board and ski) will predispose them to upper extremity injury (Pen *et al.* 1996; Jackson 2017). It is difficult to assess the effects that injuries may have on the training and competitive performance of lifesavers, as the incidences and severity of these injuries have not previously been studied in South Africa. Therefore, the purpose of this study was to retrospectively survey the type, location and severity of musculoskeletal injuries incurred by lifesaving competitors as a consequence of their participation in and training for lifesaving events.

South Africa has a unique socio-economic and demographic structure in comparison to other countries such as Australia, where the majority of research on lifesavers has been conducted (Erby, Heard and O'Loughlin 2010; Pen *et al.* 1996; Carter, Marshall and Abbott 2015 and Mitchell 2013) . In addition, currently there is no medical or physical screening for competitive or community lifesavers, apart from a retest enforced by LSA. This retest is conducted annually and includes a run-swim-run with a time limit of eight minutes, a CPR test and beach signals practical assessment. In the competitive aspect of the sport, the relevant governing bodies do not accept liability for injury or death caused during lifesaving competitions (Erby, Heard and O'Loughlin 2010). Therefore, data collection and analysis of injury profiles of South African lifesavers is crucial for providing suitable prevention, treatment and management strategies for injuries associated with lifesaving.

South Africa has a diverse culture compared to Australia. At Australian Lifesaving Nationals, over 7000 competitors from 313 clubs in Australia competed (*2016 Aussie SLS Championships*). Lifesaving Australia has financial support, athlete funding, national physiotherapy teams which work with the athletes and world class infrastructure compared to South Africa, which is hindered by a lack of financial support for athletes
(H. Herbert, personal communication, 15 June 2017).

This study will add to the literature by providing information about lifesaving injuries which could lead to improved injury prevention methods by the Chiropractors and other health care professions.

1.3 Aims and Objectives

1.3.1 Aim of the study

The aim of this study is to determine the epidemiology of lifesaving induced MSK injuries in competitive lifesavers in KwaZulu-Natal.

1.3.2 Objectives of the study

The objectives of this study are to:

1) Determine the lifetime, point and period prevalence of MSK injury due to lifesaving participation in competitive lifesavers in KwaZulu-Natal.

2) Determine demographic, anthropometric, activity participation and environmental risk factors for MSK injury in competitive lifesavers in KwaZulu-Natal.
3) Determine the impact of MSK injuries in competitive lifesavers in KwaZulu-Natal.

1.4 Rationale

Lifesavers are under-investigated, yet the growth and development of the sport requires that athletes are assessed for injury. The submission of this study to organisations such as Lifesaving South Africa and South African Sports Confederation and Olympic Commission (SASCOC) could aid in educating coaches and athletes regarding MSK injuries sustained by lifesavers. Furthermore, characterization of epidemiology of South African lifesaving related injuries will assist athletes to be more competitive at national and international competition levels.

1.5 Delimitations

This study was limited to MSK injuries arising from competitive lifesaving. There are many factors that can contribute to a person developing an MSK injury. However, the focus of this study was on the demographic, anthropometric, activity participation and environmental risk factors for MSK injury in competitive lifesavers in KwaZulu-Natal. The study used a cross-sectional design, thus cause and effect cannot be inferred, however the association of variables were assessed.

In order to determine the prevalence and find associations between risk factors, selected variables were investigated. It should be noted that other variables exist but were not investigated within the scope of this study but could have influenced participants' responses.

1.6 Flow of dissertation

In Chapter One, the aims, objectives and study rationale have been outlined in the context of the research problem.

Chapter Two presents an overview of MSK injuries in competitive lifesavers, prevalence, risk factors and how these injuries may impact the lifesaving athlete.

Chapter Three details the methodology utilised in this study to obtain the data.

Chapter Four will present results obtained in the study.

Chapter Five contextualizes the results in terms of the current literature and highlights new findings.

Finally, Chapter Six will conclude the study by providing inferences, discussion, study limitations and recommendations for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter will provide an overview of lifesaving as a sport, the current literature regarding MSK injuries sustained from participation in lifesaving and their related risk factors. Where necessary other related sports or disciplines will be discussed, as the literature regarding lifesaving-specific injuries is sparse.

In order to source literature for this research, the following databases were utilised: Google Scholar, ResearchGate, , PubMed and Medline where access to Summon and various electronic book sources were available. The following search terms were used: lifesaving injuries, sports injuries, surf, lifesaving, muscle injuries, muscle strain, musculoskeletal, pain, epidemiology; sports injuries, injury model, overuse injuries, paddling injuries, kayaking injuries, triathlon injuries, injury incidence, injury prevalence, sports injury prevention, Royal Life Saving and musculoskeletal injuries.

2.2 Lifesaving

Surf lifesaving originated in Australia in 1907, when the relaxation of laws barring daylight bathing on Australian beaches saw an increase in drownings in Sydney. Volunteer groups of men were trained in life guarding methods and patrolled the beaches, ensuring public safety (Booth 2000).

The first Australian Surf Life Saving Championships were held at Bondi Beach, New South Wales in March 1915. After a tour of the Commonwealth countries by Sir William Henry, Secretary of the British Lifesaving Authority at the time, a lifesaving organisation was formed in South Africa. The first lifeguarding qualifications were awarded in 1913 under the control of the Royal Life Saving Society of Great Britain. This society remained in control until 1961, when

South Africa formed its own governing body, known as the Surf Lifesaving Association of South Africa (SLASA) which later became Lifesaving South Africa (LSA).

LSA consists of representation form each province, with Lifesaving Kwa-Zulu Natal (LKZN) having the largest memberships. LSA is affiliated to the International Lifesaving Federation (ILS) and South African Sports Confederation and the Olympic Committee (SASCOC). There are two distinct divisions to LSA: lifesaving and lifeguarding. Lifeguarding is the profession of protecting bathers from drowning in aquatic situations and includes patrols. Whereas lifesaving is an athletic sport (R. Sadler, personal communication, 17 July 2019). The lifesaving athlete may perform in one or more of the following disciplines: swimming, ski paddling, board paddling and beach running (Pen *et al.* 1996). Each discipline exposes the athlete to a different environment and requires specialised training.

2.2.1 Swimming Discipline

In the surf swim discipline, on the starter's signal, the athletes run into the water until they reach swimming depth. They then swim out and around markers before returning to shore, making use of sandbanks, rip currents and body surfing skills (Quigley 2012). The surf swim race, which is approximately 300 meters, finishes between two flags on the beach, as seen in Figure 2.1. Unlike swimming in a pool which is a controlled environment (Fitzgerald and Harrison 2003), the surf has rip currents, waves and sand banks that must be negotiated, adding an element of unpredictability to the sport (Erby, Heard and O'Loughlin 2010). Thus, surf swim athletes are at increased risk of injury (Fitzgerald and Harrison 2003) and are particularly susceptible to abrasive injuries and bruises (Erby, Heard and O'Loughlin 2010).

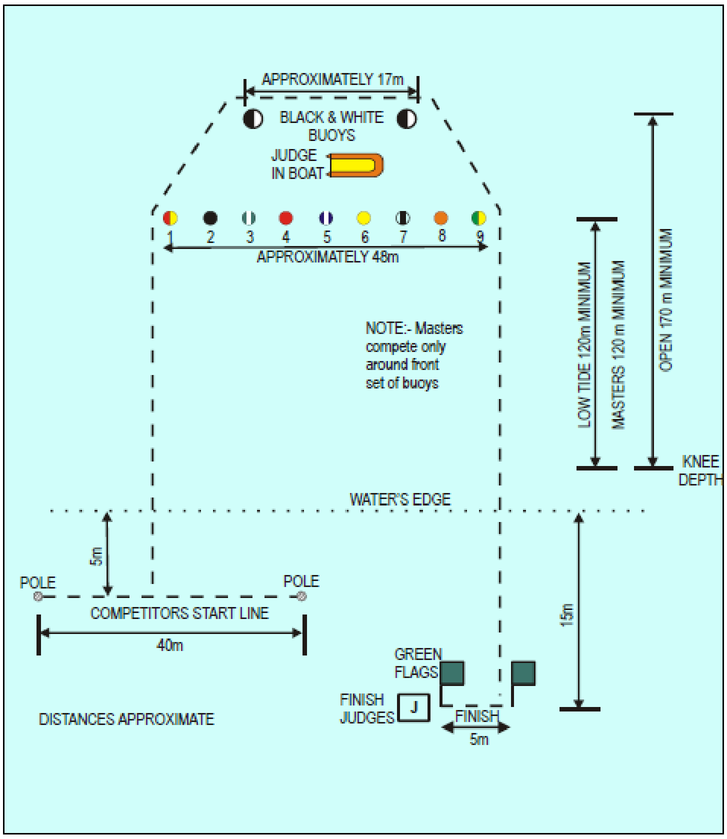

Figure 2.1: The competition arena for the swim event (ILS Competition Manual 2013)

Swimming injuries in lifesavers often occur due to overuse (Erby, Heard and O'Loughlin 2010), excessive mileage, high intensity and incorrect technique (Carter, Marshall and Abbott 2015). The shoulder is the most frequently reported injury, often resulting in a tendonopathy. The repetitive motion of extension, internal rotation and elevation of the arm during the swimming stroke can lead to overuse injuries, which can be exacerbated further by incorrect technique (Carter, Marshall and Abbott 2015). Surf lifesavers swim against waves and currents in the ocean, compounding the risk and leading to higher prevalence of injury, as seen in Figure 2.2.

Figure 2.2: The surf swim (Topfoto 2012)

Compared to other swimmers, the force and demand that lifesavers exert on their shoulders leaves them at increased risk of rotator cuff tendinopathy, bursitis and bicipital tendinopathy (Wernicki and Glorioso 1991). Moreover, the overuse syndrome of "swimmer's shoulder" is frequently seen. Lifesavers generally use only one swimming stroke, freestyle, intermittently mixed with backstroke. The hours of swimming training to maintain fitness required each week further exacerbates the overuse syndromes mentioned (Wernicki and Glorioso 1991).

2.2.2 Craft Disciplines

In the craft disciplines, the athlete races from the beach to the sea, carrying a craft, which they then paddle around marker buoys before returning to shore, making use of sandbanks, rip currents and waves (Quigley 2012). This discipline is divided into two categories: board or ski paddling.

In the Malibu board paddling event, the craft used is similar in design to a surfboard. A knee board style craft with a length of 3.2m and a minimum weight of 7.6kg, as seen in Figure 2.3 (Quigley 2012). The competitors start on a start line facing out to sea and in contact with their racing boards. The boards are propelled using the athlete's body only, from either a kneeling or prone position (Surf Life Saving Australia Coaching Manual 2007). On the starter's signal, the athletes run into the water until paddling depth. They then paddle out and around coloured markers and return to shore, making use of sandbanks, rip currents and wave riding skills. The total race distance is approximately 500 metres and finishes between two flags on the beach (ILS Competition Manual 2013).

Figure 2.3: The Malibu board (Hurricane Surf 2019)

The board paddling stroke begins with the individual in a forward flexed position with scapula protraction, glenohumeral abduction and flexion to 'catch' the water and then the arm is progressed into glenohumeral internal rotation and extension while the thorax extends, as seen in Figure 2.4. By consistently cycling through the positions, the sub acromial space is decreased and may predispose board paddlers to impingement syndromes (Carter, Marshall and Abbott 2015).

Picture 2.4: The kneeling position in board paddling (Brian Spurr 2019)

Mendez-Villanueva and Bishop (2005) reported that the most frequent injuries from board paddling include over-use of shoulder, knee, lower back and neck, as well as hyper extension of cervical and lumbar spine. However, this study was conducted in prone surfboard paddling, which differs from lifesaving board racing with regards to board design, racing conditions and stroke, limiting the applicability of the results to lifesaving board racing. In addition, isometric hyperextension of the back and neck while paddling the board, can lead to strains and sprains (Pen *et al.* 1996).

Figure 2.5: Wave catching on the Malibu board (Topfoto 2012)

These boards are paddled in either the kneeling, as seen in Figure 2.5, or prone positions and can lead to the development of certain "surfing syndromes". Increased injuries are due to the extra-long length of the boards and include rotator cuff tendonopathy, mid and lower back strain, lateral epicondylitis and " surfer's knots”. These are growths of subcutaneous connective tissue over bony prominences often seen in the region of the tibia tubercles, ribs and anterior superior iliac spines (Wernicki and Glorioso 1991).

The ski paddling event makes use of a surf ski craft, which is a kayak style craft with a maximum length of 5.79m and a minimum weight of 18kg, as seen in Figure 2.6, (Quigley 2012). Competitors steady their skis/ kayaks in line, in knee-deep water, in contact with their ski. On the starting signal from the Starter, the single skis are paddled around all the craft buoys and return to the finish line, between two finish flags. The athletes are required to make use of the rip currents and wave riding skills. The finish is judged when any part of the ski crosses the finish line with the competitor in contact with their craft. The race distance is approximately 800 metres (Quigley 2012). In contrast to the board paddling event, the ski discipline requires the athlete to propel the craft forward by using tear drop shaped paddles from a sitting position (Franklin and Leggat 2011). The kayak stroke is broken down into phases, with the definition of these phases differing among researchers (McDonnell, Hume and Nolte 2012).

The paddling stroke is a combination of four movements (catch, pull, stroke exit and recovery) The correct paddling technique combines the paddle grip, sitting in an upright position, knees slightly bent and feet flush on the footplate, rotating the body at the waist through each stroke with the leg drive and pulling the blade through the water in a set path next to the ski.

- The catch: This is the start of the stroke. The blade is placed in the water as far forward as possible. This part is important in setting up the rest of the stroke and allows the correct muscles to be engaged.
- Direction of catch: The direction is slightly downward, pulling the blade of the paddle close to the ski. Power must be applied as soon as the blade strikes the water. The initial movement is downwards and then backwards.
- The leg drive: As the blade strikes the water, the unilateral heel of the foot must drive against the footplate. This allows the leg drive and body rotation to proceed and the correct muscles are activated. The timing of the leg drive and blade entry must happen concurrently to ensure correct and efficient completion of the catch.
- The stroke: This is the movement where the paddle will lock in the water, the ski is then pulled past a stationary blade, creating the power that will propel the ski forward.

When the left-sided paddle exits the water, the pelvis is rotated in the transverse plane with the left hip situated posteriorly. The paddler then flexes the trunk forward, the right shoulder flexes and the right elbow extends to allow optimal paddle advancement. As soon as the paddle enters the water, the right shoulder begins to extend and the elbow begins to flex, drawing the paddle through the water from front to back. At the same time, trunk rotation occurs through the thoracic spine and shoulder girdle. The right knee extends, and the pelvis rotates, moving the right hip from anterior to posterior to enhance and assist the second part of shoulder extension. Once the wrist reaches the level of the pelvis, retraction of the paddle from the water begins. This occurs in a diagonal movement with the paddle moving away from the kayak due to right shoulder abduction. In this phase the trunk should not extend beyond the vertical. From here, the cycle of the left side begins (Limonta *et al.* 2010), occurring in a mirror fashion. Efficient paddling movement through the stroke allows the correct muscles to be activated and reduces the risk of injury (Bjerkefors *et al.* 2018).

Figure 2.6: The surf ski (Topfoto 2017)

Paddling in a controlled, flatwater environment gives rise to overuse syndromes and fewer incidences of abrasions, or collisions with other craft when compared to surf ski paddling through the surf and over waves (Powell 2009). A recent survey of competitive canoeists in Japan found that 55% (n= 417) had recently experienced one or more physical problems when paddling, including pain, movement limitation or numbness. Lower back and shoulder pain were common, 22.5% and 21% respectively. It was suggested that paddling concentrates stress on certain parts of the body, such as the shoulder and lower back, and that the repetitive nature of the activity leads to overuse injury (Holland, Torrance and Funk 2018).

Injuries associated with surf ski/kayak paddling include sprains, tendinopathies, dislocations, fractures and chronic muscle pain (Mallac 2015). Lifesavers using surf skis with kayak style paddles are at similar risk of these injuries, in addition to extensor tenosynovitis and tendinopathies, shoulder bursitis and back strain, which are frequently seen in lifesavers (Pen *et al.* 1996; Wernicki and Northfield 2014).

2.2.3 Beach events

In the flags event, the competitors start from a prone position on the beach facing away from the finish line. Competitors rise, turn and race to obtain a baton (beach flag) placed upright, approximately three quarters above the sand, 20m behind the competitors. There are always fewer batons than Competitors, as seen in Figure 2.7. Those who fail to obtain a baton are eliminated from the event (Quigley 2012).

Figure 2.7: The beach flags (Brian Spurr 2019)

In the beach sprint event, competitors take their positions in their allotted lanes. At the starting signal, competitors run the course to the finish line. The finish is judged on the competitor's chest (only) crossing the finish line. Competitors must finish on their feet in the upright position (ILS Competition Manual 2013).

