AN INJURY PROFILE OF MUSCULOSKELETAL INJURIES IN MOUNTAIN BIKERS IN THE ETHEKWINI MUNICIPALITY

By

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

I, Rochelle Van Eck, do declare that this dissertation is representative of my own work in both conception and execution

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DEDICATION

To my parents, Evelyn and Stefan, my brother Stefan Jnr, and my Grandparents.
I hope you are proud of me for conquering this 'Mount Everest'.

"All our dreams can come true if we have the courage to pursue them"

– Walt Disney

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ABSTRACT

Background: Mountain biking is a sport that appeals to men and women who enjoy an adrenalin rush. It is practised on any terrain classified as 'off-road' such as gravel roads, sugar cane fields, farmland, mountainous areas, and forests. It involves riding over rough and tricky terrain with a mountain bike and has become a global phenomenon among many athletes of all fitness levels. The popularity of this sport has grown as it is well known for its health benefits, family participation, recreational enjoyment, its ability to enhance overall fitness, and the fact that it offers those who are driven opportunities to be highly competitive. However, as is the case with any competitive and recreational sport, mountain bikers are prone to suffering a unique set of injuries. Mountain bikers want to recover and get back on their bikes as soon as possible, but there is a paucity of literature on the injury profile of mountain bikers in South Africa, hence recovery strategies may not always have the desired results.

Aim: The aim of this study was to establish the injury profile of the musculoskeletal injuries that mountain bikers sustain, with special focus on those enthusiasts in the eThekwini municipality of KwaZulu-Natal, while the risk factors associated with this sport were also explored.

Methodology: Participants were recruited at cycling clubs, after training sessions when they gathered in coffee shops, and individually at mountain bike parks. Before completing the questionnaire, each participant was required to read a letter of information and sign an informed consent form. Informed consent and post-pilot study questionnaires were completed, gathered, and deposited into separate sealed boxes. Each questionnaire was given a code for statistical analysis before data were captured on a spreadsheet.

Results: A total of 175 questionnaires were received and the data were statistically analysed. The results revealed that not applying any preventative measures when training for this sport was the main causative factor of injuries among mountain bikers in the eThekwini Municipality. The majority of the injuries occurred in white males between the ages of 45 to 50 years and in participants who practised this sport for more than 12 hours a week. The most common areas of the body that sustained injuries were shoulders, legs, knees, and wrists, while the most common types of injuries were bruises, cuts, and sprains. The predominant mechanisms that caused these injuries were falls and contact with stationary objects.

Conclusion: The findings that emerged from the data were consistent with the literature on mountain biking, but it must be mentioned that the injuries that were described related to earlier studies that had been conducted among either international mountain bikers or road cyclists. The current study's findings are distinctive of the eThekwini Municipal area in KwaZulu-Natal, South Africa. Additional studies need to be conducted in other provinces of South Africa in order to create a more accurate injury profile associated with the mountain biking sport in this country.

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LIST OF ABBREVIATIONS

BMX	Bike Motocross
etc.	et cetera
e.g.	for example
IREC	Institutional Research and Ethics Committee
ITB	Iliotibial Band
kg	kilogram
km	kilometre
KZN	KwaZulu-Natal
m	meter
MTB	Mountain Bike
SA	South Africa

LIST OF DEFINITIONS

Acute injury

An injury that occurred suddenly, which is usually due to a physical trauma of some kind such as an ankle sprain or a broken wrist (Pulido, 2017: 1).

Biomechanics

The observation of the motion of animate beings utilising the knowledge of mechanics (Priego-Quesada, 2021).

Camelback

A water carrier (Zaseck et al., 2017).

Cross country racing

Racing that occurs over multiple terrains that includes high-performance climbing with less intense descents (Miller et al., 2017:279).

Eccentric contraction

A muscle contraction that encompasses a high force but has low energy expenditure (Hessel, Lindstedt and Nishikawa, 2017:1).

Endurance racing

Racing for an entire day or sometimes over multiple days in timed competitions where the race is divided into stages and the person needs to finish in the given time limit (McKnight, 2018).

Four cross

Racing between four mountain bikers on a course resembling that of a BMX track (Alfaro and Glass, 2020).

Iliotibial band syndrome

A syndrome caused by an overuse injury of the iliotibial band located on the lateral aspect of the thigh from the pelvis to the knee (Wedro, 2020).

Incidence

The rate at which something occurs (Cambridge Dictionary, 2021a).

Kinetic chain

Movement of the human body via multiple connected segments affecting one another (Ellenbecker and Aoki, 2020).

Mountain biking

Mountain biking (MTB) is cycling over rough and rugged terrain (Moorman, 2007).

Mountain bike

A bike for riding over hills and rough terrain (Cambridge Dictionary, 2020).

Musculoskeletal injury

An injury to the musculoskeletal system such as bones, muscles, tendons, ligaments, nerves, and blood vessels which is caused by a fatiguing and/or repetitive action (Alsheikly and Alsheikly, 2018).

Overuse injury

An injury to a muscle or a joint that is caused by repetitive trauma over a period of time (Roos and Marshal, 2014).

Patellofemoral pain

Pain that is present around the patella and over the front of the knee (Nall 2017).

Paucity

When there is not enough information about something (Cambridge Dictionary, 2021b).

Period prevalence

A percentage of the population with an ailment for the duration of a length of time (Tenny and Hoffman 2017).

Prevalence

How often something happens (Cambridge Dictionary, 2021c).

Tendonitis

Swelling of the tendon (Davis, 2021).

Terrain

A region of land and its physical features (Cambridge Dictionary, 2021d).

Trauma

A physical injury caused by harm to the body's tissue (Garland, 2018).

Treatment

The application of medication and exercise to heal an injury sustained by an individual (Cambridge Dictionary, 2021e).

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

This chapter explains the background of mountain biking as a sport and presents the aim, objectives, and purpose of this study.

1.2 BACKGROUND

Cycling is known to improve the emotional well-being as well as the physical fitness of the cyclist. It is a sport that is enjoyed by many people of all ages as the physical exertion associated with it is easier on the joints than for example running and walking (Srtastná et al. 2018). Cycling is believed to improve cardiovascular health in a remarkable way, making it a sport with health benefits (Olmedillas et al. 2012). There are many different types of cycling, one of which is mountain biking (MTB), also known as off-road cycling (Impellizzeri and Marcora 2012). Mountain biking provides mainstream recreational exercise and is also an Olympic sport (Impellizzeri and Marcora 2012). This sport involves cycling over rough and rugged terrain (Moorman 2007) and thus mountain bikes are different from road bikes in that they have flat handlebars with thick, knobbly, heavy-duty tires in order to withstand the different types of terrain that are ridden (Lindsey 2020). However, due to its popularity, injuries resulting from this sport have been escalating (Ansari, Nourian and Khodaee 2017). There is evidence of injury profiles associated with mountain biking in the United States of America (Nelson and Mckenzie, 2010: 404) and United Kingdom (Apsingi, Chakravarthi and Bakul, 2006: 487), while injury profiles have also been created for the Enduro event mountain bikers. Enduro is a long-distance stamina event that is popular among mountain bikers (Palmer, Ball and Florida-James, 2020: A155). However, there is a paucity of literature on mountain biking in the South African context and injury profiles of mountain bikers in this country are limited.

Biomechanically, a cyclist is able to propel him/herself forward by means of the contact between the feet and the pedals (McCulloch 2018). By increasing the amount of contact between each foot and the pedal, the risk of developing knee injuries is diminished and the rider's performance can be enhanced (McCulloch 2018). This is possible by using the pedals that lock the feet in place while pedalling, thereby optimising the contact between the foot and the pedal (McCulloch 2018). Not only does the contact between the cyclist's feet and pedals affect performance, but the way in which each component of the bike is set up affects the position of the spine. If not set up correctly, it can lead to low back pain, thus affecting performance negatively (Streisfeld et al. 2017). Streisfeld et al. (2017) thus argue that modified spinal kinematics and activation patterns of the core muscles, together with the tedious continual nature of cycling, may result in lumbar spine overuse injury.