Figure 2.8: The beach sprints (Melissa Corbett 2018)

Running is a highly repetitive movement, involving large forces, applied through the lower limbs approximately 90 times per minute. Joint motion and muscle activity, both before and after ground contact, determine the impact force vector, stabilise the limb, store energy and apply force to the ground in order to maintain forward motion (Müller, Siebert and Blickhan 2012). Upon contact with the ground, forces are transferred up the kinetic chain via the joints, allowing progressive dissipation of the forces via absorption by the bony structures and soft tissue (Zhang, Bates and Dufek 2000). From the foot, forces are transferred via the ankle to the Achilles tendon and calf muscles. As a soft tissue structure, encountering forces early in the absorption process, the Achilles tendon is subject to high loads, up to six times body weight (Lorimer and Hume 2014). Biomechanical characteristics of gait are modified in response to the training environment in order to reduce potentially injurious forces to the musculoskeletal system and maintain performance (Müller, Grimmer and Blickhan 2010).

In the running discipline, competitors face similar risk factors to road running, with increased possibility of exacerbation due to the unstable surface. These injuries include: ankle sprain and instability, Achilles tendinopathy, plantar fasciitis, shin splints, hamstring strains and muscle cramps (Erby, Heard and O'Loughlin 2010). Other common running conditions such as stress fractures and iliotibial band syndrome have also been reported to result from lifesaving training and activities (Wernicki and Northfield 2016). Beach runners in particular, can develop syndromes such as Lifesaver's Calf (Wernicki and Northfield 2016), which is used to describe a common complaint seen in lifesavers who frequently run barefoot over soft sand. The increased degree of plantar flexion and dorsiflexion required to manoeuvre across soft sand is associated with increased stress and inflammation of the plantar and dorsi-flexors of the foot and ankle, and can lead to a greater incidence of conditions like plantar fasciitis (Fletemeyer 1989). Foot pronation syndromes such as shin splints and ankle sprains, and conditions associated with asymmetrical gait patterns, induced by running on a camber have all also been reported in athletes who run excessively on sand (Pen *et al.* 1996). Increased stretch in the posterior leg compartment during the support phase of running on sand can lead to Achilles tendinopathy or Achilles rupture. Inadequate support due to the sandy surface can cause the foot to pronate or supinate excessively and, at heel strike, stretch the Achilles tendon abnormally due to the heel sinking into the sand (Pen *et al.* 1996).

In a study of 19 elite Australian lifesavers, running was the race component most frequently associated with injury (n=33; 49% of all injuries) and accounted for the greatest number of athletes seeking medical treatment. Pen *et al.* (1996) describe sand running by means of a technique called "up-stepping" where the leg is lifted up and out of the sand to prevent the heel sinking deeply into the sand during the support phase. The technique is also characterised by initial foot contact with the ankle in a plantar flexed position, so that the toes enter the sand first. This technique contrasts with running on conventional surfaces, where approximately 80% of roadrunners land heel first with the foot almost flat to the surface at foot strike. Sand running places increased emphasis on the hip flexor muscles due to a diminished ability to generate the desired horizontal ground reaction force caused by the heel sinking and the foot slipping on the sand surface, which could lead to hip, hip flexor and quadriceps strains and injuries. A reduced stride length on sand running was believed to be offset by an increase in stride frequency (Pen *et al.* 1996). From a total of 35 injuries reported by the athletes in the running component, there were three reports (9%) of shin splints/stress fractures, no reports of Achilles tendinopathy/rupture and plantar fasciitis. However, knee injuries (n=18) accounted for 51% of all injuries in the running component. In this study, the low incidence of Achilles tendinopathy/rupture and plantar fasciitis injuries could possibly be because the ankle does not undergo sufficient dorsiflexion to enable heel contact, which would in turn reduce Achilles stretch.

Hamstring injuries are frequent among individuals participating in high speed running events, such as track sprinting. Rehabilitation and treatment of hamstring injuries is challenging, as evidenced by almost 30% of individuals experiencing a re-injury within the first year after initial injury (Orchard and Best 2002; Woods *et al.* 2004). Of particular clinical concern is that subsequent injuries are often more severe and require more time away from sport than the initial injury (Brooks *et al.* 2006; Koulouris *et al.* 2007). Re-injury rates have been shown to be higher among individuals that sustain a more severe original injury (Koulouris and Connell 2005; Koulouris *et al.* 2007). It has been hypothesized that scar tissue formation, along with weakness or atrophy of the previously injured muscle may be contributing factors to re-injury (Orchard and Best 2002).

Training and competing in running events involves long periods of repetitive stress on the musculoskeletal system, with the feet striking the ground with forces two to three times body weight (Zemper 2005). As a result, the majority of running injuries are attributable to overuse of that system. Lower-limb injuries have been identified as the most common overuse injuries in running athletes (Saragiotto 2014). Of these, chronic Achilles tendon injuries, are one of the most severe in terms of the amount of training and racing time lost as a result of the injury (Lorimer and Hume 2014).

Runners typically use one of two distinct types of foot strikes during running; forefoot strikes (FFS) and rear foot strikes (RFS). In forefoot strike, the ball of the foot contacts the ground before the heel (toe–heel–toe running). During a rear foot strike, a runner usually lands with the foot in front of the knee and hip, with a relatively extended knee, and with a dorsiflexed, slightly inverted and abducted ankle. The runner then plantarflexes rapidly as the ankle everts just after impact. In contrast, a forefoot strike runner lands with a more flexed knee and plantarflexed ankle, usually making ground contact below the fourth or fifth metatarsal heads; the runner then simultaneously everts and dorsiflexes the foot during the brief period of impact, usually with more ankle and knee compliance (Lieberman *et al.* 2010). Sprinters often forefoot strike (Lieberman *et al.* 2010) which is more comparable with beach sprinting.

2.2.4 Multi sport events

Lifesaving includes multi-sport events, such as the ironman and ironwoman events. These events are comprised of four components (beach run, swim, Malibu board paddle and surf ski) as seen in Figure 2.9 (Mitchell 2012). In a study on triathletes by Andersen *et al.* (2013), the average prevalence of overuse problems was 56% (490 cases). In this study, athletes spent a total of 276h in training during the 26-week study period, at an average of 11.1h/week. Of this, 1.4h/week were spent swimming (12%), 5.8h cycling (48%) and 2.9h running (24%). The remaining training time (16%) was spent on other training such as weightlifting, skiing or other activities (Andersen *et al.* 2013). The average prevalence of substantial overuse problems was 20% (165 cases). The most prevalent sites of overuse problems were the knee (25%), lower leg (23%) and lower back (23%). The acute injury incidence was 0.97 injuries per 1000 hours of training (36 cases) and 1.02 injuries per 1000h of competition (5 cases). The majority of moderate and severe acute injuries were located at the knee, shoulder/clavicle and sternum/ribs. The predominant types of acute injuries were contusions, fractures and sprains. Overuse problems constitute the majority of injury cases among iron-distance triathletes and are far more common than acute injuries and illnesses. The most prevalent sites of injury in the study were the knee, lower leg, lower back and shoulder.

Similar, to triathletes, lifesavers tend to divide their training between multiple sport disciplines. One study by Pen *et. al*. (1996) reported that Australian lifesavers typically trained an average of 69.1 mins (± 43.3 mins) per week in the run component; 292.5 mins (SD+95.6 mins) in the swim component; 69.1 mins (SD+ 41.7 mins) in the board component; and 94.1 mins (SD+ 59.7 mins) in the ski component, over one year. On average these lifesavers trained for 8.7 hours per week. Similarities in training styles and times facilitate comparisons between triathletes and lifesavers, as well as the types of injuries sustained.

The literature concerning the disciplines of lifesaving, as well as the lifesaving-specific injuries involved is sparse. Thus, it has been previously necessary to extrapolate injury data from similar sports. While these comparisons have been helpful, there is a clear need for stand-alone data within the lifesaving discipline. Consequently, this review serves as motivation to investigate lifesaving-specific injuries within the scope of this study to better understand the mechanisms and causes thereof. The implications of this study include creating awareness for athletes competing in lifesaving events, enabling a better understanding of the mechanisms and risks of lifesaving-specific injury and assisting healthcare providers with specific information in order to treat and rehabilitate these athletes appropriately.

Figure 2.9: Multi discipline events in lifesaving include Malibu board paddling, surf ski paddling, surf swimming and beach running (Brian Spurr 2019).

2.3 Theoretical model for injury in sport

A physically active lifestyle has many benefits (Wilson, Ellison and Cable 2016). However, sports participation also carries a risk for injury (Meeuwisse *et al.* 2007; Timpka *et al.* 2014). It has been said that although developing improved treatment methods for injuries remains an important goal, it may be even more important to prevent injuries (Drawer and Fuller 2002; Timpka *et al.* 2014). Injury surveillance allows one to assess the impact of sports participation on an athlete's health and can help in establishing cause which will assist with putting injury prevention strategies in place (Timpka *et al.* 2014). This includes identifying why particular athletes may be at risk in a given situation (i.e. risk factors) or how the injuries happen (i.e. injury mechanisms) (Gissane *et al.* 2001). In a recursive model of sport injuries, Meeuwisse *et al.* (2007) describe how a single exposure can alter risk factors and allow an athlete to cycle through the model repeatedly, independently of outcome (Figure 2.10). This is due to the fact that in real life, the sporting environment and a participant's risks are dynamic and can change frequently (Meeuwisse *et al.* (2007). Moreover, one exposure to a potential inciting event can alter an athlete's intrinsic risk factors and change their predisposition to injury. The athlete can then be exposed to the same or different extrinsic risk factors and have a different susceptibility.

This paints a recursive picture where an athlete can enter a given athletic event cyclically with a differing set of risk factors.

Exposure is a combination of both possessing a risk factor and then participating (to a greater or lesser degree) with the risk factor. An individual may be exposed to the same or different risk factors repeatedly through multiple participations. Injuries may or may not occur under similar conditions. In most cases, the occurrence of injury does not permanently remove an individual from participation and, therefore, may not represent a finite end point.

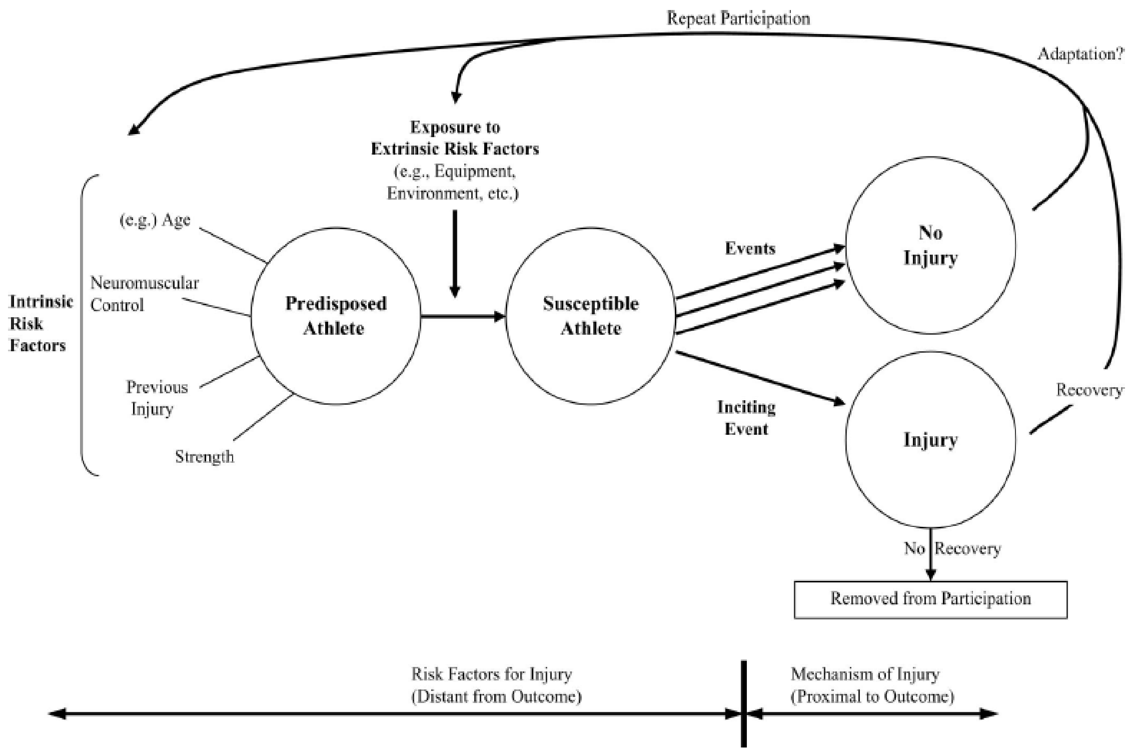

Figure 2.10: A dynamic, recursive model of aetiology in sports injuries (Meeuwisse et al. 2007)

The use of this model represents a dynamic approach that incorporates the consequences of repeated participation in sport, both with and without injury. This model assumes that any risks may interact with any other risks to produce joint interaction effects. As such, intrinsic factors may interact with extrinsic factors to produce a joint interaction. Essentially, the ‘‘susceptible athlete’’ phase is where the intrinsic and extrinsic risks, and the interactions between all of the risks accumulate.

Athletes each have their own independent group of intrinsic risk factors (e.g. bone strength, neuromuscular control, age and previous injury history). A risk factor can be reduced as the athlete takes part in and adapts to the environment or to potentially injurious situations without sustaining injury. For example, repetitive body collisions in contact sports may result in injury but may also result in conditioning and strengthening. If intrinsic strength improves, the athlete could be less predisposed to injury. In this example, exposure to extrinsic factors and other events (which might otherwise incite an injury) could actually reduce the chance of intrinsic risk, which would decrease overall injury risk. The opposite may also occur. If repeated body collision produces asymptomatic micro-trauma and decreases strength or neuromuscular control, the athlete may be more predisposed to injury. Then, the exposure to the same extrinsic (risk) factors and same movement or event would result in the athlete being injured. In this case, we refer to the event as a mechanism of injury (Meeuwisse *et al.* 2007).

2.4 Intrinsic risk factors

Intrinsic risk factors are individual biological and psychosocial characteristics which may predispose an athlete to a musculoskeletal injury (Taimela, Kujala and Osterman 1990). This section will describe some of the more common risk factors. However, the literature is contradictory in terms of the effect of age on injury (Brown *et al.* 2016)

2.4.1 Age, gender and race

Age is a known risk factor for many diseases - for example, osteoarthritis (Blagojevic *et al.* 2010). It seems reasonable that age would also be a risk factor for injury, as older athletes typically have increased exposure over time whereas younger athletes have less exposure. Additionally, as the athletes age, the body's collagen tissue changes, becoming less elastic and less able to absorb forces. This results in the tissues being less adaptable to respond to quick force changes or recover from fatigue (Shefelbine 2015). Adult athletes need to have flawless habits and there is no reason that the same should not apply for young athletes. This goes for medical attention too, as young athletes should receive proper medical treatment to prevent long term issues and premature retirement from sport (Launey 2015; Maffulli *et al* 2010).

In an epidemiological review in Australia on surf sport-related injuries, a total of 2,645 competition or training-related incidents were reported. Individuals, 35 years and older, experienced a higher proportion of injuries during training than younger individuals (Mitchell 2012). Similarly, it was found in a survey among Californian ocean lifeguards, older lifeguards reported a higher proportion of injuries than younger lifeguards. The incidence of injury in middle aged Lifeguards (36-65) was significantly higher when compared to lower (18-35) and upper age groups (65+) (Jackson 2017).

Among Californian lifesavers, no significant differences were reported when data were adjusted for sex (59.3% males and 62.1% females) and MSK injury prevalence (Jackson 2017). Similar findings were found in Australian lifesavers who suffered shoulder pain (48.4% (n= 15) of males and 56.5% (n =13) of females) (Carter, Marshall and Abbott 2015) and in lifesavers (Mitchell 2012). It does seem surprising, however, that neither study reported differences according to sex, as it is known that women run, land, and jump differently than men when playing sports (Dugan 2005). In the available lifesaving literature, there are no significant risk factors regarding injury and race (Carter, Marshall and Abbott 2015; Mitchell 2012; Pen *et al.* 1996; Jackson 2017; Fletemeyer 1989 and Erby *et al*. 2010). Regardless, these types of data are important but are lacking within the South African context.

2.4.2 Body size

Body size in terms of height, weight, lean muscle mass, body fat, body mass index (BMI) and mass moment of inertia have been investigated too as risk factors in MSK injury (Östenberg and Roos 2000; Beynnon *et al.* 2001; Knapik *et al.* 2001). An increase in any one of these factors produces a proportional increase in the forces that articular, ligamentous, and muscular structures must resist. However, the relationship between body size and injury remains unclear. Increased adiposity has been linked to asymptomatic tendon morphological changes, although weight appears to have a very small effect on Achilles injury risk (Gaida *et al.* 2010). Once again, there has been little investigation into these factors and their role in lifesaver injuries is unknown.

2.4.3 Limb dominance

In certain sports, the dominant leg may be at increased risk of injury because it is preferentially used for kicking, pushing off, jumping, or landing. However, the association between limb dominance and injury is controversial. While several studies have reported that limb dominance has an effect on injury (Baumhauer *et al.* 1995), no effect of limb dominance was reported on severe ankle and non-contact knee injuries in male soccer players. Although the dominant leg did tend to incur significantly more contact knee injuries, therefore the type of injury seems to be important (Chomiak *et al.* 2000). Quadriceps strains were more commonly sustained by the dominant leg than the non-dominant side in female netball players, but there was no association between limb dominance and injury of the hamstrings or calf muscles (Orchard 2001). No influence of limb dominance was found on ankle sprains in a study of collegiate soccer athletes (Beynnon *et al.* 2001). Due to innate characteristics of the human body, a certain level of asymmetry is considered acceptable and estimated to occur in 96% of the population (Morouço *et al.* 2015). Although asymmetry is considered normal and adaptive in predominately unilateral sports (Saccol et al., 2010), it has been reported to weaken performance in continuous cyclic activities such as swimming (Sanders *et al*., 2012). Although these sports vary from the disciplines that lifesavers partake in, it is possible that limb dominance may be a factor related to injury.

2.4.4 Psychological

Injury is often a traumatic event where emotional and psychological reactions are experienced. Typically, these reactions are based on the individual's perceptions of loss e.g., mobility, playing time and career (Podlog *et al.* 2015). Although this loss is perceived differently by different individuals, injuries can often prevent athletes from pursuing a career in sport. As a result, they are particularly vulnerable to psychological reactions such as anxiety, depression, fear and loss of self-esteem (Rollo, Tracey and Prapavessis 2017). In South Africa, lifesaving coaches were asked what factors were important in their coaching methods. Those rated as most important included technique correction, strength and conditioning, and technique analysis. When asked about the least important - sports psychology was rated second (Morris-Eyton and Coopoo 2014). Indicating that coaches did not place much emphasis on the psychological impact of the injury on the athlete.

Damage to self-esteem is a potential result of injury that has been neglected in favour of the closer examination of emotional reactions following injury. It has been suggested that certain components of self-esteem, physical self-efficacy and perceived physical competence, can be affected by injury. It has also been suggested that injury can lead to changes in how a person views himself or herself. It was found that self-esteem was lower in injured runners than those who were able to continue running when measured by a global measure of self-esteem. When comparing injured and recovered athletes to non-injured athletes, it was found that injured athletes reported significantly lower total and physical self-esteem than non-injured athletes (Green and Weinberg 2001).

Self-confidence is derived from two elements; confidence in the injury site and confidence in performance (Forsdyke *et al.* 2016). Confidence may have a moderating effect on the emotion of fear as both seem determined by injury and performance related inputs. Confidence in returning to sport after injury appears to be multidimensional (Podlog *et al.* 2015). Developing confidence in both the injured body part and in the athlete's ability to perform to a satisfactory standard may act as a 'buffer' from injury related anxiety and fear. The implication of this is that athletes would acquire the suitable 'psychological readiness' to return (Forsdyke *et al.* 2016). These factors can influence healing and return to play and appear to be an extremely important component of performance, yet their effect on lifesavers is undocumented.

2.4.5 Lifestyle factors

While the term "health" means many things to many people, the gold standard definition of this is "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (Conference 2002). As an athlete, it is important to insist on good lifestyle habits. Thus, inadequate hydration, a poor diet, and lack of sleep are factors that must be considered (Launey 2015; Maffulli *et al* 2010; González-Gross *et al.* 2013).

In a study in Ireland on various sports such as rugby, cricket, hurling, soccer and Gaelic football, alcohol consumption appears to have a causative effect in sports related injury, with an injury incidence of 54.8% in drinkers compared with 23.5% in non-drinkers This may be due, in part, to the hangover effect of alcohol consumption, which has been shown to reduce athletic performance by 11.4% (O'Brien *et al.* 2000). Research consistently indicates that excessive alcohol consumption and negative alcohol-related consequences and behaviours are major health issues among students (Wechsler *et al.* 2002) and that student athletes are truly an at-risk population in this area (Leichliter *et al.* 1998; Nelson & Wechsler, 2001). From a sample of over 8,000 student athletes, Leichliter *et al*. (2002) reported that athletes averaged more drinks per week and engaged in more frequent binge drinking episodes than nonathletes. (Etzel 2006).

2.5 Extrinsic risk factors

These risk factors are independent of the injured athlete and predominantly related to the type of activity.

Within the possible mechanisms of injury, a number of factors have been identified that could increase the risk of developing an injury. Overuse injuries are likely to be multifactorial in nature, resulting from a combination of risk factors rather than one specific issue (Wen 2007).

2.5.1 Training and competition surface

Polymeric materials are extensively used in shoes and sport surfaces (in particular for athletics tracks) as shock absorbers to prevent joint and muscular injuries. They are able to reduce the amplitude of incoming shock waves travelling through the human locomotion system while running or jumping (Silva *et al.* 2009). The dissipative properties are expected to have an influence on the cushioning characteristics of sport surfaces, with important dampening effects on the high frequency peaks generated in the very first moments of the impact, thus increasing the comfort and the safety of the athlete (Benanti *et al.* 2013). Running on stiffer surfaces has been shown to have a moderate protective effect, and peak propulsive force a smaller protective effect (Lorimer and Hume 2014). In contrast, training on soft surfaces, such as track or sand, is associated with a small and moderate effect in increasing injury risk, respectively (Knobloch *et al.* 2008; Di Caprio *et al.* 2010). A clear and very large negative effect was seen for training distance-per-week and number-of-years running (Lorimer and Hume 2014). Indicating that the training surface itself is a risk factor for injury.

In sports like beach volleyball, players have reported that the sand quality and depth affected their injuries, especially overuse, low back and knee injuries. Venues with hard sand were particularly problematic. Players that had previously played indoors reported fewer knee and back problems in comparison to beach players than during their indoor volleyball career. The authors also hypothesised that there would be an increased risk of acute lower limb injuries when the sand was hard packed (Bahr and Reeser 2003).

It is clear that the stiffness of the surface most commonly trained on is related to incidences of injury (Knobloch *et al.* 2008; Di Caprio *et al.* 2010). More compliant surfaces such as sand and track had a negative effect, whereas stiffer asphalt had a small protective effect (Knobloch *et al.* 2008). Changes in surface stiffness during running and hopping tasks resulted in modification of the leg stiffness in order to maintain the stiffness of the environment athlete system (Dixon *et al.* 2000; Kerdok *et al.* 2002; Hardin *et al.* 2004). It is possible that the increase in pre- and post-ground contact muscle activity and decreased joint motion required to increase leg stiffness on softer running surfaces adds strain to the Achilles tendon, increasing the risk of overload and micro damage.

Using the knee joint as an example, considering the complexities of the tibio-femoral joints and the patellofemoral joint, the proximal articulations (hip, pelvis, and spine) and distal articulations (ankle and foot) also need to be considered. Knee function will, therefore, depend upon the proximal and distal position of the lower limb and trunk (Dugan 2005). Likewise, the proprioceptive function of receptors in multiple structures must be taken into account, including the anterior cruciate ligament (ACL) or quadriceps, and the alterations in proprioceptive function related to pain, oedema or loss of stability. The acknowledgment of forces of gravity, momentum, and ground reaction in multiple planes of motion dictate sports-related knee function, which can be unpredictable if the playing surface is as mercurial as beach sand (Dugan 2005). Multi-planar control at the knee may be directly impacted by foot position, ligamentous laxity, and muscle fatigue after repetitive eccentric contractions or knee joint positioning that inhibits rather than recruits the optimal muscle co-contraction patterns (Dugan 2005).

2.5.2 Situational (competition vs training)

Pen *et al*. (1996) reported in a study of 19 elite lifesavers that the majority of injuries were associated with overuse (n=34; 51%); while 51% were bilateral. Injury did not tend to prevent participation in training but did reduce training in specific race components. Subjects reported an average of 40 days per year (SD=10.6) lost in running training, 2.6 days (SD=3.5) lost per year in board training, and less than 0.5 days lost per year in swim (SD=4.3) and ski training (SD=7.1). No days were lost in competition. Overall, subjects reported 13 different types of injury (e.g. tendinopathy, overuse injuries and sore knees) with six distinct causes (e.g. overuse/overtraining, soft sand running and lack of warm up) that they perceived to be, in general, mostly associated with injury. Tendinopathy (n=6; 24%) was recognised as the main type of injury and overtraining (n=14; 56%) the major cause (Pen *et al.* 1996). Training factors are suggested to be associated with risk for all overuse injuries, typically by increasing pace or distance too rapidly (Knobloch *et al.* 2008; Di Caprio *et al.* 2010).

Incidents involving beach flags were common during competition events (13.8%), while activities related to the board (12.9%) were common during training activities. Bruises/contusions, strains, inflammation/swelling, and sprains most frequently occurred during both competition and training events. Fractures (19.9%), sprains (16.5%), strains (14.6%) and inflammation/swelling (14.2%) were the most common type of injuries experienced during competition and training for beach flags (Mitchell *et al.* 2013). During competition, minor first aid represented just over half (54.5%) of the incidents, while during training minor first aid accounted for 43.7% of incidents. Major first aid represented just over 10% of incidents during both competition and training, with 14.4% of incidents that occurred during competition identified as occurring during a carnival. Other incident types were more common during training than competition (43.5% versus 17.9%, respectively) (Mitchell *et al.* 2013).

In a study by Zemper (2005) on track and field athletes, an injury rate of 1.7/100 athletes was reported in competition and 1.4/100 athletes for training sessions. Based on athlete-exposures in competition and training (where an athlete-exposure is defined as one athlete participating in one training session or one competition where he or she is exposed to the Track and Field Injuries possibility of being injured), they report an injury rate of 2.93/1,000 athlete exposures in competition and 0.72/1,000 athlete-exposures in training. This illustrates why reporting injury 'rates' in percentages or per 100 participants per year can very often be misleading. A true picture of risk can be gained only when exposure data are part of the equation (Zemper 2005). The reported percentages indicate that many more injuries occur during training, which is not surprising, as in any sport there are many more training sessions than competitions. The rate per 100 athletes indicates a slightly higher injury rate in competitions, however the real risk cannot be appreciated unless the rate is reported in relation to the number of exposures in competition and in training sessions. In this case, the more accurate injury rates per 1,000 athlete-exposures indicate that an athlete is 4.1 times more at risk, or more likely to incur an injury, in competition than during a training session. This is a common finding across all sports, where data based on exposure show a higher injury rate in competitions, ranging from two to nine times greater than in training (Zemper 2005). As there is no available data for South African competitive lifesavers, this is a further motivation for this study.

2.6 Training load and rest days

Rotator cuff tendinopathy is a common condition that is increased in certain athletic environments where overhead arm motions are required (Jelinsky *et al.* 2008). The mechanism by which tendinopathy is induced through overuse activity is not well understood, because only end-stage tissue is typically available for analysis (Archambault *et al.* 2007). Current treatment for patients with this type of injury begins with rest or activity modification, and often includes a course of nonsteroidal anti-inflammatory drugs. Rest is believed to allow the tendon to repair itself (Jelinsky *et al.* 2008). Including rest days in athletic training schedules and periodisation is believed to reduce the formation of tendinopathies and overuse injuries (Fordham, Garbutt and Lopes 2004; Ristolainen *et al.* 2014). Specifically, tendon cross-sectional area increases with overuse and modulus and maximum stress decrease relative to control. Structural and cellular changes include increased collagen fibre disorganisation, hyper-cellularity and a change in cell morphology from elongated spindle-shaped cells to more round, plump cells. These findings suggest a scientific basis for the use of rest as at least one component of treatment for tendinopathy (Jelinsky *et al.* 2008).

A study by Ristolainen *et al.* (2014), of top-level Finnish athletes consisted of 446 men and women, representing three different endurance sports (cross-country skiing, swimming, long-distance running) between the ages of 15-35 years old. The Self-reported anthropometric and training-related variables (such as starting age of training, years of active training, hours trained yearly, competition hours and weekly resting days) were correlated with the occurrence of overuse injuries. Athletes with less than two rest days per week during the training season had 5.2-fold risk (95% confidence intervals [CI] 1.89-14.06, p=0.001) for overuse injury, and athletes who trained more than 700 hours during a year had 2.1-fold- risk for overuse injury compared to the others. The study concluded that a low number of recovery days and a high amount of training were training-related risk factors for overuse injuries in top-level endurance athletes (Ristolainen *et al.* 2014). Athletes participating in British adventure racing, a sport that includes running, swimming and canoe training, and is comparable to the sport of lifesaving, were found to experience overuse injuries due to the lack of adequate rest days (Fordham, Garbutt and Lopes 2004).

Young surf lifesavers with a history of shoulder pain, were found to complete more swimming sessions (p = 0.008), hours of swimming (p = 0.015) and distance swimming per week (p = 0.005) than those without shoulder pain (Carter, Marshall and Abbott 2015). Prolonged high training loads can have a detrimental effect on glenohumeral stability due to repetitive loading of ligamentous structures. This lack of stability requires increased dynamic stabilisation through the rotator cuff complex which could cause muscular fatigue resulting in shoulder injury or dysfunction. The idea of shoulder laxity resulting in shoulder dysfunction or injury further supports the findings of this study and is in line with previous research (Carter, Marshall and Abbott 2015).

2.7 Impact

South Africa has a unique socio-economic and demographic profile when compared to other countries such as Australia, from where most of the research on lifesavers has been conducted. In addition, currently there is no medical or physical screening for competitive or community lifesavers, apart from a retest enforced annually by Lifesaving South Africa (LSA). This retest is conducted annually and includes a run-swim-run with a time limit of eight minutes, a CPR and beach signals practical assessment (International Life Saving Federation 2015). In the competitive aspect of the sport, the relevant governing bodies do not accept liability for injury or death caused during lifesaving competitions (Erby, Heard and O'Loughlin 2010). This along with the socio-economic situation of a considerable number of the members of LSA makes it necessary to collect data and analyse the injury profile of lifesavers in order to provide suitable prevention, treatment and management methods of the injuries associated with lifesaving.

Mitchell *et al.* (2013) found that less than 40% of individuals who were injured during competition or training were not referred for further treatment (39.6% and 36.1%, respectively). Of the remaining individuals that were injured during competition or training, less than one quarter were referred to a medical practitioner (22.2% and 26.0%, respectively), with others transported by ambulance to hospital (14.9% and 20.1%, respectively), or referred to a physiotherapist (5.2% and 4.3%, respectively), while the remaining individuals were referred for treatment to other or unknown services (18.0% and 13.5%, respectively). Due to lack of funding, lifesaving athletes in South Africa are expected to pay for their own medical costs as an out of pocket expense, unless they frequent the government hospitals.

The prime research focus in sports injuries has been on physical factors (Walker, Thatcher and Lavallee 2007). This is despite our understanding that when an athlete sustains a sports injury, it also has great psychosocial impacts (Brewer, Andersen and Van Raalte 2002). A common hypothesis has been that physical and psychosocial recovery occurs at the same time. However, it should be appreciated that physical and psychological readiness to return to sport after injury do not always coincide (Podlog *et al.* 2015). This leads to athletes returning to training and competition when they are physically able but not necessarily psychologically ready. Many athletes do not return to their pre-injury level of activity, and fewer return to competition. Moreover, competitive athletes are less likely to return to a pre-injury level of performance than recreational athletes. Therefore, it is one of the underlying objectives of this study to determine whether a significant emotional response to injury exists, and how this response could impact training and re-injury.

There is scant literature world-wide regarding the injuries associated with the multiple disciplines involved in Surf Lifesaving, particularly in South Africa. With regards to swimming, there is ample information regarding MSK injuries, but little that is specific to lifesaving, and even less still, specific to South Africa. The ever-changing environment that South African lifesavers encounter, both during training and in competitions, may contribute to a different injury profile than that which is seen in flatwater swimmers. This is true of the craft disciplines as well, being multi-disciplinary and taking place in a fluctuating environment. Furthermore, the beach events are entirely unique to lifesaving, taking place on an uneven surface and utilizing completely different biokinetic chains to traditional running.

This research intended to investigate the MSK injury profile in the South African lifesavers specifically, which will help support South African lifesaving athletes, not only in terms of understanding injuries from a prevention point of view, but also to provide useful information that could influence policy-making decisions by relevant governing bodies in the future.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter will detail the research methodology utilised in this study. This will be followed by ethical considerations pertinent to the study and a summary of how the data was analysed.

3.2 Study design and approval

This research made use of a quantitative approach including a descriptive, cross-sectional epidemiological survey design to fulfil the research aim. Survey-based research allows for the collection of data from a large, diverse target population, from which the descriptive information generated can undergo statistical analysis allowing for an understanding of the relationships between variables (Mitchell and Jolley 2012). The characteristics of this type of design made it most appropriate for use in this study.

This study was approved by the Durban University of Technology (DUT), Institutional Research and Ethics Committee (IREC) prior to the collection of data (IREC: 187-17) (Appendix I).

3.3 Setting and population

The study took place in KwaZulu-Natal and the study population consisted of competitive lifesavers over the age of 16 years. All active members of Lifesaving Kwa-Zulu Natal (LKZN) fitting these criteria were invited to participate (N=130).