The biomechanics of mountain biking are thus closely related to bike fit while the risk of overuse injuries because of inappropriate bike fit also exists (Ansari, Nourian and Khodaee 2017), which in turn affects the mechanics of the musculoskeletal system. Having said this, the majority of mountain bike studies focused on how biomechanics affected the performance of cyclists rather than how the injuries that cyclists sustained were caused (Ansari, Nourian and Khodaee 2017). Commonly, correct bike setup involves a medical history of the type of injury or injuries that the cyclist has sustained, a physical examination that focuses on any spinal and lower limb problems, followed by a fit while the biker is seated on the bike (Ansari, Nourian and Khodaee 2017). For example, a subtle change in the saddle height can change the biomechanics of the knee by increasing the amount of flexion in each pedal stroke. If the saddle is too low, it results in patellofemoral pain syndrome while a saddle height that is too high, leads to hamstring injuries (Ansari, Nourian and Khodaee 2017). If the correct modifications are done, it will result in the desired change in the neuromuscular activation patterns of the muscles (Ansari, Nourian and Khodaee 2017) and will, in turn, affect the mechanics of the musculoskeletal system.

1.3 AIMS AND OBJECTIVES

1.3.1 Aim of the Study

The aim of this study was to determine the injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality of KwaZulu-Natal.

1.3.2 Objectives Of The Study

Objective 1: To determine the incidence and period prevalence of musculoskeletal injuries in mountain bikers in the eThekwini Municipality.

Objective 2: To determine the impact of selected risk factors (bike setup, riding style, shoes, distance ridden, type of terrain) of musculoskeletal injuries in mountain bikers in the eThekwini Municipality.

Objective 3: To determine the impact of musculoskeletal injuries on mountain bikers in the eThekwini Municipality.

Objective 4: To create an injury profile of mountain bikers in the eThekwini Municipality.

1.4 RATIONALE

Mountain biking has become a very popular sport since its origin in the 1970s. However, this increase in popularity has been associated with an increase in the injuries that mountain bikers have sustained (Stoop et al. 2019). Many studies have shown that MTB has become one of the world's most favoured outdoor recreational activities (Kronisch and Pfeiffer 2002: 526), although acute injuries have required many riders to stop training in order to heal (Stoop et al. 2019). The causes of common injuries among mountain bikers are over-use injuries, bike related causes and trauma (Thompson and Rivara 2001: 2007). Traumatic injuries usually occur as a result of crashing or falling due to mechanical defects, slipping on loose terrain, or losing control of the bike (Bingley et al. 2019: 578). Such falls can cause concussion, fractures, and torn ligaments or tendons. Overuse injuries are common in the spine, knee, and upper extremities of the body and can cause low back and neck pain, strains, inflammation, nerve compressions, skin chafing, and tendonitis, all of which are affected by the fit of the rider's bike and the interaction between the cyclist's body and the bike (Thompson and Rivara 2001: 2007).

Comprehensive understanding of how these common injuries occur in mountain bikers will make it easier to prevent them. For instance, it is argued that an injury profile of mountain bikers can enhance knowledge of the most common injuries that occur as a result of various factors and circumstances. When these factors and circumstances are narrowed down, the findings will show more precisely what the causes of the injuries were. This will not only assist in understanding how to avoid injuries in the future, but also how to treat them more effectively. Mountain bikers will undeniably benefit from this knowledge as they will be able to both avoid and treat their injuries more effectively. This study will also be beneficial to health care providers such as chiropractors, physiotherapists, and occupational therapists as it will increase their knowledge of the most common injuries sustained by mountain bikers, and this will enhance their overall management of such injuries. Moreover, these healthcare providers will be able to use the injury profile information to assist them to devise effective treatment and management regimes that are injury-specific and orientated towards mountain bikers.

Certain risk factors are unique to MTB in South Africa compared to those internationally. For instance, it is commonly accepted that the terrain in South Africa is much more difficult and treacherous to navigate and races are thus quite difficult (Bordelon and Ferreira 2019: 43-44). The tracks are often characterised by strenuous rocky uphill climbs or technically challenging downhill descents with gravel paths that are dusty and arduous to negotiate. An example of this is the Absa Cape Epic mountain bike race that is held over a period of eight days in Cape Town. This race has been given the nickname 'The Tour De France of MTB' and is regarded as the most difficult event on the Union Cyclist international calendar (Bordelon and Ferreira 2019: 43-44). Another example is the Mountain Biking World Championships that was held in Pietermaritzburg from 2009 to 2015. This was an arduous race because of the skill level required to negotiate the terrain (Preez, 2016).

1.5 DISSERTATION STRUCTURE

This dissertation is presented in dissertation format as approved by the Durban University of Technology (DUT). It consists of six chapters.

Chapter 1: Introduction. This chapter presents the problem, states the aim, and lays out the structure of the dissertation.

Chapter 2: Literature review. The review gives a general overview of mountain biking with specific focus on the structure and design of the mountain bike, and covers the injuries commonly sustained by mountain bikers and the causes for these aches and pains they experience.

Chapter 3: Methodology. In this section the methods that were used in this study are described.

Chapter 4: Results. In this chapter the data are presented. The data are summarised in tables and graphs and briefly discussed.

Chapter 5: Discussion. The results are discussed and evaluated.

Chapter 6: Conclusions and recommendations. In this chapter the profile of mountain biker injuries is presented. The limitations are acknowledged and recommendations for further research are offered.

1.6 CONCLUSION

This chapter provided an introduction to the study and presented the aim and objectives. The research problem, context, and background were discussed. The scope of the study was presented with brief reference to each of the six chapters. The following chapter outlines the literature that was reviewed using Google Scholar and the online library from Durban University of Technology. This review will elicit an improved perception of mountain biking and the injuries related to this sport.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, the literature in relation to this study is reviewed. The discourse covers the natural mechanics of cycling, bike setup, the biomechanics in normal cycling versus the biomechanics in mountain biking, the prevalence and nature of mountain biking-related injuries, risk factors related to the injuries sustained due to mountain biking, and extrinsic and intrinsic risk factors associated with this sport. The chapter is concluded with some reflections on the position of health care providers who treat injuries associated with mountain biking. Search engines that were used to gather the information were Google Scholar, PubMed, the Durban University of Technology (DUT) library site, and Open Athens. Some of the key words used to access these search engines were mountain biking, cycling mechanics, bicycling, cycling biomechanics, bike setup, cycling tourist attraction, cycling and health, and cycling popularity.

2.2 THE INCIDENCE AND PREVALENCE OF MOUNTAIN BIKING RELATED INJURIES

In relation to the incidence and prevalence of injuries among mountain bikers, a study done in a mountain bike park in Scotland revealed the overall injury rate was 1.54 injuries per 1000 biker exposures (Aitken, Biant and Court-Brown 2011: 275). They defined a “biker exposure” as being a mountain biker cycling at the park anytime of the day or night (Aitken, Biant and Court-Brown 2011: 275). Of these overall injuries, 1.64 per 1000 biker exposures that occurred was in men and 1.08 per 1000 biker exposures were found in women (Aitken, Biant and Court-Brown 2011: 275).

The mean age of these injuries was 31.5 years, with males being 31.5 (11-58 years) and women being 32.0 (10-49) years (Aitken, Biant and Court-Brown 2011: 275). The most common age bracket for males to be injured was 30 to 39 years (Aitken, Biant and Court-Brown 2011: 275). In a New Zealand study, injury rates have been documented to be high at 4% for a single event (Pratt, Primrose and Fulcher 2019:

28). Of all the mountain bikers that took part in the study, 55% stated that they had to take a week or more off work because of their injury, 20% had to take more than a month off and 40% stated that they had ongoing symptoms from the injury (Pratt, Primrose, and Fulcher 2019: 28).

According to a study done by Bush, Meredith and Demsey (2013) at the Municipality of Whistler and district of Squamish, they found that upper extremity injuries had a number of 511 out of 1,079 injuries which presented to an emergency department from mountain bike cyclists who completed the survey. Their study also revealed that the mechanism of injury occurring the most was falling forward over the handlebars on an outstretched hand, also called “FOOSH” mechanism which stands for “Fall On Outstretched Hand” (Bush, Meredith and Demsey 2013*)*. In addition to this, their study revealed that the scaphoid in the wrist and the distal radius were the most affected in these injuries, with 25 scaphoid fractures: 14 isolated distal radius fractures and 10 combined distal radius and ulna fractures (Bush, Meredith and Demsey 2013). The rough terrain and rocky trails of mountain biking as well as the cyclists’ instinctive reaction to guard their head and neck by stretching out their arms first during impact all contribute significantly to these injuries (Bush, Meredith and Demsey 2013).