3.4 Sampling

3.4.1 Sample recruitment

The study was advertised to potential participants via advertisements which were distributed through the Lifesaving South Africa Head Office to the provincial lifesaving association for dissemination to all the clubs affiliated with LKZN (Appendix G).

3.4.2 Sample characteristics

The lifesavers were required to meet the inclusion and exclusion criteria to be eligible for the study:

3.4.2.1 Inclusion criteria:

1. The lifesaver had to aged 16 years or older to participate.
2. A registered member of a club affiliated with LKZN.
3. Participate in lifesaving in the capacity of an amateur (non-professional) competitive athlete, competing in either regional or national championships during the 2016/2017 season.
4. Provide a signed letter of information and consent (LOIC).

3.4.2.2 Exclusion criteria:

1. Participants who took part in the expert group and pilot study.

3.4.3 Sample size

At the time of the study, the sample size was N=130 of active lifesavers participating in the competitive lifesaving season (L.Lunn, personal communication, 5 April 2016). These were all invited to participate. Their participation was by self-selection. Due to the difficulties in obtaining samples in survey research, the researcher aimed for at least a minimum response rate of 70% to allow for generalisability.

3.5 Measurement tool

3.5.1 Development of the questionnaire

A self-report musculoskeletal questionnaire was compiled by the researcher for use in this study. The researcher identified two studies, one conducted in Australia investigating shoulder injuries in young lifesavers by Carter, Marshall and Abbott (2015) and the other, a South African study investigating injuries in triathletes by Coetzee (2014). After obtaining permission from the authors (Appendix E), the questionnaires were combined and adapted specifically for this study. This resulted in a pre-validated questionnaire (Appendix M). Sections A and C were derived from Coetzee (2014) these sections detailed questions related to the injury profile of body areas and section B was derived and adapted from Carter, Marshall and Abbott (2015) and pertained to questions related to lifesaving specific questions.

In order for the questionnaire to be used in this research project, the validity of the questionnaire needed to be determined. Validity refers to the accuracy and dependability of instrument, information, statistics and results in research, so that a particular tool utilised in a research investigation ensures accuracy (Bernard and Bernard 2012). The procedure to validate the questionnaire in this study made use of an expert group and pilot study.

3.5.1.1 Expert group

Following provisional approval from the IREC, an expert group meeting was organised. It consisted of ten members meeting the following criteria:

- The researcher
- The research supervisor/s
- At least one person who has had experience in survey research
- At least one person who is an expert in lifesaving sport
- At least one person who has had experience in quantitative research methodologies
- A masters student who has conducted or is presently conducting survey research

At the start of the expert group, members were welcomed and given verbal instructions as to the role of the expert group. They were asked to give their verbal consent to the expert group discussion being recorded. Once agreed, members were informed that their names would not be divulged in the research and they were requested to not discuss the expert group findings, allowing for confidentiality of the participants.

Each member was given a LOIC (Appendix L) to read and sign, along with a copy of the pre-validated questionnaire (Appendix M). Members were required to sign a code of conduct form (Appendix N) and a confidentiality statement (Appendix O). Once all members agreed to the terms of the expert group, the researcher allowed the participants' time to read through the questionnaire, and they were encouraged to interrogate and consider the significance of each question relevant to the study aim objectives. Following this, the researcher posed each question to the expert group for discussion. Members then presented modifications, suggestions and/or recommendations. Each suggestion was discussed by the group with changes being made and recorded through group consensus. Following the expert group meeting, the questionnaire was modified to produce the pre-piloted questionnaire (Appendix F).

The expert group allowed for face and content validation of the questionnaire. Face validity refers to the 'face value' of the questionnaire and is a subjective decision as to whether the research tool appears to be valid and unambiguous on the surface (Bernard and Bernard 2012).

This was determined by the expert group members agreeing that the questionnaire would allow adequate answering of the study aim and objectives.

Content validity involves the assessment of the content specific to the questionnaire. This method of validity relies on the knowledge of individuals who are familiar with the concept and constructs being investigated in the research (Bernard and Bernard 2012). Thus, members of the expert group had a variety of characteristics ranging from research to discipline-specific expertise. This allowed the questionnaire to be critiqued to assess if the content was appropriate to the study. The expert group members had to agree that the questions are effective and suitable to the aim and objectives of the study in order for content validity to be ensured.

3.5.1.2 Pilot testing

Following the expert group meeting, the pre-pilot questionnaire was subjected to pilot testing. This entailed a trial run of the research, conducted on a sample of members of the research population, to determine the viability of the research measurements (Trochim 2000). The aim of the pilot study was to determine if the research population could relate to the questionnaire and to identify the presence of any potential oversights or discrepancies (Brancato *et al.* 2006).

Five lifesavers were included in pilot testing of the questionnaire. They were required to complete the LOIC (Appendix L) and the pre-pilot questionnaire (Appendix F), as well as a pilot testing evaluation form (Appendix H). They were instructed to make any necessary changes to the questionnaire as they answered it. The pilot participants made no changes to the questionnaire, therefore assuring that the questionnaire was unambiguous and easy to administer. The pre-piloted questionnaire then became the final questionnaire that was utilised in this study (Appendix H).

3.5.2 Final Questionnaire

The research study questionnaire (Appendix F) consisted of questions in the following categories:

- Socio-demographic
- Anthropometric
- Activity participation
- Area of MSK pain, severity of MSK pain and if they had medical treatment

3.6 Research procedure

Once permission was obtained from LSA and LKZN to conduct the study (Appendix G & H), the researcher approached the active members of LKZN at the lifesaving clubs. The lifesavers were informed that participation was voluntary and that their participation would be confidential. The questionnaires and the LOIC documents were kept separately. Those wanting to participate were given a LOIC (Appendix A & B) with parental consent and the research study questionnaire (Appendix H) to complete. The researcher instructed participants not to place their names on the questionnaires to maintain confidentiality and was present to address any questions or queries that arose.

3.7 Data analysis

Upon completion of the study, the data were reduced and coded as necessary, to ensure participant confidentiality. Coded data was entered into an excel spread sheet and analysed descriptively, mean, mode, frequency and percentages, and inferentially. Inferential statistics included the analysis of categorical data groups using Chi squared or Fishers exact test, while the students' T- tests and Mann Whitney tests were applied to assess significant differences between numerical data. Where the variables were numerical normality testing was conducted. IBM SPSS version 25 was used to analyse the data. Descriptive statistics such as frequencies and percentages were used to summarise categorical outcomes while mean and standard deviation were used to summarise continuous variables and probability set at $p \leq 0.05$ (Esterhuisen, personal communication August 2020).

3.8 Ethical considerations

Participant autonomy was maintained as participation in this study was voluntary after participants were informed of the study both verbally and through the LOIC (Appendix L). Participants were also informed that they were free to withdraw at any time without penalty, should they so wish. Minors were included as the under 19 age group was the biggest age group at the time of the study, was obtained. Participants were requested not to place their name or any other identifier on the questionnaires. Questionnaires were also coded, and the use of separate ballot boxes ensured participant confidentiality and no harm to the participants. In addition, data obtained from the study was accessed by the researcher, the research supervisor and the co-supervisor only. Throughout the study, the research questionnaires and LOIC were kept in a locked safe. On completion of the study, the research data (Excel spreadsheet, LOIC and the questionnaires) will be stored safely in the DUT Chiropractic department for five years, thereafter, all data will be disposed of by means of shredding.

All participants meeting the study criteria were invited to participate, in line with ethical principles of justice. Justice ensures an impartial selection of participants (Emanuel, Wendler and Grady 2000). In this study there was no discrimination utilised in sample selection based on race or gender.

Beneficence is an ethical principle that addresses the idea that actions should promote good. Doing good is thought of as doing what is best for the patient. Beneficence should not be confused with the closely related ethical principle of non-maleficence, which states that one should not do harm to patients. Beneficence was retained in this study, as this study was conducted in the best interest of the competitive lifesavers in the province and will add to the literature in this area. Non-maleficence was addressed as this was an anonymous survey with little risk the participants as the data was generalised and no individual results would be given to the lifesaving clubs or to Lifesaving SA.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the results of the data analysis. It begins with the response rate and is followed by the results reported for each study objective.

4.2 Response rate

The response rate was 77% with one hundred participants agreeing to participate (n=100).

4.2.1 Objective one: To determine the lifetime, point and period prevalence of MSK injuries in competitive lifesavers in KwaZulu-Natal

The total number of respondents who reported a lifetime prevalence of MSK injury arising from lifesaving was 72% (n=72). Table 4.1 shows the regions of the body where the participants (n=72) reported to have experienced MSK pain either currently, in the last 12 months or in their lifetime. Respondents could indicate more than one region of injury per body area. This resulted in 177 lifetime, 133 twelve-month period and 86 current lifesaving injuries being reported. The most common lifetime injury was shoulder pain (38%), whereas lower back pain was more frequently reported for period (26%) and current (22%) pain.

Table 4.1: Lifetime, period and current MSK pain experienced by the participants (n=72), per body region

Region	Lifetime		Period *		Current	
	n	%	n	%	n	%
Neck	14	7,9	10	7,5	8,0	9,3
Shoulder	38	21,5	24	18,0	13,0	15,1
Upper Back	6	3,4	6	4,5	7,0	8,1
Upper Arm	3	1,7	2	1,5	2,0	2,3
Elbow	4	2,3	2	1,5	2,0	2,3
Lower Back	29	16,4	26	19,5	22,0	25,6
Forearm	2	1,1	0	0,0	0,0	0,0
Wrist	6	3,4	1	0,8	0,0	0,0
Hip/Buttock/Groin	18	10,2	20	15,0	8,0	9,3
Thigh	14	7,9	7	5,3	4,0	4,7
Knee	12	6,8	9	6,8	9,0	10,5
Lower leg	19	10,7	15	11,3	4,0	4,7
Foot/Ankle	12	6,8	11	8,3	7,0	8,1
Total	177	100	133	100	86	100

***Period = 12 months**

4.3 Objective two: To determine the demographic, anthropometric, activity participation and environmental risk factors for MSK injury

4.3.1 Socio-demographic characteristics

4.3.1.1 Demographic characteristics

The mean age of the participants was 28.6 years (±SD 14, range 16-73), with the majority of the participants being between 16 to 19 years of age (39%, n=39). There was a male preponderance of 65% (n=65) with the majority of the participants (89%, n=89) being from the White race group. Age, gender and race were not significantly associated with reported MSK injuries, as seen in Table 4.2.

Table 4.2: Demographic characteristics of participants and their relationship to MSK pain as a result of lifesaving participation (n=100)

Characteristic		**Total**		**Experienced MSK pain related to lifesaving**				*p* value
				Yes		**No**		
		n	**%**	**n**	**%**	**n**	**%**	
Sex	**Male**	65	65	46	63.9	19	67.9	0.709
	Female	35	35	26	36.1	9	32.1	
Age	**16-19**	39	39	24	33.3	15	53.6	0.218
	20-24	19	19	14	19.4	5	17.9	
	25-34	15	15	12	16.7	3	10.7	
	35-44	8	8	8	11.1	0	0	
	>45	19	19	14	19.4	5	17.9	
Race	**African**	7	7	7	9.7	0	0	0.335
	Coloured	1	1	1	1.4	0	0	
	Indian	3	2	2	2.8	1	3.6	
	White	89	89	62	86.1	27	96.4	

4.3.1.2 Occupation

Most of the participants were scholars (30%), as seen in Table 4.3.

Table 4.3: Occupation of participants

Occupation	**n**	**%**
Scholar	30	30.0
Student	21	21.0
Self employed	11	11.0
Lifeguard	7	7.0
Trainer	6	6.0
Non manual work	21	21.0
Bio-kineticist	1	1.0
Retired	1	1.0
Unknown	2	2.0
Total	100	100.0

4.3.2 Hand dominance

Table 4.4 shows the hand dominance of the competitors, the majority were right-handed (95%, n=95). There was no significant difference found between left- or right-hand dominance and MSK pain injury.

Table 4.4 Hand dominance of the participants and its relationship to MSK pain as a result of lifesaving participation

Hand Dominance	Total		MSK pain				*p* value
			Yes		No		
	n	%	n	%	n	%	
Right	95	95	69	69	26	26	0.55
Left	5	5	3	3	2	2	

4.3.3 Anthropometric characteristics

The height, weight and BMI of the participants is shown in Table 4.5. The mean BMI was 24.2 (±3.35 SD), indicating that on average the participants were within the normal BMI range. There was no significant relationship found between the participant's anthropometric measures and MSK pain related to lifesaving using students T-tests.

Table 4.5: Anthropometric characteristics of the participants and its relationship to MSK pain

Characteristic	Total			MSK pain				*p* value
				Yes		No		
	n	Mean (SD)	Range	n	Mean (SD)	n	Mean (SD)	
BMI	98	24.20 (3.35)	16.81-34.15	70	24.3 (3.4)	28	24 (3.2)	0.638
Height (cm)	98	1.76 (0.11)	1.45-2.1	70	1.77 (0.11)	28	1.74 (0.10)	0.204
Weight (kg)	100	75.55 (14.73)	46-122	72	76.5 (15.0)	28	73 (13.9)	0.285

4.3.4 Lifestyle and health related factors

The lifestyle and health related factors of the participants are presented in Table 4.6. None of the participants smoked, only 5% (n=5) reported using social drugs and 55% (n=55) indicated using alcohol. On average a mean of 4.53 (± 7.29) alcohol units were reported to be consumed per week (range from 0 to 30). No relationships were found between injury, alcohol consumption, social drug use or smoking.

Table 4.6 : Lifestyle and health factors

Characteristic		Total		MSK pain				*p* value
				Yes		No		
		n	**%**	**n**	**%**	**n**	**%**	
Alcohol	Yes	55	55	42	58.3	13	46.4	0.238
	No	45	45	30	41.7	15	53.6	
Social drugs	Yes	5	5	4	5.6	1	3.6	0.673
	No	94	94	67	94.4	27	96.4	
Smoking	Yes	0	0	0	0	0	0	-
	No	100	100	100	100	100	100	

4.3.5 Systemic diseases

Only 5% (n=5) of the participants reported experiencing a systemic disease these included Marfan's Syndrome, asthma, hypothyroidism and high cholesterol. There was no significant relationship between MSK injuries and systemic disease (*p*=1.000).

4.3.6 Activity participation

4.3.6.1 Lifesaving competition participation in the previous 12 months

The competition participation of the respondents is presented in Table 4.7. The majority (48%) of respondents participated in between one and three competitions per season. The number of competitions within which the participants partook was not related to the prevalence of MSK injuries.

Table 4.7: Number of competitions the competitors competed in, in the previous 12 months

Number of competitions		Total		MSK pain				*p* value
				Yes		No		
		n	%	n	%	n	%	
Between 1 and 3 competitions	Yes	48	48	33	68.8	15	31.3	0.821
	No	51	51	0	0	51	100	
Between 4 and 5 competitions	Yes	13	13	10	76.9	3	23.1	0.821
	No	86	86	0	0	86	100	
More than 5 competitions	Yes	38	38	28	73.7	10	26.3	0.821
	No	61	61	0	0	61	100	

4.3.6.2 Lifesaving events

Table 4.8.1 shows the type of events that the competitors competed in. The board race was most popular (76%). No individual event was associated with an increased risk of injury.

Table 4.8.1: The lifesaving events correlated with MSK pain

Competition event		Total (n=100)		MSK pain*				*p* value
				Yes		No		
		n	%	n	%	n	%	
Beach sprint	Yes	42	42	28	67	14	33	0.370
	No	58	58	44	76	14	24	
Board race	Yes	76	76	56	74	20	26	0.603
	No	24	24	16	67	8	33	
Ironman	Yes	57	57	40	70	17	30	0.661
	No	43	43	32	74	11	26	
Surf ski	Yes	69	69	47	68	22	32	0.235
	No	31	31	25	81	6	19	
Beach flags	Yes	36	36	24	67	12	33	0.487
	No	64	64	48	75	16	25	
Surf Swim	Yes	67	67	48	72	19	28	1.000
	No	33	33	24	73	9	27	

Table 4. 9.1 shows the combined events grouped by specialised areas of lifesaving: Board, ski and ironman events. The craft events 85% (n=85) were most popular, followed by multiple events 79% (n=79) and thirdly the swim events 67% (n=67). None of the combined events were associated with MSK injury.

Table 4.9.1 The combined events grouped by lifesaving speciality

Events		Total (n=100)		MSK pain				*p* value
				Yes		No		
		n	%	n	%	n	%	
Beach: beach flags and sprints	Yes	43	43	28	65.1	15	34.9	0.261
	No	57	57	44	77.2	13	22.9	
Craft: board, ski and ironman	Yes	85	85	62	72.9	23	27.0	0.756
	No	15	15	10	66.7	5	33.3	
Swim Events: swim races	Yes	67	67	48	71.6	19	28.4	1.000
	No	33	33	24	72.7	9	27.3	
Multiple: combination of beach, craft and swim	Yes	79	79	59	74.7	20	25.3	0.279
	No	21	21	13	61.0	8	38.0	

4.3.6.3 Type of training

Figure 4.1 shows the different types of training the respondents did while training for lifesaving events. The most popular training options were functional strength training (46%) road running (51%), ski paddling (40%), board paddling (48%) and pool swim training (53%).

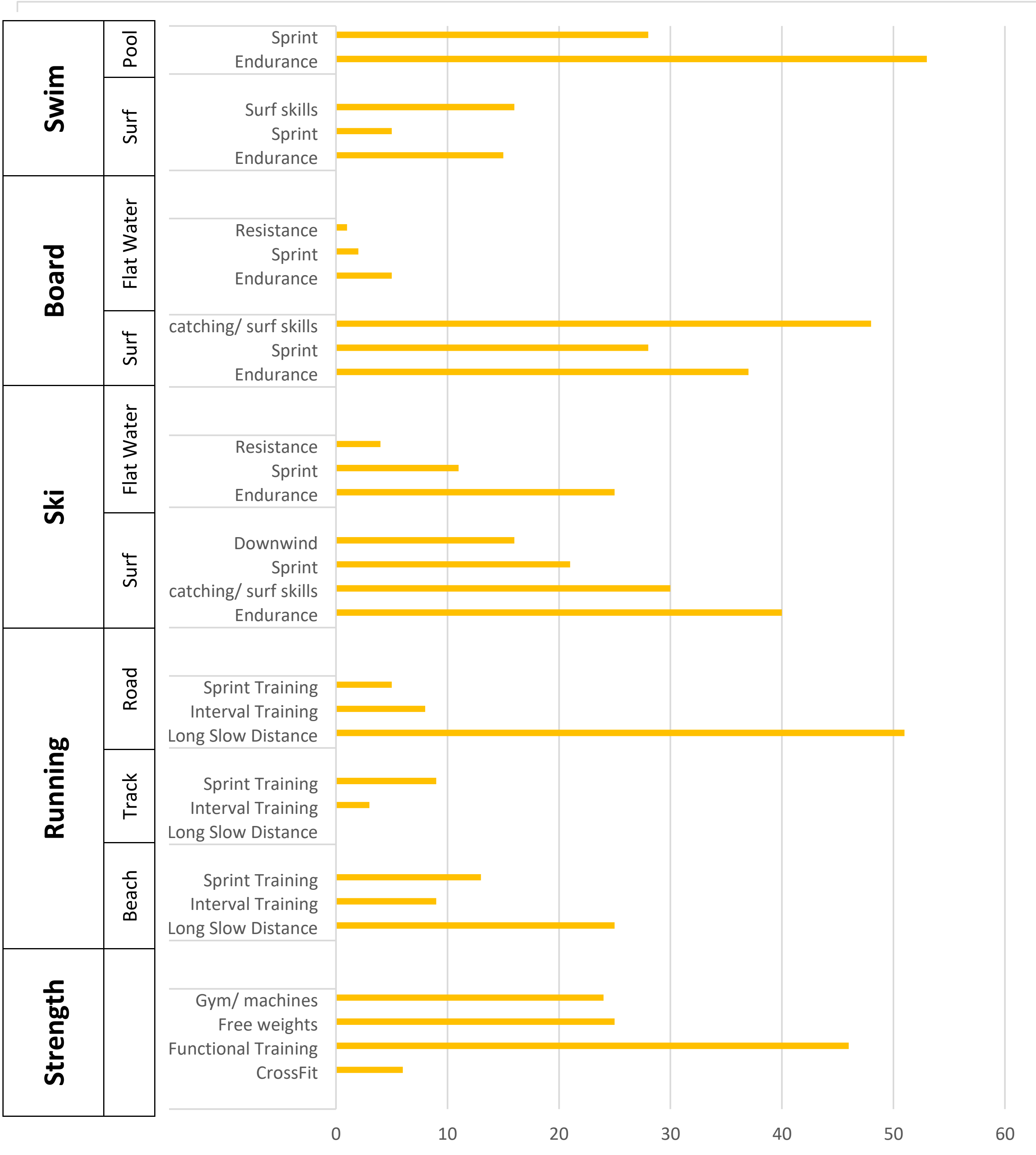

Figure 4.1: Type of training used by the respondents

Table 4.10.1 shows the different types of strength training the respondents used when training for lifesaving events related to injury. The most popular type of strength training was functional training (46%), with an injury rate of 80.4% (n=37). This was followed by free weight training at 25% with an injury rate of 76% (n=19). There were no significant relationships between MSK pain and strength training.

Table 4.10.1 The different types of strength training used by the respondents

Strength		Total (n=100)		MSK pain				*p* value
				Yes		No		
		n	%	n	%	n	%	
None	Yes	24	24	15	62.5	9	37.5	0.298
	No	76	76	57	75.0	19	25.0	
Cross fit	Yes	6	6	5	83.3	1	16.7	1.000
	No	94	94	67	71.3	27	28.7	
Functional training	Yes	46	46	37	80.4	9	19.6	0.118
	No	54	54	35	54.8	19	35.2	
Free weights	Yes	25	25	19	76	6	24.0	0.798
	No	75	75	53	70.7	22	29.3	
Gym/ machines	Yes	24	24	17	70.8	7	29.2	1.000
	No	76	76	55	72.4	21	27.6	

Table 4.11.1 shows the different types of training the respondents used when training for running events. The most popular beach running training was long slow distance training (25%) (n=25), with an injury rate of 84% (n=21). The most popular track training was sprint training (9%) (n=9) with an injury rate of 88.9% (n=8). Long slow distance in the road running category was the most popular at 51% (n=51) with an injury rate of 72.5% (n=37). There were no significant relationships between MSK pain and running training.

Table 4.11.1: The different types of running training used by the respondents

Running			Total		MSK pain*				*p* value
					Yes		No		
			n	%	n	%	n	%	
Beach (n=99)	None	Yes	57	57	36	63.2	21	36.8	0.041
		No	42	42	35	83.3	7	16.7	
	Long slow distance	Yes	25	25	21	84.0	4	16.0	0.132
		No	75	75	50	67.6	24	32.4	
	Interval training	Yes	9	9	8	88.9	1	11.1	0.285
		No	91	91	63	70.0	27	30.0	
	Sprint training	Yes	13	13	11	84.6	2	15.4	0.340
		No	86	86	60	69.8	26	30.2	
Track (n=98)	None	Yes	84	84	58	69.0	26	31.0	0.539
		No	12	12	10	83.3	2	16.7	
	Long slow distance	Yes	0	0	0	0	0	0	-
		No	98	98	98	98.0	98	98.0	
	Interval training	Yes	3	3	2	66.7	1	33.3	1.000
		No	95	95	68	71.6	27	28.4	
	Sprint training	Yes	9	9	8	88.9	1	11.1	0.282
		No	89	89	62	69.7	27	30.3	
Road (n=100)	None	Yes	36	36	28	77.8	8	22.2	0.365
		No	64	64	44	68.8	20	31.3	
	Long slow distance	Yes	51	51	37	72.5	14	27.5	1.000
		No	49	49	35	71.4	14	28.6	
	Interval training	Yes	8	8	6	75.0	2	25.0	1.000
		No	92	92	66	71.7	26	28.3	
	Sprint training	Yes	5	5	3	60.0	2	40.0	0.617
		No	95	95	69	72.6	26	27.4	

Table 4.12.1 shows that the most popular surf ski paddling training was endurance training (40%) (n=40), with an injury rate of 77.5% (n=31). The most flat-water ski paddling training was endurance (25%) (n=25) with an injury rate of 64% (n=16). No significant relationships were found between MSK pain and ski paddling training.

Table 4.12.1: The different types of ski paddling training used by the respondents

Ski Paddling			Total (n=100)		MSK pain				*p* value
					Yes		No		
			n	%	n	%	n	%	
Surf (n=100)	None	Yes	41	41	33	80.5	8	19.5	0.174
		No	59	59	39	66.1	20	33.9	
	Endurance	Yes	40	40	31	77.5	9	22.5	0.369
		No	60	60	41	68.3	19	31.7	
	Wave catching/ surf skills	Yes	30	30	20	66.7	10	33.3	0.472
		No	70	70	52	74.3	18	25.7	
	Sprint training	Yes	21	21	14	66.7	7	33.3	0.589
		No	79	79	58	73.4	21	26.6	
	Downwind	Yes	16	16	12	75.0	4	25.0	1.000
		No	84	84	60	71.4	24	28.6	
Flat water (n=98)	None	Yes	69	69	50	74.6	17	25.4	0.341
		No	31	31	20	64.5	11	35.5	
	Endurance	Yes	25	25	16	64.0	9	36.0	0.442
		No	73	73	54	74.0	19	26.0	
	Sprint training	Yes	11	11	8	72.7	3	27.3	1.000
		No	87	87	62	71.3	25	28.7	
	Resistance	Yes	4	4	2	50.0	2	50.0	0.322
		No	96	96	68	72.3	26	27.7	

Table 4.13.1 shows the different types of training the respondents used when training for board paddling events. The most popular board paddling training in the surf was wave catching/ surf skills training (48%) (n=48), with an injury rate of 70.8% (n=34). The most flat-water board paddling training was endurance training (5%) (n=5) with an injury rate of 100%, (n=5). No significant relationships were found between MSK pain and board paddling training.

Table 4.13.1: The different types of board paddling training used by the respondents

Board paddling			Total		MSK pain				*p* value
					Yes		No		
			n	%	n	%	n	%	
Surf (n=99)	None	Yes	37	37	26	70.3	11	29.7	0.821
		No	62	62	45	72.6	17	27.4	
	Endurance	Yes	37	37	27	73.0	10	27.0	1.000
		No	62	62	44	71.0	18	29.0	
	Sprint training	Yes	28	28	19	67.9	9	32.1	0.625
		No	72	72	52	73.2	19	26.8	
	Wave catching/ surf skills	Yes	48	48	34	70.8	14	29.2	1.000
		No	51	51	37	72.5	14	27.5	
Flat water (n=98)	None	Yes	92	92	64	69.6	28	30.4	0.178
		No	6	6	6	100	0	0	
	Endurance	Yes	5	5	5	100	0	0	0.317
		No	93	93	65	69.9	28	30.1	
	Sprint training	Yes	2	2	2	100	0	0	1.000
		No	96	96	68	70.8	28	29.2	
	Resistance	Yes	1	1	1	100	0	0	1.000
		No	99	99	69	71.1	28	28.9	

Table 4.14.1 shows the different types of swimming training used by the respondents. The most popular surf swimming training was endurance training (15%) (n=15), with an injury rate of 73.3% (n=11). The most popular pool swimming was endurance training (53%) (n=53) with an injury rate of 73.6% (n=39). No significant relationships were found between MSK pain and swimming training.

Table 4.14.1: The different types of swim training used by the respondents

Swim training			Total		MSK pain				*p* value
					Yes		No		
			n	%	n	%	n	%	
Surf (n=96)	None	Yes	67	67	49	73.1	18	26.9	0.805
		No	29	29	20	69.0	9	31.0	
	Endurance	Yes	15	15	11	73.3	4	26.7	1.000
		No	81	81	58	71.6	23	28.4	
	Sprint training	Yes	5	5	5	100	0	0	0.317
		No	91	91	64	70.3	27	29.7	
	Surf skills	Yes	16	16	11	68.8	5	31.3	0.766
		No	80	80	58	72.5	22	27.5	
Pool (n=97)	None	Yes	37	37	27	73.0	10	27.0	1.000
		No	60	60	43	71.7	17	28.3	
	Endurance	Yes	53	53	39	73.6	14	26.4	0.821
		No	44	44	31	70.5	13	29.5	
	Sprint training	Yes	28	28	21	75	7	25.0	0.805
		No	69	69	49	71	20	29.0	

Figure 4.2 shows the average duration of training per week per activity. Most of the respondents partook in pool swimming training, with an average of 340.5 minutes per week compared to only 64 minutes of surf swimming per week.

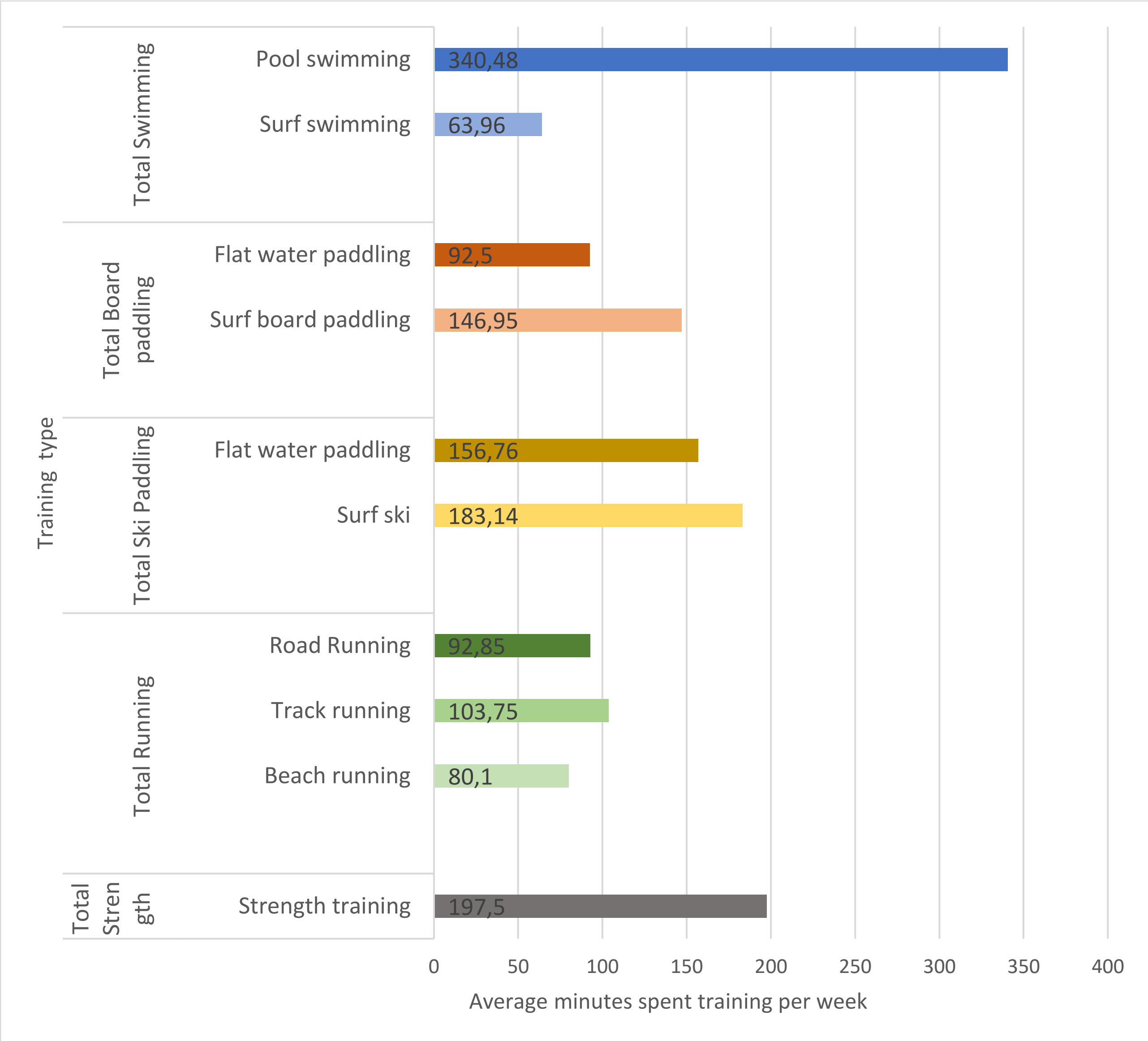

Figure 4.2: Average duration of training per week per activity

4.3.6.4 Number of rest days

There was a significantly higher number of rest days in those who had no MSK pain versus those who did have MSK pain. Those with no MSK pain had double the rest days of those who suffered MSK pain; two to one day (*p*= 0.004).

Table 4.15: Shows the number of rest days and MSK pain related to lifesaving

	MSK pain related to lifesaving					
	Total		Yes		No	
Rest days	n	%	n	%	n	%
0	8	8.1	7	9.7	1	3.7
1	57	56.6	45	63	11	40.7
1.5	1	1	1	1	0	0
2	23	23.2	15	20.8	8	29.6
3	10	10.1	3	4.1	7	26
5	1	1	1	1.4	0	0
Total	100	100	72	100	27	100

4.3.6.5 MSK pain in last 12 months un-related to lifesaving

Sixty-four (64%) of the competitors (n=64) reported that they had experienced MSK pain in last 12 months that was un-related to lifesaving.

4.4 Objective three: To determine the impact of MSK injuries in competitive lifesavers in KwaZulu-Natal.

4.4.1 Psychological impact

Of the 72 competitors that experienced lifesaving MSK injuries more than half reported that it negatively affected them either in training, competition or overall, as seen in Table 4.16.