In the following table, percentages of injuries in mountain bikers and the regions where they occurred, were recorded in a study done by Gaulrapp, Weber and Rosemeyer (2001)

Table 2.1 Percentages of Injuries occurring in Regions of the Body

Upper Extremities	45.8%
Lower extremities	38.8%
Head	91%
Trunk	6.3%
Skin lacerations, contusions and wounds	75.4%
Joint lesions – sprains, ligament tears and dislocations	9.9%
Fractures	5.5%
Muscle injuries	5.4%

The statistics mentioned above, was collected through sending out questionnaires to cyclists with a subscription to the most popular mountain bike magazine (Bike) in Germany, Austria, and Switzerland (Gaulrapp, Weber and Rosemeyer 2001).

In a study done on cyclists over the course of four years in the United States of America, the injuries that were documented were 51.1% overuse injuries and low back pain was the most common overuse injury with 58% of professional riders who had low back pain (Streisfeld et al. 2017: 75). Kotlyar (2016: 316) stated in a different study that took place in Southwest Colorado that while most of the injuries that occur in cyclists tend to be minor, around 80% of non-amateur and 50% of amateur cyclists state that out of all their injuries at the very least one is a severe mountain biking related injury

2.3 INTRODUCTION TO MOUNTAIN BIKING

Mountain biking (MTB) is a sport in which participants cycle on rough and rugged terrain (Moorman 2007) using a bike that is designed to go down difficult descents, climb hills, and manoeuvre tricky obstacles (Kruger and Saayman 2014: 137). A mountain biker is defined as someone who rides a mountain bike over hills and rough terrain (Cambridge Dictionary, 2020). It involves long hours of hard work and facing the challenges of a rough terrain. The cyclist also has to contend with constant demands on the body to stay on the bike and not end up on the ground (Moorman 2007). The tracks and trails that mountain bikers negotiate are mostly found in mountain bike parks, across farms, and in forests (Moorman 2007). Mountain biking can either be practised as a professional and competitive sport or it can be enjoyed as a recreational activity to keep fit and healthy (Shueller 2010).

Participation in mountain biking is on the rise and this sport has become not only more popular than road cycling, but has also become a tourist attraction, especially on an international scale (Bryant 2013). In South Africa, mountain biking has become a popular tourist attraction as visitors are allowed to ride along trails through game reserves, which offers an interactive experience with wildlife (Cooper 2018). Internationally, tourists flock to Bali not just to surf or shop, but also to go on mountain bike tours through the jungle and, for more experienced riders, to enjoy a quick descent down a volcano (Matthews 2016). Its popularity has also risen substantially in the last 15 years in Australia (Newsome et al. 2016). The International Mountain Biking Association (IMBA) strives to give mountain bikers of all skill levels opportunities to enjoy the sport around the world (Moorman 2007). They motivate volunteers to help maintain the tracks and trails and to establish new MTB parks with suitable trails in and around national parks and recreational areas (Moorman 2007).

The majority of mountain bike races cater for the entire family; thus mountain biking has ballooned as a sport in South Africa. This country is now regarded as a hot spot for mountain biking because the number of races held annually exceed 750 (Preez 2016). There are an estimated one million cyclists in South Africa of which 200 000 to 300 000 participate in races. Of these, about 60% are mountain bikers (Preez 2016). Its rising success in this country has been cemented by multiple popular events such as the ABSA Cape Epic in Cape Town that has eight stages over eight days, the Sani2c that is currently considered to be the biggest race in MTB globally, and the UCI Mountain Bike World Cup that was hosted in Pietermaritzburg from 2009 to 2015 (Preez, 2016). An international supplier once stated that South Africa was the highest spending country in terms of mountain bike equipment (Preez 2016).

Although mountain biking has enjoyed rising popularity since its inception in the 1970s, this increased popularity has seen an increase in injuries associated with this sport (Stoop et al. 2019). The most common injuries are categorised as overuse injuries, but acute injuries are the main reason why riders have to stop training as they need to heal (Stoop et al. 2019). Overuse injuries that are mountain bike-related are generally caused by physiological trauma (Thompson and Rivara 2001: 2007). Traumatic injuries usually occur as a result of crashing and falling that are commonly caused by mechanical defects, slipping on loose terrain, and losing control (Bingley et al. 2019: 578). Such incidences result in concussion, fractures, and torn ligaments or tendons. Overuse injuries are also common in the spine, knee, and upper extremity of the body resulting in low back and neck pain, strains, inflammation, nerve compressions, skin chafing, and tendonitis, all of which are affected by the fit of the rider’s bike and the interaction between the cyclist’s body and the bike (Thompson and Rivara 2001: 2007).

One common overuse-associated non-traumatic injury among cyclists is low back pain (LBP). Streisfeld et al. (2017) reported a frequency of 58% of this injury which they associated with the lumbar spine being in an overly flexed position resulting in a shift in the loadbearing zone of the spine (Streisfeld et al. 2017). The manner in which the bike is set up alters the way the spine is positioned; for example, if the handlebars are too low it increases the amount of flexion in the spine, resulting in LBP (Streisfeld et al. 2017). Studies have shown that dysfunctional spinal kinematics, as well as increased spinal stresses, result in a higher probability of developing LBP while cycling (Streisfeld et al. 2017).

Incorrect biomechanics and bike setup will exacerbate injuries and diminish performance, therefore it is necessary to ensure that the cyclist has the correct bike setup for optimal performance and to avoid overuse injuries (Wisbey-Roth 2010). The correct bike size is also very important, as one that is too large will be uncomfortable and one that is too small will cause biomechanical faults. A very heavy bike is also not recommended as this will cause more injuries if it falls on top of the cyclist during a fall (Quinn 2019). Pedalling technique is a vital contributor to the performance of a cyclist. Therefore, when the bike setup has been altered optimally, it will improve the pedalling technique and result in improved performance and fewer or diminished overuse injuries (Wisbey-Roth 2010).

The literature indicates that there is a correlation between injury profiles, the type of terrain, bike setup, and knowledge of the correct setup as all of these play a role in the impact that mountain biking has on the injuries that mountain bikers sustain. In South Africa there has been a paucity of research on the injury profile of mountain bikers, which makes this study relevant as it will attempt to fill this gap and add to the existing literature. There is not only a paucity of research on the injury profile of mountain bikers in South Africa, but Ansari, Nourian and Khodaee (2017) argue that there is a lack of proper evidence concerning the typical overuse injuries caused by mountain biking and their treatment, preventative measures, as well as associated sport-specific pathogenesis.

2.4 NATURAL MECHANICS OF CYCLING

2.4.1 Bike Setup

Each bike encompasses a variety of diverse parts from various manufacturers, but the way in which the frame is designed and built essentially determines how the bike will perform (Downs 2010: 47, 48). The frame itself does not need a lot of maintenance, but this being said, a damaged frame can only be properly repaired by a trained professional (Downs 2010: 48). Among the many parts of the bike, the frame is paramount as its dimensions are responsible for how the bike fits the rider as well as how it handles when cycling (Downs 2010: 48). These dimensions place the body in its optimal position for effective pedalling by dictating the positioning of the handlebars, the crank set, and seat (Downs 2010: 48). The relationship between these dimensions also controls the stability of the bike (especially when going downhill), the way it is able to go around sharp turns, and its capacity to bear a load (Downs 2010: 48).

It is impossible to combine all these different elements in order to create the perfect bike, which is why certain elements are traded with others to determine what type of bike an individual wants or needs, e.g., a racing bike, a mountain bike, a touring bike, or just a convenient long-distance bike (Downs 2010). Although the perfect bike does not exist, it can be customized to one's needs, for example replacing the wheels with lighter and thinner wheels will make it easier to climb up steep hills and speed up faster (Downs 2010). The typical frame consists of two triangles. The front triangle comprises the head tube, top tube, seat tube, and down tube, while the rear triangle comprises the chain stays and seat stays (Downs 2010: 49). The substance used to construct the frame determines how it feels and how heavy or light it is, but ultimately the dimensions of the tubes and their length determine how the bike will behave (Downs 2010: 50).

Although there has been some stiff competition regarding the design of the frame in the history of bikes, the diamond shape design has been the design of choice for the last 100 years and still remains the most popular choice today because of how it blends rigidity, strength, and light weight (Downs 2010: 50). Rigidity in a bike frame is essential, as a frame that is too pliable can break easily and will squander pedalling energy. In the past, frames were made of heavy and cost-effective tubing, but in recent years the demand for a high-quality lightweight bike has increased and manufacturers have evolved their technology in order to manufacture lighter and high-quality frames at a cheaper price (Downs 2010: 50). Bike frames can be made from various materials with steel, titanium, and aluminium being the most commonly used. However, carbon fibre is the most popular material among them all and is used not only for the frame, but for the components as well (Sani et al. 2016: 2). Aluminium is also a frame material of choice due to its strength, light weight, and low price (Downs 2010: 54). It provides stiffness where it is needed and ensures an enjoyable ride (Downs 2010: 54). It is an outstanding material to use in the manufacturing of mountain bike frames because of its ability to take some damage without breaking, the fact that it does not rust, and its light weight (Downs 2010: 54).