Table 4.16: Negative psychological impact of MSK injuries on the participants

Have you been negatively affected psychologically by your injury:	Total		Yes		No		Unsure	
	n	%	n	%	n	%	n	%
During Training	72	100	46	63.9	25	34.7	1	1.4
During competition	72	100	45	62.5	26	36.1	1	1.4
Overall confidence	72	100	38	52.8	29	40.3	5	6.9

4.4.2 Location, duration and severity of lifesaving MSK injuries

Table 4.17 details the location and severity of the sustained lifesaving MSK injuries. For lifetime knee pain (n=12,) 83.33%, (n=10) respondents indicated that their pain was severe. For lifetime thigh pain (n=14), 78.57% (n=11) indicated that the pain was severe and for lifetime foot/-ankle pain (n=12), 58.33% (n=7) indicated that the pain was severe.

Table 4.17: Pain location and severity

	Mild		Moderate		Severe	
	n	%	n	%	n	%
Neck pain						
Current pain (n=8)	2	25	5	62.5	1	12.5
12 months pain (n=10)	2	20	7	70	1	10
Lifetime pain (n=14)	4	28.6	6	42.9	4	28.5
Shoulder pain						
Current pain (n=13)	3	23.1	7	53.8	3	23.1
12 months pain (n=24)	4	16.7	14	58.3	6	25
Lifetime pain (n=38)	7	18.4	9	23.7	22	57.9
Upper Back pain						
Current pain (n=7)	3	42.9	4	57.1	0	0
12 months pain (n=6)	3	50	3	50	0	0
Lifetime pain (n=6)	4	66.7	2	33.3	0	0
Upper arm						
Current pain (n=2)	1	50	1	50	0	0
12 months pain (n=2)	2	100	0	0	0	0
Lifetime pain (n=3)	2	66.7	0	0	1	33.3
Elbow						
Current pain (n= 2)	0	0	1	50	1	50
12 months pain (n=2)	0	0	2	100	0	0
Lifetime pain (n=4)	0	0	1	25	3	75
Lower back						
Current pain (n= 22)	9	40.9	8	36.4	5	22.7
12 months pain (n=26)	8	30.8	12	46.2	6	23
Lifetime pain (n=29)	6	20.7	13	44.8	10	34.5
Forearm						
Current pain (n=0)	0	0	0	0	0	0
12 months pain (n=0)	0	0	0	0	0	0
Lifetime pain (n=2)	0	0	0	0	2	100
Wrist						
Current pain (n=0)	0	0	0	0	0	0
12 months pain (n=1)	0	0	0	0	1	100
Lifetime pain (n=6)	1	16.6	4	66.7	1	16.7
Hip/Buttock/Groin						
Current pain (n=8)	4	50	0	0	4	50
12 months pain (n=20)	5	25	8	40	7	35
Lifetime pain (n=18)	1	5.6	11	61.1	6	33.3
Thigh						
Current pain (n=4)	1	25	2	50	1	25
12 months pain (n=7)	0	0	1	14.3	6	85.7
Lifetime pain (n=14)	0	0	3	21.4	11	78.6
Knee						
Current pain (n=9)	5	55.6	3	33.3	1	11.1
12 months pain (n=9)	1	11.1	4	44.4	4	44.4
Lifetime pain (n=12)	1	8.3	1	8.3	10	83.3
Lower leg						
Current pain (n=4)	0	0	3	75	1	25
12 months pain (n=15)	3	20	7	46.7	5	33.3
Lifetime pain (n=19)	2	10.5	6	31.6	11	57.9
Foot/Ankle						
Current pain (n=7)	2	28.6	4	57.1	1	14.3
12 months pain (n=12)	1	8.3	5	41.7	6	50
Lifetime pain (n=12)	4	33.3	1	8.3	7	58.4

4.4.3 Impact of the worst MSK injury reported by the respondents

The following questions were completed by the respondents related to the worst lifesaving MSK injury they had sustained.

4.4.3.1 Diagnosis of the competitor's worst injury

Table 4.18 shows that the diagnosis of the worst lifesaving MSK injury experienced by the respondents.

Table 4.18: Diagnosis of Worst Lifesaving injury

Diagnosis	n	%
Fracture	3	4.2
Sprain	3	4.2
Strain	6	8.3
Tendonopathy	6	8.3
Muscle tears	18	25.0
Dislocations	8	11.1
Disc herniations	5	6.9
Plantar Fasciitis	4	5.5
Other	19	26.3
Total	72	100.0

4.4.3.2 Activity precipitating the onset of pain, mechanism of injury and season of onset

The majority of the injuries were caused due to running 44% (n=32) followed by swimming 33% (n=24) then board paddling 32% (n=23), as seen in Table 4.19.

Table 4.19: Activities that precipitated the onset of pain

Activity	Total		Yes		No	
	n	%	n	%	n	%
Running	72	72	32	45.1	39	54.9
Swimming	72	72	24	33.8	47	66.2
Board paddling	72	72	23	32.4	48	67.6
Ski paddling	72	72	15	21.1	56	78.9

The mechanism most often involved was overuse (43%), followed by trauma during either lifesaving racing or training, as seen in Table 4.20.

Table 4: 20: Mechanism of injury resulting in worst MSK pain

Mechanism of injury	n	%
Traumatic incident during:		
- racing	16	22.2
- training	15	20.8
Overuse	31	43.1
Cross training	8	11.1
Other	1	1.4
Unknown	1	1.4

Most of the injuries occurred during the lifesaving season (70%), as seen in Table 4.21.

Table 4.21: What period the injury was sustained

Period	Total		Yes		No	
	n	%	n	%	n	%
Pre-Season	72	100	16	22	56	78
In-Season	72	100	50	70	22	30
Off-Season	72	100	6	4.3	66	91.7

4.4.3.3 Pain character, duration and rating

Figure 4.3 shows that 71% (n=51) of the participants described the pain as sharp shooting, compared to only 36% (n=26) who described it as aching or dull (15%; n=11).

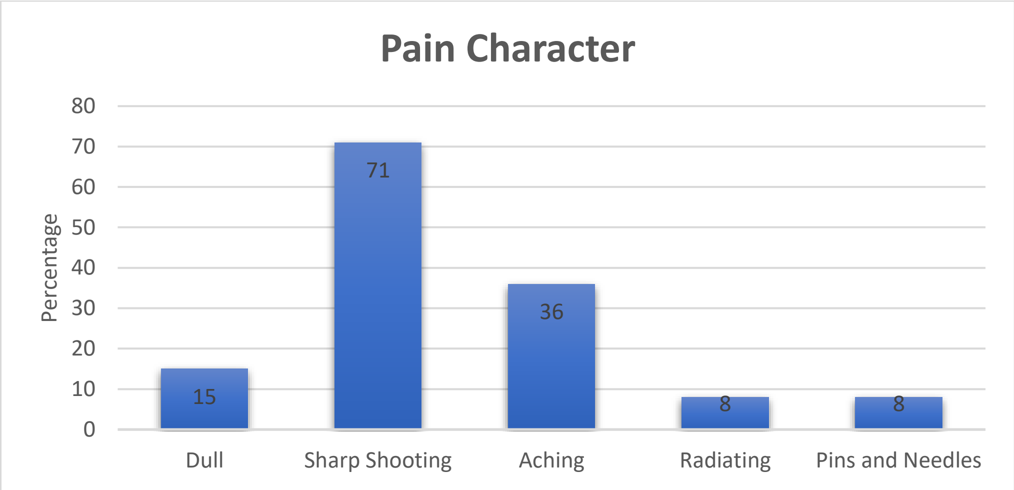

Figure 4.3: Character of pain experienced

Table 4.22 shows the majority of the respondents reported that the pain lasted longer than a few weeks (n=59; 82%) with a mean pain rating of 7 (±1.79), ranging from 2 to 10. Twenty-five percent (n=18) indicated that the pain was constant with 75% (n=54) saying it was recurrent in nature.

Table 4.22: The duration which the pain lasted

	n	%
Years	11	15.3
Months	25	34.7
Weeks	23	31.9
Days	7	9.7
Hours	5	6.9
Minutes	1	1.4
Total	72	100.0

4.5 Impact of MSK injury on training and competition

Two thirds (75%; n=54) of the respondents had to stop training/competing as a result of their injury, with more than half (56%) having to adapt their training to compensate for their injury, as seen in Table 4.23.

Table 4.23: The impact of the MSK pain on the training and competing of respondents

Impact		n	%
Did the MSK pain prevent participation in competition/ training?	Yes	54	75.0
	No	18	25.0
How long did it prevent training?	No loss	13	18.1
	1 day	0	0.0
	> 1 day	1	1.4
	> 7 days	17	23.6
	> 1 month	17	23.6
	>6 months	17	23.6
	>12 months	7	9.7
How long did it prevent you from participating in competition?	no loss	41	56.9
	1 day	2	2.8
	> 1 day	0	0.0
	> 7 days	3	4.2
	> 1 month	6	8.3
	>6 months	13	18.1
	>12 months	7	9.7
Did you adapt your training or did you stop training because of injury?	Adapt	40	55.6
	Stop	27	37.5
	other	5	6.9

4.5.1 Treatment of worst MSK injury

Out of the 72 competitors, 89% sought medical treatment, with the majority consulting physiotherapists (58%), as seen in Table 4.24. Some respondents sought treatment from more than one medical practitioner thus the total exceeds 100. The table also shows how many sessions the competitors attended with each practitioner, the competitors mainly attended Physiotherapy (n=37) other practitioners included general surgeons and acupuncturists.

Table 4.24: Practitioners who treated the respondents and the number of sessions with each practitioner

	Total		Yes		No		Mean number of visits	Range
	n	%	n	%	n	%	n (SD)	Min-max
Bio-kineticist	64	100	17	26.6	47	73.4	10.53 (10.32)	2-35
Chiropractor	64	100	20	31.3	44	68.8	5.68 (3.71)	1-12
General Practitioner	64	100	7	10.9	57	89.1	3.50 (4.31)	1-12
Orthopaedic surgeon	64	100	12	18.8	52	81.3	9.09 (21.10)	1-72
Physiotherapist	64	100	37	57.8	27	42.2	12.16 (20.66)	1-84
Massage Therapist	64	100	5	7.8	59	92.2	35.40 (40.56)	2-84
Other	64	100	3	4.7	61	95.3	3.00 (1.73)	2-5

4.6 Conclusion

The majority respondents were white males under the age of 25 and partook in all lifesaving disciplines. The vast majority of the respondents were right-handed and of normal BMI. The results of this study showed that there was a high lifetime, period and point prevalence of MSK pain in lifesavers in Kwa-Zulu Natal. The body regions most commonly affected were the low back, shoulder, lower leg and hip/buttock/groin. These regions were rated as severe in the pain rating scale. The Healthcare providers most commonly visited were predominantly physiotherapists, followed by chiropractors, bio-kineticists and orthopaedic surgeons. There was a significantly higher number of rest days in those who had no MSK pain versus those who had. Otherwise, none of the training or sport variables were significantly different between those with and without MSK pain. The mechanism of injury was sustained due to overuse, traumatic incident during training or traumatic incident during a race. The competitors were negatively affected by injuries sustained during training, during competition and their overall confidence was also affected.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter will discuss the response rate and the findings of the study, relative to the available literature.

5.2 Response rate

The goal of most epidemiological research is to acquire approximations that can be generalised to the target population (Mealing *et al.* 2010). Low response rates indicate a potential for the study to introduce bias to the study's findings and therefore limit the validity of the results (Mouton 2002). In order to obtain a reasonable response rate, comprehensive data collection methods must be used (Russel *et al.* 2004). These include, but are not limited to, factors such as direct contact when delivering questionnaires (Szolnoki and Hoffman 2012) and the length of the questionnaire (Sahlqvist *et al.* 2011).

In this study, a response rate of 77% (n=100) was obtained. The population being investigated was small in size, and through the assistance of Lifesaving KZN, 100 potential respondents were willing to participate. The lifesaving club managers and coaches were considerate and accommodating and this played a role in attaining the achieved response rate. In addition, the researcher was present when the questionnaires were distributed and assisted the participants if they had any queries or questions about the questionnaire.

Favourable response rates occur when they approximate or exceed 60% (Draugalis *et al*. 2008) this allows for generalisability of the population being studied (Copp *et al.* 2007). Therefore, with a 100% response, the findings of this study could be generalisable to the total population, from which the sample was drawn.

5.3 Discussion of the results

MSK injuries are common in sports (Bahr and Krosshaug 2005). A sport such as lifesaving, exposes the participant to conditions which are unpredictable (Erby, Heard and O'Loughlin 2010) and thus a different profile of injuries may occur, when compared to sports like pool swimming. This study found a high prevalence of MSK injury whereby 72% of the participants reported sustaining an injury in their lifetime as a result of lifesaving. There was a total of 177 MSK injuries reported over the participants' lifetime, 133 for the preceding twelve-month period and, at the time of completing the questionnaire, 86 injuries were reported% currently. Irrespective of when the injury was sustained, the shoulder (21%) and lower back (26%) were most commonly affected. Similar results were found in Australian lifesavers (n= 354) where descriptive and injury incident data were obtained reporting the following injuries: shoulder injury 32%, the lower back 28% and the foot/toes 42% (Erby *et al.* 2009).

When assessing demographic factors in the current study, there were no statistically significant relationships between MSK injury, age, gender and/or race. There was however a trend which is affected by age, and can be seen in participants younger than 19, who had a high injury prevalence (33.3%). In a study spanning eight years, Mitchell *et al.* (2013) found that those aged between 15 and 19 years suffered 23.3% of the injuries, second only to those under 15 years of age (25.3%) for injuries reported during competition (n=1448). These results highlight the importance of young athletes receiving proper medical treatment to prevent long term issues and premature retirement from sport in general (Launey 2015; Maffulli *et al* 2010).

Very few studies report a race profile, which could possibly be due to the fact that these studies have been done in counties where the majority of the citizens are from one race group (Carter, Marshall and Abbott 2015; Mitchell 2012; Pen *et al.* 1996; Jackson 2017; Fletemeyer 1989 and Erby *et al*. 2010). It is important to see, in a multi-cultural country like South Africa, if race is a risk factor. Although there was no significant correlation, this may not in fact be indicative of the risk factor, but perhaps because the country is in the process of transformation. The racial demographic across participants showed 89% to be white. Thus, it cannot decisively attribute the non-significance of the result to race not being a risk factor, but rather a symptom of the sport's demographic and perhaps this needs to be investigated further. However, this study found that it was not significant.

With regard to limb dominance, no significant association was found between limb dominance and MSK injury, similar results were found in a study on runners (Brown *et al*. 2014), college athletes and Australian football respectively (Beynnon *et al.* 2001; Orchard 2001). While several studies have reported that limb dominance has an effect on injury (Baumhauer *et al.* 1995; Chomiak *et al.* 2000).

That the majority of the population portray a dominate side is considered normal. Asymmetry and dominance could affect continuous and cyclic sports more than unilateral sports (Morouço *et al.* 2015; Saccol et al., 2010 and Sanders et al., 2012). It was, however, demonstrated that 60% (n=3) of the left-handed participants also reported MSK injuries. Although this is a low number, it is worth mentioning because it could be attributed to the craft disciplines and equipment being designed for primarily right dominant athletes. For example, in events such as the board race, the board is picked up and carried over the finish line with the handle being on the left-hand side of the craft in order to be picked up by the right arm. Thus, left-handed athletes, may be obligated to use their weaker limb in such cases, which could result in an MSK injury. Since a small percentage of left-handed lifesavers were part of this study, further investigation into this factor will need to be established to find comparable results.

The lifesavers who participated in this study were generally healthy, had a normal BMI and were non-smokers, with only 5% of the participants having a systemic disease. The nature of sport requires active participation and healthy living (González-Gross *et al.* 2013). There was however a considerable amount of alcohol consumed by the lifesavers which could indicate the social aspect of the sport. There was no relationship with alcohol consumption and MSK pain, despite other studies reporting that alcohol use was a risk factor (Leichliter *et al.* 1998; O'Brien *et al.* 2000; Nelson & Wechsler, 2001; Wechsler *et al.* 2002 and Etzel, 2006).

When looking at activity participation, it was found that the board race was the most popular event (76%), with a high MSK injury rate (56%). This was also found in the study done by Carter et al. (2015) that the surf lifesaving activity most effected was board paddling at 56.5% for females and 29% for males. Furthermore 34.8% of females and 22.6% of males missed or adapted their swimming training sessions due to shoulder pain and dysfunction (Carter, Marshall and Abbott 2015).