To reiterate, although aluminium is the most commonly used material in the manufacturing of mountain bikes, carbon fibre is the material of choice for optimal performance (Downs 2010: 55). Combinations of different types of carbon fibre and resins create the stiffest and lightest frame available, allowing it to absorb and disperse vibrations better (Downs 2010: 55). Carbon fibre was previously seen as too fragile for mountain bikes and was thus mostly used for cross-country bikes. However, it has been incorporated effectively into full suspension mountain bikes, and this has allowed these bikes to be ridden on the roughest of terrains (Downs 2010: 55). Although carbon fibre has many advantages, the downside is that it is expensive and difficult to engineer. A hard fall can cause a crack in the frame or it can even break (Downs 2010: 55). That being said, the pros outweigh the cons as the number of cyclists riding bikes with a carbon fibre frame outnumber those who use other types of material for the frame (Downs 2010: 55).

Although the basic geometry of bike frames is relatively similar, their parts may have small differences depending on what type of cycling an individual needs the bike for. These parts are mainly the seat angle, the head angle, the fork rake, the chain stay length, and the bottom bracket drop (Downs 2010: 57). The pedal stroke can be altered depending on what the rider's leg position is relevant to the crank set, which is determined by the seat angle (Downs 2010: 57). Sharper angles are usually for high tempo pedalling whereas acute shallower angles are used for pedalling in large gears at a slower tempo (Downs 2010: 57). Typically, bikes that are more performance based like road racing bikes and cross-country mountain bikes have sharper angles than those used as tourist bikes, downhill mountain bikes, and bikes made for comfort during long rides (Downs 2010: 57). Typically, the head angle is sharper if one wants to ride at high speed, on twisting single tracks, downhill, or in the mountains. This is because the head angle determines how the bike handles (Downs 2010: 57). If the cyclist wants to do sightseeing and spend hours on the bike, or if the rider wants to enjoy some downhill mountain biking, then a shallower angle will be the best option (Downs 2010: 57).

It is very important to get the right fit for each biker—from the frame size all the way to the components—as this will determine whether one can ride for long periods without getting uncomfortable (Lindsey 2021). Different types of frames for different types of bikes change the pedal stroke rhythm and thus the performance of the bike due to the differences in the setup, shape, and features of the bike (Devys, Bertin and Rao 2018: e281). If athletes prepare for a race by training on a specific bike with a specific setup, they will have a negative race outcome if they were to change to a different type of bike with a different setup (Devys, Bertin and Rao 2018: e281).

The correct setup will help prevent overuse injuries that are caused by poor positioning due to incorrect setup, but not every rider will have the same setup for the following reasons: age differences, rider flexibility, and what type of riding they are used to (Lindsey 2021). Doing the setup at home can get the rider started, but it is recommended that a professional is approached to do it and that the cyclist test-rides the bike after it has been done to make sure that it feels correct and comfortable (Lindsey 2021).

Depending on whether the rider uses flat pedals or clip-in pedals, it is essential to have the correct cleat placing (Brenan 2020: 1). Having incorrect cleat placing that results in malalignment can cause a domino effect of injuries all the way up the body from the ankle to the lower back (Brenan 2020: 1). This is because the cyclist's feet are the most fixed parts of the entire body when cycling with cleats (Brenan 2020: 1). The cleat placement on the shoe should be in the centre of the ball of the foot, which is simply done by marking the position on the shoes while the rider is wearing them (Brenan 2020: 1). The centre of the cleat should be placed and secured on a line drawn on the bottom of the shoe, which is done by doing the following: make a mark on both sides of the shoe by feeling for the head of the first metatarsal (hard bony bump) on the medial side of the shoe and the head of the fifth metatarsal on the lateral side of the shoe, and then draw a straight line through the two points with a marker to form the line (Brenan 2020: 1). The rotation of the cleats is also important, because either over or under rotation can result in knee pain (Brenan 2020: 1).

Figure 2.1 Image of the components of a Soft-tail Mountain bike (Liv-cycling 2021)

The mountain bike style has evolved over the last 30 years and today there are a multitude of different types of mountain bikes: cross country, downhill, 29er, and all terrain, just to name a few (Downs 2010: 61). Even though there are so many different types of mountain bikes, they all share the same basics, which are stability, wide wheels, and a straight handlebar that are all ideal for spending time in the mountains (Downs 2010: 61). However, mountain bikes are not only designed with the sole purpose of off-road riding, but they are also used in and around suburbs as well as on tarred roads. In fact, as little as 10% of mountain bikes are bought for off-road purposes only (Downs 2010: 61). The main factor that draws people to purchasing a mountain bike is that it is so versatile. It can for instance be ridden in a more upright position with a stable base resulting in easier balancing that is very appealing to riders (Downs, 2010: 61).

The typical mountain bike can be one of three types: the rigid type which is when there are no front or rear shocks (i.e., no suspension); the hard-tail type which is when there are front shocks only; or the soft-tail type which is when there are both front and rear shocks (Downs 2010: 61). Mountain bikes are even called SUVs in the cycling world because of their versatility (Downs 2010: 61).

2.4.2 Riding Posture

It is imperative to review the ideal bike setup and riding posture to ensure that both are favourable to the rider's biomechanical shortcomings and needs, because doing this will reduce the risk of injury and enhance performance (Parish 2017). The relationship between the cyclist and the bike is paramount because the structure and profile of the frame affect how the bike is set up as well as the effects that it will have on the biomechanics and physiology of the rider (Devys, Bertin and Rao 2019: e279).

The incorrect height of the seat has been shown by various studies to cause a rider to experience knee pain (Parish 2017). When sitting on the bike, the cyclist places their heal on the pedal and lifts the seat until the knee is fully extended. When the ball of the foot is placed on the pedal, there should be a slight bend in the knee (Brenan 2020: 1). If the cyclist is experiencing knee pain over the front of the knee, then the seat is too low, resulting in an increased force in the front of the knee with each pedal stroke. If the seat is too high, the cyclist can experience pain in the back of the knee, the hamstrings, or the iliotibial band (ITB) as well as in the low back (Brenan 2020: 1). The low back pain caused by a seat that is too high is due to the constant repositioning of the cyclist on the seat. This can lead to pain in the Achilles tendon as a result of a chain reaction/domino effect (Brenan 2020: 1).

Ensuring that the knee is directly over the pedal when both pedals are aligned horizontally can be done by taking fishing line with a weight tied to the end and holding the line next to the back of the cyclist's kneecap, ensuring that the weight hangs directly over the centre of the pedal (Brenan 2020: 1). The distance from the seat to the handlebars is called the 'handlebar reach' and having this done correctly helps to prevent pain in the upper body (Lindsey 2021). In order to do this correctly, the cyclist needs to be able to easily reach the handlebar grips on the mountain bike or the brake hoods on a road bike when sitting on the seat, with a minor bend in the elbows without having to move forward or backward on the seat to accomplish this position (Lindsey

2021). If the setup is incorrect, the cyclist may experience numbness, tingling, and pain in the hands, feet, and buttocks (Lindsey 2021).

Knee pain can also be caused by incorrect seat positioning while an incorrect handlebar reach can cause upper back and neck pain (Lindsey 2021). Where the seat is positioned can affect the hip angle as well. Moving the seat forward opens the hip angle and moving the seat backward closes the hip angle (Brenan 2020: 1). Not all cyclists are built the same, but some can experience hip pain from a seat that is too far forward, and some can experience knee pain from a seat that is too far backward (Brenan 2020: 1). A key point to remember is that moving the seat forward or backward will change the seat height as well. Moving it backward makes it higher and moving it forward makes it lower, therefore always rechecking these measurements and positions is very important (Brenan 2020: 1). The setback position on a bike refers to how far back the seat is set on the seat post, and this setting is a very important determinant of the rider's performance and pedalling efficiency (Ménard Lacouture and Domalain 2020: 959). Having a setback position that is too far back results in the rider having to overreach towards the handlebars as the rider's posture is set too far back (Ménard et al. 2020: 959).

The correct width of the handlebars can prevent shoulder and wrist pain as it will relieve some of the weight going through the wrists onto the handlebars (Brenan 2020: 1). The handlebars should ideally be the width of the cyclist's shoulders. This can be determined by looking in a mirror and comparing the handlebar width with the shoulder width (Brenan 2020: 1). Never move the seat forward to correct handlebar reach, as the cyclist's knee should still remain over the centre of the pedal. If necessary, change the stem on the handlebars by getting a shorter stem (Brenan 2020: 1).

Having the correct setup means that the cyclist can achieve a comfortable position on the bike for longer than an hour without readjusting position whilst riding (Lindsey 2021). Professional cyclists who feel that they have hit a wall and are not improving can benefit from having a professional setup done; this is because their positioning on the bike can be altered in order to allow them to have more speed and power at the same fitness level (Lindsey 2021).

Figure 2.2 Image of the components of a Road bike (Liv-cycling 2021)

The road-racing bike is modelled for stability at high speeds, manoeuvring corners, and minimizing energy loss as much as possible (Downs 2010: 59). These aspects make it difficult for this bike to be stable at low speeds and it is harder to control when a load is added while riding (Downs 2010: 59). It also demands increasing attention in order to keep the bike gong in a straight line and any knocks on the road are relayed directly to the body as the bike does not have any shocks (Downs 2010: 59).

2.4.3 Biomechanics Of Normal Cycling And Mountain Biking

The relationship between the cyclist and the bike is multifarious as the riding posture is affected by a multitude of aspects such as body proportions, power, flexibility, and the length of the muscles in the lower limbs (Wisbey-Roth 2010: e4). The position in which the cyclist rides affect power output as well as aerodynamics and the effective use of energy (Wisbey-Roth 2010: e4). Being able to achieve the best bike setup is important in ensuring that the cyclist can exert optimal energy and skill when riding, while minimizing injury. This is important for both professional cyclists and fun riders (Wisbey-Roth 2010: e4).

The manner in which the cyclist pedals alter the power output that can be produced and determines whether or not all the muscles are recruited with each pedal stroke

(Wisbey-Roth 2010: e4). When riding, the force that the cyclist exerts on the pedal is what creates the power and having the optimal pedalling technique can improve the force of power that a cyclist exerts (Wisbey-Roth 2010: e4). By merging the perfect bike setup and an optimal pedalling technique, full muscle recruitment will occur which will increase the power output and decrease strain in the knees (Wisbey-Roth 2010: e4).

Sitting on the bike and bending forward to reach the handlebars results in lumbar spine flexion, which is the predominant but not the only position in cycling (Streisfeld et al. 2017: 75). The various positions a cyclist employs allow the body to be aerodynamic while they also decrease wind drag as much as possible to improve momentum and efficiency (Streisfeld et al. 2017: 75). The flexion of the lumbar spine causes the intervertebral angle to be reversed, which changes how the spine is loaded. If this position is sustained for a prolonged period, it is associated with low back pain in cyclists (Streisfeld et al. 2017: 75). Attaining a strong core and the correct bike component setup are thus imperative to improve the cyclist's power output, because the positioning of the components affects the positioning of the spine which has a knock-on effect on the efficiency of the cyclist (Streisfeld et al. 2017: 75, 76). Altered core muscle and spinal muscle activation, especially in the low back, and suboptimal component setup result in overuse injuries of which low back pain is the most common (Streisfeld et al. 2017: 75).

When a cyclist wears cleats, the shoe clips into the pedal and the foot is kept in that position for the duration of the ride (McCulloch 2018: 62). When the shoe is clipped in, the cleat allows the cyclist to still rotate the foot slightly in either abduction or adduction, but it is very limited, and the pedal stroke remains in the sagittal plane with no lateral deviation (McCulloch 2018: 62). The constant flexion and extension of the hip and knee in this sagittal plane often result in overdeveloped flexors or even extensors in professional riders, resulting in debilitated stabilizer muscles (McCulloch 2018: 62). This results in a condition that is frequently seen in cyclists called iliotibial band syndrome (ITBS), which is caused by the continual friction of the ITB on the lateral femoral condyle at each pedal stroke. The condition is also regularly linked to weak hip abductors (McCulloch 2018: 62).

The forward flexed position during cycling can also result in certain musculoskeletal (MSK) disorders and compression neuropathies that are caused by poor bike fit, which is why having the correct bike fit will minimize the risk of these conditions appearing (Balasubramanian, Jagannath and Adalarasu 2014: 339). Being in this prolonged flexed position causes strain and pain in the shoulders, neck, and low back (Balasubramanian, Jagannath and Adalarasu 2014: 339). The skill to have control over a bike is directly related to the ability of the cyclist to balance the upper body and how strong the core is. This is because the less energy that is used to balance the upper body, the more energy can be used to propel the bike (Balasubramanian, Jagannath and Adalarasu 2014: 339).

The power that is produced by a cyclist during the pedal stroke is facilitated by the contraction of the muscles in the lower limb that reach across the ankle, knee, and hip, as well as the muscles of the upper body. This delivers power to the hip which is then translated into a force that is exerted onto the pedal (Martin and Brown 2009: 474). Exhaustion can result in strain in the joints along the chain in the lower limb, e.g., the ankle, knee, and hip joints, and is caused by resistance of the muscles that span up the leg. This condition can be due to peripheral or central mechanisms (Martin and Brown 2009: 474). By decreasing the amount of ankle movement in a pedal stroke, the amount of effort and strain that goes through the knee and the hip is decreased, which in turn simplifies the pedal stroke to essentially improve knee and hip flexion and extension (Martin and Brown 2009: 475).

Simultaneous activation of the quadriceps muscle, the hamstrings, and the gluteus maximus muscles is crucial for the muscle forces to be carried across the hip and knee joints in order to enhance the direction of the pedal stroke force (O’Bryan et al. 2014: 12). During the pedal stroke, simultaneous activation between the ankle plantar flexors and the gluteus maximus muscle, together with the vastus recti muscle, is a main component for improving the power shift from the ankle joint to the crank in cycling (O’Bryan et al. 2014: 12). It is important for cyclists to have a strong upper body because it provides strength to the lower back, which is one of the main posture divisions in a cyclist. The performance of a cyclist can thus be directly linked to the amount of muscle fatigue that is experienced during the ride (Balasubramanian, Jagannath and Adalarasu 2014: 339).

2.5 RISK FACTORS RELATED TO INJURIES IN MOUNTAIN BIKING

Even though cycling is associated with overuse injuries, there is limited literature on the risk factors that cause injuries and the preventative measures that can be taken to curb such injuries in mountain bikers (Quesada et al. 2019: 1). Cycling has many health benefits, but it also has risk factors that will result in injury (Kotler, Babu and Robidoux 2016: 199). Overuse and degenerative injuries that are non-traumatic tend to be common among fun riders, but it does not exclude them from sustaining traumatic injuries, especially if they are cycling at high speed, ride in large groups, and navigate tricky terrain (Kotler, Babu and Robidoux 2016: 199). Most traumatic injuries occur in the soft tissue and skin or as fractures and concussion (Kotler, Babu and Robidoux 2016: 199). The areas that usually present with overuse injuries are the Achilles tendons, knees, buttocks, lumbar spine, forearms, wrists, and cervical spine (Kotler Babu and Robidoux 2016: 199).

Both extrinsic and intrinsic risk factors cause mountain bikers to suffer injuries (Johnston 2017: 1024). Extrinsic risk factors exist outside the cyclist such as bike components, equipment, riding method, and training (Johnston 2017: 1024), while intrinsic risk factors are natural to the cyclist such as fitness level and anatomical alignment of the lower limbs (Johnston 2017: 1024). Certain risk factors are predictors for a rise in the risk of crashing in mountain biking, namely a previous history of injuries, cycling after dark, riding errors, trail conditions, obstacles, fatigue, and bad weather (Ansari, Nourian and Khodaee 2017: 404). Risk factors also include, but are not limited to, gender, age, cycling profile and posture, bike components, combining more than one discipline, and terrain (Quesada et al. 2019: 2). Any type of cycling commonly causes the formation of muscle imbalances in a cyclist's body which increases the likelihood of the cyclist sustaining an injury somewhere on the kinetic chain (Kotler, Babu and Robidoux 2016). The abductors of the hip have been known to be weak in cyclists and have been associated with injury (Kotler, Babu and Robidoux 2016: 199). The hip abductors affect biomechanics in the lower limb as they stabilise the pelvis and prevent over rotation in the knees. Weakness in these muscles results in low back and hip pain which makes it difficult to pedal and increases the movement in the frontal plane which, in turn, reduces power and puts the cyclist at risk of injury (Kotler, Babu and Robidoux 2016: 199). The gluteus medius has also been shown to be involved in a few adverse conditions in cyclists as a result of an unusual activation pattern. These conditions are mainly lateral ankle sprains, patellofemoral pain, iliotibial band friction syndrome, and anterior cruciate ligament injury (Kotler, Babu and Robidoux 2016: 201).