In the current study, when looking at the combined events, 43% of the participants competed in beach flags and sprints and reported an MSK pain rate of 28%. The craft (board and ski) specialist athletes (85%) reported an MSK pain rate of 62%. The swim event specialists (67%) reported an MSK pain rate of 48%. The multi-discipline participants (79%) reported an MSK pain rate of 59%. Despite these differences there was not one combined event that was more prone to respondents reporting an MSK injury. The multi-discipline and craft specialists are more prone to MSK injury. This is feasible due to the intensity of the training required to compete in multiple disciplines, as well as the increased environmental (and which other risks) of craft disciplines. They deal with unpredictable conditions; craft etc. and thus are more at risk of injury. Pen *et al.* (1996) grouped the disciplines into Aquatic components (swim, board and ski) and the running component. He reported that the Aquatic component produced upper limb injuries and the running component produced lower extremity injuries. The difference between running on hard sand verses soft sand is the contact time with the sand. With hard sand there is a shorter contact time, the angle of entry and foot planting will be slightly different on soft sand. On hard sand, there will be a track style of running, using predominantly the quadriceps and calf muscles. On hard sand, the effort is more isometric, this is possibly due to the resistance of the surface. On soft sand, the hamstrings and hip flexor muscles are utilised more than the quadriceps and calves, because the contact time is longer. Therefore, the end of each stride is an eccentric motion. Future research should be conducted using the recommendations as outlined below. In the present study there was no statistical significance regarding the disciplines and MSK pain.

When asked about their worst lifesaving injury, the respondents reported that running produced the most pain (44%; n=32) followed by swimming (35%; n=25) and then ski paddling (21%; n=15). Similarly, Pen *et al.* (1996) found that running was reported to be the race component most associated with occurrence of injury (49%; n=33) and accounted for the greatest number of medical treatments (n=33; 49% of all injuries). Most injuries were associated with overuse (n=34; 51%); and 51% of the injuries were bilateral. Injury did not tend to prevent participation in training but did reduce training in specific race components (Pen *et al.* 1996).

In the study done by Pen *et al.* (1996), of the injuries reported, they did not result in withdrawing from competition. If training was interrupted due to injury, it resulted in cessation of training for the component of the race that was associated with the injury while maintaining or increasing training in other race components. In the present study, 75% of participants were unable to compete in competitions or training as a result of their injury. Fifty-six (56%) of competitors adapted their training to compensate for their injury and 36% of competitors had to stop training completely. Thus, these athletes train and compete with injury which could lead to the athlete sustaining more injuries (Gabbett, 2016).

The nature of injuries has been reported to be tendinitis, overuse injuries, sore knees caused by overuse/overtraining, soft sand running, lack of warm up. Tendinitis (n=6; 24%) was perceived to be the main type of injury and overtraining (n=14; 56%) the major cause (Pen *et al.* 1996). Previous literature has suggested that excessive running on sand could lead to a variety of leg and foot injuries including Achilles tendinitis, Achilles rupture, plantar fasciitis and foot pronation syndromes such as shin splints and ankle sprains. However, few studies have associated knee injuries with sand running (Pen *et al*. 1996). From a total of 35 injuries reported in the running component in the study by Pen *et al.* (1996), there were only three reports (9%) of shin splints/stress fractures, no reports of Achilles tendinitis/rupture and plantar fasciitis, whereas knee injuries (n=18) accounted for 51% of all injuries in the running component. Most data collected on running injuries to date, have concentrated on the track and/or road running and have shown that running appears to affect the knee more than the ankle (Pen *et al*. 1996).

In the present study, most of the lifesaving injuries reported occurred in-season (70%) compared to the pre-season period (22%) and the off-season (6%). Fifty four percent of the lifesavers reported that they had to stop training or competing due to their injury. Sixty-five (65%) of lifesavers had pain unrelated to lifesaving. This could be considered as a risk factor that would predispose the lifesaver to injury (Carter, Marshall and Abbott 2015).

The results of this study demonstrated that the training load and number of rest days was of significance (p=0.004) in the development of MSK injuries. There was a significantly higher number of rest days in those who had no MSK pain versus those who had (p= 0.004). It is well accepted, based on both human and animal models, that overtraining is primarily linked to the failure of effective recovery periods, which may be related to a persistent inflammatory response and linked to brief recovery periods between periods of stress (Foster *et al.* 2001). This is important with regard to the development of training programs, as well as the scheduling during and between competitions (Sargent *et al*. 2014). Otherwise, none of the training or sport variables were significantly different between those with and without MSK pain.

Tendinopathy and overuse were responsible for the majority of the reported injuries in this study. The injuries reported in Australian lifesavers were considered, by the participants, to be overuse in nature and mostly involved the knee and shoulder (51%) (Pen *et al.* 1996). The findings from this study by Pen *et al.* (1996) showed overuse to be the majority of respondents worst MSK injury mechanism (43%), followed by trauma during either lifesaving racing or training, which could include colliding with another competitors craft or their own craft, being hit by a wave or running into a hole in the sand. Twenty percent (20%) of competitors sustained their injuries as a result of a traumatic incident during training.

The self-esteem, both total and physical, of an athlete can be affected due to injury (Green and Weinberg 2001). This can lead to athletes not returning to sport after recovery. Psychological impact to MSK injury, in this study, was reported by more than half the participants that reported MSK injuries. This has significance for the coaches and development of the sport in general. Sports psychologists should be on hand for the provincial and national teams to prevent and address the psychological impact of injuries in South African lifesaving. This has been identified as the least important factor in coaching methods, and this will need to be addressed going forward (Morris-Eyton and Coopoo 2014). In this study more than half of the respondents who were suffering an injury felt that they were negatively affected by their injury during training (64%), or competition (63%) and therefore had negatively affected their overall confidence (53%). A loss of confidence can negatively impact the athletes mindset and ability to perform at their full potential (Forsdyke *et al.* 2016).

In a study by Erby *et al.* (2010), 28% of injured competitors were referred to a physiotherapist, and 11.9% were referred to a medical practitioner (Erby *et al.* 2010). This was the same for young lifesavers in the study done by Carter *et al.* (2015), the most common medical practitioner consulted for treatment was also a physiotherapist (Carter, Marshall and Abbott 2015). In the present study 10.9% of the competitors saw a medical practitioner, while 57.8% of competitors saw a physiotherapist. This could be due to lack of knowledge of the chiropractic profession, personal preference or South African culture and access to practitioners (Keyter 2010). Some athletes attended up to 84 sessions with a medical practitioner. Future research needs to be conducted to determine the cost that these competitors encounter as a result of these injuries.

All of the accumulated information regarding MSK injuries in KwaZulu-Natal lifesavers can be used to develop holistic training regimes to prevent injury and promote MSK health. Furthermore, not enough attention is given to the psychological aspects of MSK injuries and rest, i.e. the average KwaZulu-Natal lifesaver in this sample swam 340 minutes, ran 104 minutes, cross trained 198 minutes and paddled 330 minutes per week. Therefore, reducing the opportunity for rest and hence the increase in risk of an MSK injury. As well as the psychological damage and the costs incurred with seeking professional medical help.

CHAPTER SIX

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

6.1 Conclusion

This study aimed to determine the prevalence of and impact of MSK injury and its relationship with demographic, anthropometric, activity participation and environmental risk factors for MSK injury in competitive lifesavers in KwaZulu-Natal. The results showed that there was a high lifetime, period and point prevalence of MSK pain in the respondents. The body regions most commonly affected were the low back, shoulder, lower leg and hip/buttock/groin. The athletes partook in a range of lifesaving events with board racing being the most popular, followed by surf ski and then the surf swim event. Irrespective of the event there was a high report of MSK pain. The only factor found to be related to MSK injuries was the number of rest days, which was significantly lower in those who suffered injuries (p=0.04). All other demographic, health, lifestyle and lifesaving activity participation factors were not associated with MSK lifesaving injuries ($p < 0.05$).

When assessing the impact of the MSK injuries the majority of respondents reported that that it occurred due to running, was overuse related, occurring in season and described as a sharp, shooting severe pain with a constant and recurrent nature. It affected the athlete's participation in the sport and required them to seek medical attention. A high number of respondents indicated that the injury not only affected them physically but also mentally.

This study highlights that athletes competing in lifesaving are not exempt from MSK injury and that these injuries have a negative impact on the ability to perform and compete competitively.

This study elucidated that rest days, overuse injuries and psychological factors had implications on MSK injuries. Although external risk factors such as environment play a role in these injuries, training and coaching can play a large role in prevention of these injuries with well-managed rest and mileage.

6.2 Limitations

When carrying out survey-based research, the researcher relies on self-reported data from a sample of participants, which are then used to make inferences about the greater population (Kelley *et al.* 2003). Therefore, the integrity of the study depends on respondents being open and honest when completing the questionnaire, with their responses being thoughtful and reflecting authenticity at the time of questionnaire completion.

The sample in this study was drawn from the members of the LKZN. Although there was a good response rate, provisional differences may be observed due to different climates and sea conditions, thus limiting the ability of the findings to a subset of lifesaving athletes, rather than to all competitive lifesavers in South Africa. Similarly, this study excluded participation of minors under the age of 16 and as such the results cannot be extrapolated to younger populations.

The nature of the questionnaire relied on self-reporting of the injuries experienced. This method may lead to recall bias and an inaccurate description of the injury experienced. The questionnaire gave an overall picture of the lifesaver's personal training and injury statistics; however, it remains a research tool that allows for associations to be determined but cannot be used to infer causality. The type of data obtained is widespread but should help to direct further research in this area. Therefore, longitudinal studies are recommended.

The definition of injury as it pertained to this study, was included in the questionnaire in order for participants to consider their injury relevant to this definition. This can lead to bias and may have affected the manner in which injuries were reported. A global definition of injury has not been standardised in sport literature to date (Coetzee 2014).

6.3 Recommendations

6.3.1 Recommendations to Lifesaving SA

- Education should be provided to the competitive lifesavers on the value of having an appropriate strength and conditioning programme, which includes rest days, with the goal to prevent injuries in this population.
- Further studies are required in other regions for South Africa to determine if similar results are obtained.

6.3.2 Recommendations for future research

- This study was designed as a cross-sectional epidemiological study; future studies should use a longitudinal cohort design to further establish risk factors.
- A study using a larger sample size will increase the power of the study.
- A broader age range should be used in future studies.
- This study evaluated all regions of the MSK system, however future studies should focus further investigation on the most commonly affected regions in order to develop training strategies and safe training environments to reduce the impact of MSK pain.
- In this study, more females reported injury than males, suggesting a potential correlation between female participation and injury which should be investigated as a future study.
- A future study could include an objective to determine the cost of injury.
- A future study could include running position during beach events.

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Appendices

Appendix A: Letter of Information

LETTER OF INFORMATION

Dear Lifesaver
Thank you for taking the time to participate in the research.
Title of the Research Study: The epidemiology of musculoskeletal injuries in competitive lifesavers in KwaZulu-Natal

Researcher: Carmel Billson (0827816804)

Supervisor/s: Dr Laura O'Connor, MTech Chiropractic, Dr Stuart Clifton, MTech Chiropractic

Brief Introduction and Purpose of the Study:
Lifesavers as athletes are exposed to unpredictable factors, extrinsic and intrinsic factors with limited studies documenting this. This study aims to increase the literature regarding the sport and inform practitioners of possible musculoskeletal injuries in the athletes. Thus this study aims to contribute to the injury identification process, which could lead to improved injury prevention methods by the chiropractic and other health care professions.

Outline of the Procedures:
Participation in this study is voluntary. If you are interested in participating in the study then you will be asked to read this Letter of Information and a Consent form. Once you have read and understood the nature of the study and have signed the Consent form, you will be handed the questionnaire. The average amount of time required to complete the questionnaire will be no more than fifteen minutes. All questionnaires will be strictly confidential and anonymous.
Risks or Discomforts to the Participant: There are no risks to by being involved in this study.

Benefits: By partaking in this research project, information regarding musculoskeletal injuries will be generated. This information can then be used by health professionals or be presented to lifesaving South Africa in order to put injury preventative measures in place.

Reason/s why the Participant May Be Withdrawn from the Study: There will be no adverse consequences for you. If you wish to withdraw from the study at any time, you are free to do so without adverse effects.

Remuneration: There will be no remuneration for partaking in the study.

Costs of the Study: There will be no costs to participate in this study.
Confidentiality: Your identity will be kept confidential, only the researcher and the supervisors will have access to the completed questionnaires. All data will be coded for purposes of recording, analysis and reporting and thus no participant will be identifiable in the dissertation or publication. During the study

the documents will be kept safe in ballot boxes in a secure location. All material related to you in the study will be kept in the Chiropractic Program for 5 years before the data will be shredded.
Research-related Injury: There is no risk of injury by partaking in this study.

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

Please contact the researcher (0827816804), my supervisor (0865324209) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support, Prof C. Napier on 031 373 2326 or carinn@dut.ac.za.

Appendix B: Letter of Consent

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Carmel Billson, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: 187-17,
- 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, Carmel Billson, 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 under 18 years old)	Date	Signature

Appendix C: <u>Code of Conduct (Members of the Focus group)</u>

This form needs to be completed by every member of the focus group prior to commencement of the focus group.
As a member of this committee I agree to abide by the following conditions:

1. All information contained in the research documents and any information discussed during the focus group meeting will be kept private and confidential.
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 of this focus group will be made public in terms of journal publication, which will in no way identify any participants of this research.

Member Represents	Member's Name	Signature	Contact Details

Appendix D: Confidentiality Statement

IMPORTANT: This form is to be completed and understood before the focus group commences.

1. All information contained in the research documents and any information discussed during the focus group meeting will be kept private confidential.
2. The patient files will be coded and kept anonymous in the research process.
3. 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.
4. The information of this focus group will be made public in terms of journal publication, which will in no way identify any participants of this research.

Member Represents	Member's Name	Signature	Contact Details

Appendix E: Permission to use questionnaire

BEACON BAY CHIROPRACTIC

Dr Gregg Audie	083 654 3990	M.Tech. Chiropractic (SA) M.C.A.S.A.
Dr Cuan Coetzee	071 876 9709	M.Tech. Chiropractic (SA) M.C.A.S.A.
Dr Jason Dicks	079 428 5156	M.Tech. Chiropractic (SA) M.C.A.S.A.

78 BONZA BAY ROAD (Famcare)
BEACON BAY
EAST LONDON

To Whom It May Concern:

I hereby give my written consent to Carmel Billson for the use of a modified version of my musculoskeletal injury questionnaire in her research.

Yours truly, [redacted]

Dr Cuan Coetzee

[redacted]

Appendix F: Pre – focus group questionnaire

The epidemiology of musculoskeletal injuries in competitive lifesavers in KwaZulu-Natal

- **Please mark an X indicating your choice where applicable.**
- **Some questions are open-ended and will entail a more detailed answer**

Section A – Demographics

Age:			Gender	Male	Female
Ethnicity	African	Coloured	Indian	White	Other
Height		m	Weight		kg
Hand Dominance	Right	Left	Occupation:		
Do you smoke?	No	Yes: How many per day? ____	Do you drink alcohol?	No	Yes: How many units per week? ______

How many lifesaving competitions have you participated in the previous 12 months?	
Do you suffer from any systemic diseases? i.e heart disease	

Section B - Training Schedule

1	What event do you partake in?	Beach sprint	Board race	Ironman	Surf ski	
		Beach flags	Surf swim	Other:		
2	What strength training do you participate in?	Free weights	CrossFit	Functional Training	Gym	
		Other Sports (please specify)		None		
4	What type of running training do you perform?	**None** **(mark with an X)**				
		Type of training	*Sessions per week*	*Distance (m) per session*	*Duration (minutes) per session*	
		Long Slow Distance				
		Interval Training				
		Sprint Training				
		Other, please Specify 1 2				
5		**None** **(mark with an X)**				

<table>
<tr><td rowspan="6"></td><td rowspan="6">What type of ski paddling/ canoeing training do you perform?</td><td>Type of training</td><td>Sessions per week</td><td>Distance (km) per session</td><td>Duration (minutes) per session</td></tr>
<tr><td>Endurance</td><td></td><td></td><td></td></tr>
<tr><td>Wave catching/ surf skills</td><td></td><td></td><td></td></tr>
<tr><td>Sprint</td><td></td><td></td><td></td></tr>
<tr><td>Downwind</td><td></td><td></td><td></td></tr>
<tr><td>Other, Please Specify
1
2</td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">5</td><td rowspan="6">What type of board paddling do you perform?</td><td>None (mark with an X)</td><td colspan="3"></td></tr>
<tr><td>Type of training</td><td>Sessions per week</td><td>Distance (km) per session</td><td>Duration (minutes) per session</td></tr>
<tr><td>Endurance</td><td></td><td></td><td></td></tr>
<tr><td>Sprint</td><td></td><td></td><td></td></tr>
<tr><td>Wave catching/ surf skills</td><td></td><td></td><td></td></tr>
<tr><td>Other, Please Specify
1
2</td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">6</td><td rowspan="5">What type of swim training do you perform?</td><td>None (mark with an X)</td><td colspan="3"></td></tr>
<tr><td>Type of training</td><td>Sessions per week</td><td>Distance (m) per session</td><td>Duration (minutes) per session</td></tr>
<tr><td>Endurance</td><td></td><td></td><td></td></tr>
<tr><td>Sprint</td><td></td><td></td><td></td></tr>
<tr><td>Other, Please Specify
1
2
3</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">7</td><td rowspan="4">What other sporting activities do you participate in?
I.e school sports</td><td>Please Specify</td><td>Sessions per week</td><td>Distance (m) per session</td><td>Duration (minutes) per session</td></tr>
<tr><td>1</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td></tr>
<tr><td>8</td><td>How many rest days do you have a week:</td><td colspan="4"></td></tr>
<tr><td>9</td><td>Have you ever experienced MSK pain that is related to lifesaving?</td><td>Yes</td><td>No</td><td colspan="2">If Yes, please proceed to Section C.