Bike fit and the positioning of its components affect the cyclist's riding posture, which will result in overuse injuries when there is poor bike fit (Kotler, Babu and Robidoux 2016: 200). The way that a cyclist rides the bike may also promote the risk of sustaining an injury, for example riding at very high speeds, doing tricks, and riding in the dark early in the morning or late at night (Corden et al. 2005: 35). During the winter months, riders prefer to train indoors on a trainer, and this carries the risk of injury when returning to outdoor riding because of the difference in physiology between indoor cycling and outdoor cycling, particularly as outdoor cycling requires a much higher power output (Kotler, Babu and Robidoux 2016: 200).

2.6 INTRINSIC RISK FACTORS

2.6.1 Age

Age has been shown to be a very important contributing factor of injuries related to risk taking behaviour, such as in mountain biking (Useche et al. 2019: 106). According to Fergus et al. (2019: 550), cycling-related injuries seem to increase in adults, and especially in older adults. In the study done by Fergus et al. (2019: 552), there was a rise in the number of injuries occurring in cyclists over the age of 45 years. Hospitalisation and visiting the emergency department also increased in this age group. This being said, the rate at which individuals younger than 45 years were injured and hospitalised was higher than that of cyclists over 45 years of age (Fergus et al. 2019: 552). When comparing the data from a mass study to a per cyclist basis, it was concluded that the rate of injury was fastest in young cyclists and that this was due to the risks they took and the dangers of cycling that they disregarded (Fergus et al. 2019:

555). However, a study that was conducted in Canada also revealed that an older age could also be associated with injuries in cyclists (Gopinath et al. 2016: 2).

The information from two studies that were done in Queensland, Australia and in New Zeeland respectively coincides with the results from the studies previously mentioned, namely that the number of injuries is highest among young to middle-aged cyclists and that the injury rate is highest among children, followed by adolescents (Heesch, Garrard and Sahlqvist 2011: 2086). In the United Kingdom, the risk of being injured or sustaining an injury that results in death is highest for cyclists between the ages of 10 to 15 years. Risks are slightly decreased for the middle-aged category but increase again after the age of 70 years (Heesch et al. 2011: 2086). The latter study found that the number of injuries was highest among children, but that the number of serious injuries was highest among adults (Heesch et al. 2011: 2086). In terms of serious injury, Heesch et al. (2011: 2089) state that cyclists between the ages of 18 to 24 years are not as likely to note such injuries compared to cyclists aged 45 to 54 years.

Younger cyclists in the age bracket 25 to 30 years have been shown to be involved in high risk-taking behaviour and are thus much more likely to be involved in a crash than older cyclists (Useche et al. 2019: 106). Cyclists younger than 25 years tend to have a higher rate of crashes and falls due to the following factors: inexperience, a bad safety attitude, and a lower perception of risk (Useche et al. 2019: 106).

2.6.2 Gender

Gender distinctively distinguishes between behaviours and safety outcomes in cycling but this variable is not limited to cycling only (Corden et al. 2005: 35). Despite the fact that gender differences generally occur under specific circumstances in countries such as Europe where cycling is particularly popular, multiple studies have shown that there are generally more male than female cyclists (Prati et al. 2019: 1). There are three main reasons for gender differences in cycling. First, men seem to have a more positive outlook and attitude towards cycling than women; secondly, women have a different attitude towards the environment and this accounts for a higher awareness of risk in cycling; and thirdly, culturally relevant aspects like a cycling culture and gender discrepancies play a role (Prati et al. 2019: 1). Fractures and back injuries seem to occur more often in women, and this is possibly due to the fact that they are lighter and tend to be less experienced in comparison to men (Fiore, Fellows and Henner 2020: 188). Men have a higher risk of being injured due to their impulsive nature and risk-taking behaviour and therefore they are three times more prone to sustain an injury while cycling compared to women (Corden et al. 2005: 35). Useche et al. (2018:87) state that men presume they are safer riders than women but the former study noted that they were more distracted and engaged in more risky behaviour than women (Corden et al. 2005: 35). Due to the fact that cycling is still a highly gendered sport in countries in Europe as well as North and Latin America, the differences between cycling patterns, habits, intensity, and bike-using motivations vary significantly (Corden et al. 2005: 35). It has been shown that women prefer to choose pathways that have been clearly marked with signs and existing courses, while men tend to prefer the fastest available route rather than marked tracks (Corden et al. 2005: 35). Women are also less likely to be involved in accidents and falls because they tend to sense possible dangerous situations and avoid them, whereas men are more likely to take risks (Corden et al. 2005: 35).

Attitude towards cycling indirectly affects behaviour during cycling and, according to Prati et al. (2019: 2), women who are affiliated with an association are more inclined to have a positive attitude towards cycling. However, it could not be established if the positive attitude of women was because of their cycling behaviour or their affiliation with the association (Prati et al. 2019: 2). Women also tend to be underrepresented in the cycling world and many races cater only for men. This results in the perception that men are more likely to ride bikes more often than women (Prati et al. 2019: 2). Men have also been found to have a greater probability of sustaining more severe injuries than women, which is probably due to differing skills, risk perceptions, and riding behaviours (Prati et al. 2019: 1).

2.6.3 ETHNICITY

According to Bordelon and Ferreira (2019), participation in lifestyle sports like mountain biking has experienced an extraordinary spike in interest due to the advertising impact of the Entertainment and Sports Programming Network's *X-Games* and various extreme sports films and TV programmes that are specifically directed at young, white, middle-class males. Such sports have grown since such programmes were first introduced and have become more integrated into the mainstream sport culture due to a combination of conventional competitive sports and lifestyle sports. This opened the door for a much wider demographic representation of participants in sports like mountain biking (Bordelon and Ferreira 2019). The majority of mountain bikers tend to be from the white ethnic group. This may be attributed to the fact that 55.5% of the population lives beneath the poverty line and mountain biking is an expensive sport or hobby to maintain (Bordelon and Ferreira 2019). The latter authors also point out that in large and very popular mountain bike races, like the ABSA Cape Epic, very affluent business people form the core demographics of the race. For instance, in the 2017 Cape Epic race 90% of the cyclists were white men with 69% of these holding a high-level position in their companies (Bordelon and Ferreira, 2019). The predominant presence of the white ethnic group in mountain biking may also be attributed to the fact that South Africa has a history of segregation that precluded previously disadvantaged individuals from participating in an expensive sport at competitive and even recreational level (Bordelon and Ferreira 2019).

2.6.4 HISTORY OF INJURIES ASSOCIATED WITH MOUNTAIN BIKING

When athletes sustain an injury, they cannot take part in their sport for some time and they cannot participate for their team whether they are professional or amateur athletes (Peterson and Renstrom 2017: 1). In England, football (soccer) has always, at any point in time, seen 10% of the players suffering from injuries, which means that these payers are injured so often that they must have a history of past injuries. The time that an athlete requires to recover and rehabilitate the body after an injury is very important, as going back too soon and not rehabilitating adequately will result in a recurring injury (Peterson and Renstrom 2017: 3). Having had a previous illness can also lead to injury internally as the body can be over exerted when the athlete does not take care, for instance in the case of an asthma or heart disease sufferer (Peterson and Renstrom 2017: 10). Having a history of concussion is also associated with an increased likelihood of developing Alzheimer's disease and sustaining brain trauma with repetitive head injuries (Peterson and Renstrom 2017: 10).

Lareau and McGinnis (2011) state that it is difficult to establish the injury rate of individual mountain bikers because cyclists have nowhere to report an injury that is monitored statistically. It is thus noteworthy that 85.7% of the participants in the latter study stated that they had sustained at least one injury in the 12 months prior to the study. An article by Loria (2018) focused on a very promising individual who participated in road cycling in Canada but who struggled with multiple prior injuries that affected his gluteus medius muscle, iliotibial band, right hamstring muscle, and both his knees. The results of the study showed that the problem was not traumatic injuries, but the riding position, training schedule, and bike fit which all exacerbated the impact of these injuries (Loria 2018: 18). Thus, with proper intervention and physical therapy, recurring injuries can be avoided. Similarly, Kronisch and Pfeiffer (2002) argue that, in general, the majority of mountain bikers who participated in surveys reported that they had a history of injuries, but later studies that were conducted during various mountain bike races revealed that recurring injury rates were less than 1%.