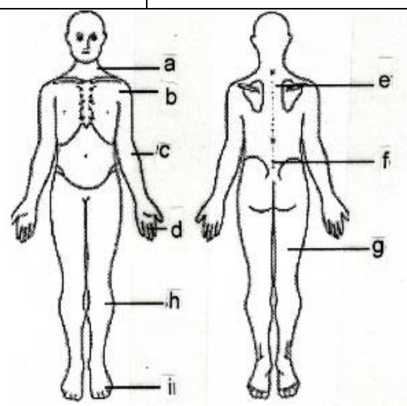
If No, thank you for your time.</td></tr>
</table>

<u>Section C – Pain appraisal</u>

The definition of musculoskeletal pain is a sensation of agony that inhibited you from participating in sport or practice for a minimum of 24 hours (adapted from van Heerden, 1996). Please report on lifesaving related musculoskeletal pain and not musculoskeletal pain contracted from other activities.

1	Have you experienced any musculoskeletal pain within the last 12 months?	Yes	No

2.1	Identify the anatomical sites where you experience musculoskeletal pain **<u>currently</u>**:	**A**	**F**
		B	**G**
		C	**H**
		D	**I**
		E	



2.2	Identify the anatomical sites where you experienced musculoskeletal pain within the **<u>last 12 months</u>**:	**A**	**F**	2.3	Identify the anatomical sites which have ever experienced musculoskeletal pain **<u>in your lifetime:</u>**	**A**	**F**
		B	**G**			**B**	**G**
		C	**H**			**C**	**H**
		D	**I**			**D**	**I**
		E				**E**	

In terms of your current pain NOTE: if no current injury, Thank You for participating.

3	What activity precipitates the onset of pain?	Swimming	Running	Board/ ski padding	Swimming and Running	Swimming and board/ ski paddling
		Board and ski paddling	All three	None	Other (specify)	
4	What type of pain have you experienced?	Dull	Sharp Shooting	Aching	Radiating	Pins and Needles

5	How long does the pain last / persist?	Years	Months	Days	Hours	Minutes	Seconds

6	How would you rate this pain from 0 – 10 (0 no pain and 10 is worst pain)										
	0	1	2	3	4	5	6	7	8	9	10

7	When did this musculoskeletal pain occur?	Pre-season	In-season	Off-sea son	Not related to sport

8	Did the musculoskeletal pain prevent you from participating in competition and/or training?	Yes	No

9	How long did it prevent you from training?	No loss	1 Day	> 1 Day	> 7 Days	> 1 Month	> 12 months

10	How long did it prevent you from participating?	No loss	1 Day	> 1 Day	> 7 Days	> 1 Month	> 12 months
11	Is the pain experienced constant or recurring (only with activity)?				Constant	Recurring	Not applicable
12	How long have you experienced the recurring pain?			Hours	Minutes	Seconds	Not applicable
13	How did you sustain the musculoskeletal pain?	Traumatic incident during a race			Traumatic incident during training		Over-training
		Incident during Cross-training (Cross-training includes Crossfit, Functional Training, Boot Camp, Gym, other sports)			If not stated here, please specify:		Unknown
14	Which type of training produces the most pain?	Swim	Run	Paddling	Swimming and Running	Swimming and paddling	Board and ski paddling
		All three	Cross training	None	Other (specify)		
15	When you sustained the musculoskeletal pain which medical practitioner did you seek treatment from?	Biokineticist	Chiropractor		General Practitioner	Orthopaedic Surgeon	
		Pharmacist	Physiotherapist		Other (Please Specify)		
16	What was the specific diagnosis of your injury given by the above medical practitioner?						
17	Have you been negatively affected psychologically by your injury?	During/in training	Yes		No	Unsure	
		During competition	Yes		No	Unsure	
		Overall confidence	Yes		No	Unsure	
18	Do you feel safer wearing a Pink Vest during competition?	Yes Comment:			No Comment:		

THANK YOU FOR TIME AND EFFORT IN COMPLETING THIS QUESTIONNAIRE

Appendix G: Permission from LKZN

LIFESAVING KWAZULU NATAL

17 May 2018

TO: Carmel Billson

FROM: KZN Lifesaving Association

RE: Permission to access members of KZN LSA athletes

To whom it may concern
This is to certify that Carmel Billson, operating in conjunction with DUT, is hereby granted permission to access KZNLSA athletes for research purposes, provided ethical approval is obtained.

For further information please contact the undersigned.
Lesley Luhnn
KZNLSA Secretary

AFFILIATED TO LIFESAVING SOUTH AFRICA
VOLUNTARY LIFESAVING

Appendix H: Post – focus group questionnaire

The epidemiology of musculoskeletal injuries in competitive lifesavers in KwaZulu-Natal

- **Please mark an X indicating your choice where applicable.**
- **Some questions are open-ended and will entail a more detailed answer**

Section A – Demographics

Age:			Gender	Male	Female	
Ethnicity	African	Coloured	Indian	White	Other	
Height		m	Weight			kg
Hand Dominance	Right	Left	Occupation:			
Do you smoke?	Yes: How many per day? ____	No	Do you drink alcohol?	Yes: How many units per week? ______ 250ml beer ½ glass wine 1 tot (25ml) spirit	No	
Do you use social drugs?	Yes	No				

How many lifesaving competitions have you participated in the previous 12 months?	

Do you suffer from any systemic diseases? i.e. heart disease, diabetes, thyroid problems	Yes, specify:	No

Section B - Training Schedule

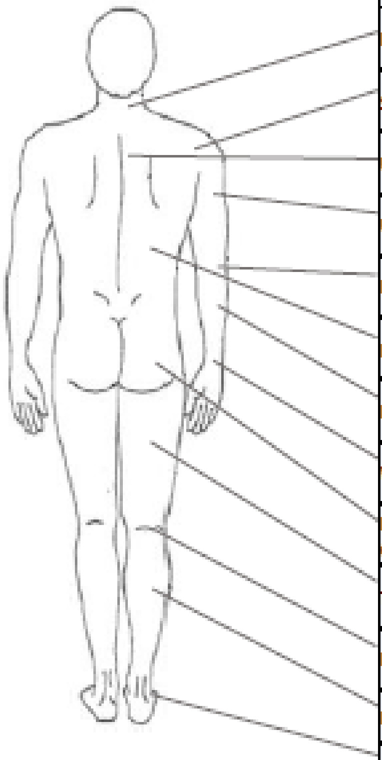
1	What events do you partake in? (you can tick more than one)	Beach sprint	Board race	Ironman	Surf ski
		Beach flags	Surf swim	Other:	

2	What strength training do you participate in?	*Type of training*	*Sessions per week*	*Distance (km) per session*	*Duration (minutes) per session*
		None			
		CrossFit			
		Functional Training			
		Free weights			
		Gym/ machines			
		Other (please specify) 1 2			

3	What type of **running** training do you perform? ***BEACH RUNNING***	*Type of training*	*Sessions per week*	*Distance (km) per session*	*Duration (minutes) per session*
		None			
		Long Slow Distance			
		Interval Training			
		Sprint Training			
		Other, please Specify 1 2			
	TRACK RUNNING	*Type of training*	*Sessions*	*Distance*	*Duration*
		None			
		Long Slow Distance			
		Interval Training			
		Sprint Training			
		Other, please Specify 1 2			
	ROAD RUNNING	*Type of training*	*Sessions*	*Distance*	*Duration*
		None			
		Long Slow Distance			
		Interval Training			
		Sprint Training			
		Other, please Specify 1 2			
4	What type of **ski paddling/ canoeing** training do you perform? ***SURF SKI***	*Type of training*	*Sessions per week*	*Distance (km) per session*	*Duration (minutes) per session*
		None			
		Endurance			
		Wave catching/ surf skills			
		Sprint			
		Downwind			
		Other, Please Specify 1 2			
	FLAT WATER	*Type of training*	*Sessions*	*Distance*	*Duration*
		None			
		Endurance			
		Sprint			
		Resistance			
		Other, Please Specify 1 2			

5	What type of **board paddling** do you perform?	*Type of training*	*Sessions per week*	*Distance (km) per session*	*Duration (minutes) per session*
	SURF	None			
		Endurance			
		Sprint			
		Wave catching/ surf skills			
		Other, Please Specify 1 2			
	FLAT WATER	*Type of training*	*Sessions*	*Distance*	*Duration*
		None			
		Endurance			
		Sprint			
		Resistance			
		Other, Please Specify 1 2			
6	What type of **swim** training do you perform?	*Type of training*	*Sessions*	*Distance*	*Duration*
		None			
		Endurance			
	SURF	Sprint			
		Surf skills			
		Other, Please Specify 1 2			
	POOL TRAINING	*Type of training*	*Sessions*	*Distance*	*Duration*
		None			
		Endurance			
		Sprint			
		Other, Please Specify 1 2			
7	What other sporting activities do you participate in? i.e. school sports	*Please Specify*	*Sessions*	*Distance*	*Duration*
		1			
		2			
8	How many rest days do you have a week? (No physical activity)				
9	Do you feel safer wearing a Pink Vest during competition?	Yes Comment:	No Comment:		

Section C – Pain appraisal **The definition of musculoskeletal (MSK) pain is an incident that prevents you from participating in sport or practice for a minimum of 24 hours.** **Please report on <u>lifesaving related</u> musculoskeletal pain.**					
1	Have you experienced **any** musculoskeletal pain within the last 12 months? (**not** related to lifesaving)	Yes		No	
2a	Have you ever experienced MSK pain that is related to **lifesaving**?	Yes Please continue		No Thank you for your time, you are finished.	
2b	Have you been negatively affected psychologically by your injury? (i.e. anxiety, depressed, demotivated)	During/in training	Yes	No	Unsure
		During competition	Yes	No	Unsure
		Overall confidence	Yes	No	Unsure
	<u>Please turn over to the injury profile table</u>				



Adapted from Cornell Musculoskeletal Discomfort Questionnaire

		Identify the anatomical sites where you experience musculoskeletal pain currently:			Identify the anatomical sites where you experienced musculoskeletal pain within the last 12 months:			Identify the anatomical sites which have ever experienced musculoskeletal pain in your lifetime:			How did you sustain the musculoskeletal pain?				
				Please rate the pain: 1= mild 2= moderate 3= severe			Please rate the pain: 1= mild 2= moderate 3= severe			Please rate the pain: 1= mild 2= moderate 3= severe	Traumatic incident during lifesaving:		Over-use	Incident during Cross-training e.g. CrossFit, Boot Camp, Gym	Unknown
											race	training			
Neck	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Shoulder	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Upper back	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Upper arm	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Elbow	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Lower back	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Forearm	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Wrist	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Hip/Buttocks/ Groin	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Thigh	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Knee	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Lower leg	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Foot/ Ankle	Right	Yes	No		Yes	No		Yes	No						
	Left	Yes	No		Yes	No		Yes	No						
Other															
Comments															

For the following questions, please complete relative to your worst injury											
3a	State your worst lifesaving injury:										
3b	When did it occur?										
4a	What activities precipitates the onset of pain?	Board padding	Running	Ski paddling	Swimming	None					
		Other (specify)									
4b	Which type of training produces the **most** pain?	Cross training	Board paddling	Running	Ski Paddling	Swimming	None				
		Other (specify)									
5a	What type of pain have you experienced?	Dull	Sharp Shooting	Aching	Radiating	Pins and Needles					
5b	How long does the pain last / persist?	Years	Months	Weeks	Days	Hours	Minutes				
6	How would you rate this pain from 0 – 10 (0 no pain and 10 is worst pain)										
	0	1	2	3	4	5	6	7	8	9	10
7	When did this musculoskeletal pain occur?	Pre-season	In-season	Off-season	Not related to sport						
8	Did the musculoskeletal pain prevent you from participating in competition and/or training?	Yes	No								
9a	How long did it prevent you from **training**?	No loss	1 Day	> 1 Day	> 7 Days	> 1 Month	> 6 weeks	> 12 months			
9b	How long did it prevent you from **participating** in lifesaving competition?	No loss	1 Day	> 1 Day	> 7 Days	> 1 Month	> 6 weeks	> 12 months			
10	Did you have to **adapt** your training or did you have to **stop** training because of injury?	Adapt	Stop	Other:							
11	Is the pain experienced **constant** or **recurring** and/or with activity?	Constant	Recurring								
13	How did you sustain the musculoskeletal pain?	Traumatic incident during a lifesaving race	Traumatic incident during lifesaving training	Over-use							
		Incident during Cross-training (e.g. CrossFit, Gym, other sports)	If not stated, please specify:	Unknown							
14	Which type of training produces the **most** pain?	Cross training	Board paddling	Running	Ski Paddling	Swimming	None				
		Other (specify)									

15 a	Did you seek medical treatment?	Yes	No		
15 b	Which medical practitioner did you seek treatment from?	Biokineticist	Chiropractor	General Practitioner	Orthopaedic Surgeon
		Pharmacist	Physiotherapist	Massage therapy	Other (Please Specify)
15 c	What was the specific diagnosis of your injury given by the medical practitioner?	Contusion	Fracture	Sprain	
		Strain	Tendonopathy	Other	
15 d	How many sessions with each practitioner did you attend?				

THANK YOU FOR TIME AND EFFORT IN COMPLETING THIS QUESTIONNAIRE

Appendix I: IREC approval letter

DUT DURBAN UNIVERSITY OF TECHNOLOGY

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: [illegible]
[illegible]

www.dut.ac.za

22 June 2018

IREC Reference Number: **REC 187-17**

Ms C B Billson
11 Snowden Avenue
Mill Park
Port Elizabeth
6001

Dear Ms Billson

The epidemiology of musculoskeletal injuries in competitive lifesavers in KwaZulu-Natal

The 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.

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 IREC according to the IREC Standard Operating Procedures (SOP's).

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

Yours Sincerely,

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY
2018 -06- 22
INSTITUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA

Appendix J: Corrections from Focus Group

FOCUS GROUP RECOMMENDED CHANGES	STUDENT/ SUPERVISOR RESPONSE	PAGE NO. WHERE CHANGE WAS MADE
Section A- demographics: add in question "Do you use social drugs? Yes/ No	Done	Section A page 1
Add in more systemic disease examples	Done	Section A, Page 1
Correct numbering and measurements	Done	Whole document
Set out section B, question 2 like the rest of the training questions	Done	Section B
Training questions: add in resistance training, flat/ surf training	Done	Section B
Add in "(no physical activity.)" in question 8	Done	Section B
Add in resistance training	Done	Section B, question 5
Make Q 9 in section B, number Q1 in section C	Done	Section C
Change the definition of MSK pain	Done	Section C
Make a new pain diagram	Done	Section C
Delete "all three"	Done	Question 3
Change seconds to weeks	Done	Question 3
Remove question 12 (duplicate question)	Done	Section C
Make the word "training" in bold in question 9 and make it 9a and add in ">6 weeks"	Done	Section C
Add in "Did you have to adapt your training or did you have to stop training because of injury? Yes/No " question 10	Done	Section C
Add and/ or in question 11	Done	Section C
Add in "lifesaving" in question 13	Done	Section C
Change overtraining to over-use	Done	Section C
Question 14 delete "all three'	Done	Section C
Add 15 a "did you seek medical treatment? Yes/No"	Done	Section C
Change 15 to 15 b and add in "massage therapy"	Done	Section C
Change 16 to 15c	Done	Section C
Move question 17 to top of section. Add in "(i.e. anxiety, depressed, demotivated)"	Done	Section C
General formatting to minimize page numbers		
Delete Pre focus group line	Done	Page 1
Second block no spaces, make block smaller	Done	Page 1
Swap Yes and No	Done	Page 1
Make block 7 and 8 longer	Done	Page 1
Add in yes: specify	Done	Page 1
Make each training aspect in bold	Done	Section B
Move each type of training to underneath the training questions	Done	Section B
Delete "per week", "(km) per session", "(minutes) per session)"	Done	Section B

Change font sizes to fit in questions	Done	Whole document
Sentence under definition centred	Done	Section C
Add; for the following questions, please complete relative to your worst injury	Done	Section C
Add: State your worst injury	Done	Section C
Add: when did it occur?	Done	Section C
Edit diagram, add in pain rating column	Done	Injury image
Format diagram for easy reading	Done	Injury image
Add “adapted from Cornell Musculoskeletal Discomfort Questionnaire	Done	Injury image
Question 15 b: delete When you sustained the musculoskeletal pain	Done	Section C
Make words bold to stand out	Done	Whole document
Pilot study changes		
Format question 14, section C, so that the options are on the same page	Done	Whole document