2.7 EXTRINSIC RISK FACTORS

2.7.1 Cycling Experience

There are many factors regarding the experiences of cyclists that predispose them to injuries, such as riding wearing heavy gear the whole distance and not changing to lighter gear as heavy gear can cause knee pain (Kotler, Babu and Robidoux 2016: 202). Other factors include not knowing how training programs work, training for excessively long periods at a time, and not changing their position frequently enough while riding (e.g., only sitting and not standing, pedalling in a plantarflexed or dorsiflexed foot position, and many more) (Kotler, Babu and Robidoux 2016: 202). Some cyclists also choose to ride trails that are above their technical skill level and this leads to injuries (Fiore, Fellows and Henner 2020: 189).

Many training errors are also related to either cycling inexperience or ignorance which can result in injuries, such as a poorly fitted bike and helmet, hyperextended elbows instead of slightly flexed elbows, not changing hand positions for long periods of time, using gears incorrectly, riding for extended periods of time on trails that are too difficult, not warming up properly, and poor technique (Anon 2021a). Some riders do not know when they have reached their limit and then experience severe fatigue to the point that it starts causing injuries (Lebec, Cook and Baumgartel 2014: 7). Cyclists with more experience and a better riding ability often tend to take risks more readily and this can lead to sustaining injuries (Romanow et al. 2012: 12). Underestimating the trail and the terrain, going too fast, not paying attention to the surroundings, and braking incorrectly are all rider errors that result in injuries (Kronisch and Pfeiffer 2002: 529).

2.7.2 Terrain

The surface of the terrain that the mountain bikers ride on plays an important role in the ability of the cyclist to balance the bike (Kronisch and Pfeiffer 2002: 528). Injuries are usually sustained when the front wheel hits an irregular obstacle, when the cyclist tries to suddenly avoid an unexpected obstacle on the track, or when the surface is very loose and unstable. The wheels then slide away easily, resulting in a fall (Kronisch and Pfeiffer 2002: 528). Not being familiar with the type of terrain that a cyclist trains on or encounters during a race has also been identified as a causative factor of injuries (Kronisch and Pfeiffer 2002: 528).

There is a wide range of terrains and tracks in mountain biking such as downhill MTB, cross country MTB, four cross, free ride (which is a normal track for all skill levels), single speed, short-track cross country, and a few more. Each category has its own distance criterion (Hagen and Boyes 2016). Rough terrain has higher impact pressure on the spine due to the constant bombardment on the body due to uneven surfaces, whereas smooth or relatively smooth terrains have little to no impact on the spine, resulting in fewer injuries and less pain (Hagen and Boyes 2016). It therefor follows that the more challenging the terrain, the higher the risk of injury due to constant impacts on the body as well as a higher risk of crashing and fatigue of the muscles resulting in poor biomechanics (Hagen and Boyes 2016). It is also logical that the longer the distance of the ride the higher the probability of injury due to muscle fatigue and resultant poor biomechanics (Hagen and Boyes 2016).

Mountain bike events are held in a variety of different topographical areas with some characterised by severe weather changes (Ansari, Nourian and Khodaee 2017: 407). Altitude illness and hypothermia can occur when cyclists swiftly ascend mountains or when events are held in extremely cold temperatures, whereas conditions like heat stroke can occur by cycling for an extended period in direct sunlight or extremely hot temperatures (Ansari, Nourian and Khodaee 2017: 408). Mountain biking generally involves riding or racing over a rough terrain that contains multiple large rocks, tree roots and stumps, tree overhangs, and sudden drops (Lebec, Cook and Baumgartel 2014:2). These types of terrains exert extra strain on the cyclist's body and allows extraordinary vibrational forces to travel through the body that are then absorbed by the cyclist or the bike, resulting in repetitive microtrauma causing tissue stress and eventually injury to the cyclist's body in the form of overuse injuries (Lebec, Cook and Baumgartel 2014:2).

2.7.3 Gear and Footwear

Having the correct equipment is essential for a safe, comfortable, and enjoyable ride (Quinn 2019). Getting the bike properly fitted and set up is crucial, as it will curb the occurrence of overuse injuries and minimise crashes and falls (Fiore, Fellows and Henner 2020: 189). The most important equipment is the bike, a helmet, sunglasses, a water bottle or camelback, the correct type of pedals for the cyclist's level of expertise or lack thereof as well as the type of terrain, cycling gloves, and the proper cycling kit such as padded shorts and a cycling shirt with a zip and back pockets (Quinn 2019). A helmet ensures that the cyclist's head is protected when a fall occurs and this helps to minimise a possible concussion. If the helmet is too small it can cause headaches and if it is too big, it will not be of any use (Quinn 2019). Head trauma and injuries make up 62% of cycling-related deaths (Corden et al. 2005: 35). Wearing a helmet that fits properly and gives the cyclist adequate protection has been shown to be effective in reducing the chance of sustaining a head injury by 69% to 88% (Corden et al. 2005: 35). Sunglasses not only protect the eyes from the glaring sun, but also from dust when it is very dry or mud and rain after or during bad weather (Quinn 2019).

A water bottle is preferred above a camelback as it does not add extra weight to the spine, but both are recommended because the rider has access to clean water that helps keep the body hydrated (Quinn 2019). The pedals can have cleats that allow the shoes to clip into them which prevents foot movement. This is preferred by more advanced cyclists. Or normal flat shoe pedals can be used as preferred by intermediate riders as it is easier to put the foot down in the case of an imminent fall (Quinn 2019). Not riding with the correct shoes or pedals will result in poor foot positioning which will, in turn, spark a considerable number of injuries (Ansari, Nourian and Khodaee 2017: 408). Gloves and the cycling kit provide comfort and protection if a fall occurs. The kit also provides storage space in the shirt for snacks and food items in the event of a long ride (Quinn 2019). Wearing gloves with poor padding increases the tension and loading on the hands which may result in paresthesia in the hands (Ansari, Nourian and Khodaee 2017: 408).

2.7.4 Training Schedule

It has been shown that cyclists who engage in other disciplines like running and swimming in conjunction with cycling have poor cycling technique that carries a high risk of being injured (Quesada et al. 2019: 10). Moreover, overburdening the cyclist with excessive training leads to overuse injuries as the capacity of the cyclist may be exceeded (Visentini and Clarsen 2021: 487). Young mountain bikers are highly susceptible to injuries due to an intense training schedule as they experience growth spurts and are vulnerable to growth plate injuries (Caine, Young and Provance 2018: 72). Moreover, the rate at which mountain bikers sustain injuries is higher during races or competitions than when they are training, which is due to psychosocial factors together with altered risk-behaviour (Caine, Young and Provance 2018: 78).

The length of most mountain bike races is usually between 60km and 120km (Buchholtz, Lambert and Bergess 2020: 3). Mountain bike race competitions have also become more taxing and strenuous which, in turn, has made training more demanding. This often leads to an increased risk of injuries due to heightened competitiveness in cycling (Buchholtz, Lambert and Bergess 2020: 3).

2.8 THE ROLE OF THE HEALTH CARE PROVIDER

The health care system has started to take cycling injuries seriously, particularly as this sport is promising for advancing fitness levels in children, adults, and the elderly (Götschi, Garrard and Giles-Corti 2015: 46). Cycling is beneficial for health as it improves physical activity, but it is also associated with risks such as falls, accidents, and crashes (Götschi, Garrard and Giles-Corti 2015: 46).

According to Visentini (2017: e69), health care practitioners encounter multiple cycling injuries that are traumatic or caused by overuse. Traumatic injuries are relatively simple to diagnose and are subjected to a comprehensive treatment protocol, but overuse injuries are not that easy to identify or treat (Visentini 2017: e69). Formulating a set of questions and reviewing the information gathered regarding the type of injury, how it occurred, where the injury is located, how this type of injury occurred, treatment, and avoidance of future injury are key in helping health care practitioners understand cycling injuries better and, in the treatment, and management of cycling injuries (Visentini 2017: e69).

The assessment and management of cycling-related injuries involve a variety of health care practitioners such as physicians, chiropractors, physical therapists, and clinicians (Kotler, Babu and Robidoux 2016: 205). According to McDowell (2017: e69), not a great deal is known about the injury rates of cyclists and the management thereof. Being able to define an injury and its management protocol is key in enabling appropriate treatment of a cyclist’s injury, the rating of the level of pain, and the discomfort experienced on and off the bike (Visentini 2017: e69).

Kotlyar (2016: 216) states that a copious body of injury profiles have been done on road cyclists, but that there is a paucity of injury profiles on mountain bikers. As the same information for road cycling studies cannot be applied to mountain bikers due to the vast differences in the terrain and the mechanism of injury, this gap needs to be filled. Comprehending the injury profiles and patterns associated with mountain bikers will yield improvements in preventative tactics to ensure safer participation in this sport (Kotlyar 2016: 216).

2.9 CONCLUSION

The literature review that was conducted concerning the topic under investigation was described comprehensively in this chapter. The literature indicated that bike setup differs for road and mountain bikes while the prevalence of injuries is much higher in mountain biking than in road biking enthusiasts. Extrinsic and intrinsic risk factors were deliberated to establish the most distinctive factors associated with incurring injuries while mountain biking. The next chapter will present all the relevant information regarding the methodology that was used in this study.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

This chapter presents the research methods and the research tool that was utilised in this study. The discourse will cover the study design, study population, sampling procedure and sample size, measurement tools, research procedure, and data analysis method.

3.2 STUDY DESIGN

This study used a quantitative cross-sectional survey design. This design is used to incite the rate of occurrence of risk factors or other variables like behaviour, attitude, or events at a specific point in time (Hoe and Hoare 2013: 56). The cross-sectional survey design was chosen as it facilitates an investigation into the cause-and-effect relationship between or among variables (Hoe and Hoare 2013: 56). According to Watson (2015: 44), quantitative research uses statistical data collected from surveys to analyse the information and come up with relevant results.

3.2.1 Study Population

All mountain bike cyclists participating in MTB in the eThekwini Municipality were able to participate in the study provided that they met the inclusion criteria.

3.2.2 Participant Recruitment

Participants were recruited by approaching them directly at events or at mountain bike parks and coffee shops where mountain bikers often pass the time. Word of mouth was also used to recruit participants. Letters to request permission (Appendix A) to place an advertisement at locations where data collection could potentially occur were issued to various owners of businesses, but no responses were received back and the advertisement method was thus not successful in the recruitment process.

3.2.3 Permission and Location

Permission from multiple parties had to be obtained before this study could commence. In order to begin data collection, approval from the Institutional Research Ethics Committee (IREC) was obtained (IREC clearance number 069/21 - Appendix B) . Permission (Appendix C) was obtained for data collection on the premises of two mountain bike parks and two coffee shops in Umdloti, which are known to be local 'pit stops' for mountain bikers. The two mountain bike parks were Holla Trails (Appendix D) and Giba Gorge (Appendix E) and the two coffee shops were Foam (Appendix F) and Selections (Appendix G). After permission had been obtained from all the relevant parties, data collection commenced.

3.2.4 Sample Selection and Size

The sample size required for this study was 174 mountain bikers. This sample size was calculated using PASS version 12 (2013). The final figure was based on the precision of the estimate of prevalence using a finite population size of 500. Based on a 95% confidence interval with a precision (half-width) of 0.0600, a minimum of 174 participants were required (Esterhuizen, 2020).

3.2.5 Inclusion Criteria

- Participants who engaged in this sport at least once a week in the eThekwini Municipality area.
- Participants over the age of 18 years.

3.2.6 Exclusion Criteria

- Participants who have not given consent and read the information letter
- Participants who do not complete any questions past the demographics.

3.3 MEASUREMENT TOOLS

To devise the questionnaire that was used for data collection, those of four earlier studies were adapted with the permission of the authors. These earlier questionnaires were thus used to formulate the pre-focus group questionnaire (Appendix H). Questions regarding demographics, musculoskeletal injury, and injury consequence were adapted from Millar (2019) and Lareau and McGuinnis (2011). The works of Downs (2010) and Lareau and McGuinnis (2011) were also adapted to formulate questions regarding the training and competition history of the respondents, their cycling gear, and mountain bike setup. The work of Quesada et al. (2018) was also adapted to help formulate the questions on injury consequence and mountain bike setup. The layout of the pre-focus group questionnaire (Appendix H) was determined by taking the work and layout of the previously mentioned authors into consideration (**Table 3.1**).

Table 3.1 Questionnaire Reference List

Questionnaire Sections	Sources
Section A: Demographics (gender, age, occupation, ethnicity)	Millar (2019: 77)
Section B: Musculoskeletal injury (where the injury occurred and how it happened)	Millar (2019: 78)
Section B: Injury consequence (current/past injury impact)	Millar (2019: 78-79), Lareau and McGuinnis (2011: 227), and Quesada et al. (2018: 843)
Section C: Training and competition history	Lareau and McGuinnis (2011: 227), Downs (2010: 64)
Section D: Cycling gear (gloves, helmet, gel seat cover, shoes, clothes, camelback)	Lareau and McGuinnis (2011: 227), Downs (2010: 64)
Section E: Mountain bike setup	Lareau and McGuinnis (2011: 227), Quesada et al. (2018: 843), and Downs (2010: 64)

3.4 RESEARCH PROCEDURE

3.4.1 Focus Group

A focus group is a means of ensuring the validity and improvement of the questionnaire by eliciting the views, opinions, and beliefs of the study population regarding the study topic (Barnes et al. 2007: 917).

3.4.1.1 Inclusion Criteria

- Mountain bikers actively mountain biking in the eThekwini Municipality area
- Participants must be 18 years old or older.
- Participants who have read the letter of information (Appendix I), read, and signed the informed consent form (Appendix J), signed the confidentiality agreement (Appendix K) and the code of conduct form (Appendix L), will be allowed to participate.

3.4.1.2 Exclusion Criteria

- Potential participants for the pilot study and the main study will be excluded.

The focus group was conducted as follows:

- The focus group meeting was structured along the lines that Morgan et al. (2001), Silverman (2016) and Streiner (2009) laid out to follow. Therefore, the focus group meeting was conducted in the following manner:
- A date and time for the focus group meeting was set.
- An online platform was allocated due to Covid-19 restrictions not allowing for a face-to-face meeting.
- The participants of this meeting included a quantitative researcher versed in surveys, the researcher, the research supervisor, one researcher versed in quantitative research, one chiropractic master's students familiar with surveys and one mountain biker.
- The participants were contacted and asked if they would like to join the focus group.
- Upon logging into the zoom meeting, the participants were greeted and asked if they have read the letter of information (Appendix I) and signed the letter of informed consent (Appendix J), the confidentiality agreement (Appendix K) and the code of conduct form (Appendix L).
- Once it was confirmed that the above-mentioned forms were read and signed, the participants were given a verbal explanation of the focus group procedure and time to ask any questions that they may have had.
- The focus group started to discuss the pre-focus group questionnaire (Appendix H).
- The researcher read each question out aloud in order to discuss the relevance of the questions in the questionnaire to the study and make a decision whether or not the questions are understandable and relatable to the target population.
- The participants were given the freedom to decide if the question will be or will not be included, but they may be undecided as well. If there are questions that are undecided a vote was taken with the majority of the vote deciding what happened to the question.

- When reviewing of the questions was completed, the participants were thanked for their time and greeted before logging out of the Zoom meeting.
- Throughout the meeting, the researcher took notes of what was said and decided as well as recorded the focus group discussion for future reference.

3.4.2 Pilot Study

The goal of a pilot study is to investigate the practicality of an approach that is intended to be used in the final sections of the study (Leon, Davis, and Kraemer 2012).

3.4.2.1 Inclusion Criteria

- Recruited mountain bikers who were 18 years and older.
- Mountain bikers who had read the letter of information (Appendix M) and signed the letter of informed consent (Appendix N).
- Mountain bikers who were not actively mountain biking were included so as not to diminish the main study population.

3.4.2.2 Exclusion Criteria

- Potential participants for the main study and participants who were part of the focus group were excluded.
- Participants who no longer wanted to be a part of the study were excluded and replaced.

The pilot study was conducted as follows:

- Two participants who are similar to the main study in terms of inclusion criteria were used.
- The participants read the letter of information (Appendix M) and signed the informed consent (Appendix N) that was emailed to them.
- Once all required forms were signed, the participants were required to complete the post-focus group questionnaire (Appendix O).
- The participants then completed a questionnaire evaluation form (Appendix P) to recognize any drawbacks in the questionnaire.

- The comments from the participants in the evaluation form were considered and incorporated into the final questionnaire (Appendix Q) which was used in the main study.

3.4.3 Main Study Procedure

The data collection phase of the study was conducted after the restrictive Covid-19 protocols had been relaxed and the country was at level 1. However, strict adherence to the wearing of masks and the sanitization of hands were maintained throughout.

- Potential participants were approached at mountain bike parks, coffee shops, and MTB events after permission had been obtained to conduct the research on these premises (Appendix C).
- A permission letter (Appendix A) to place an advertisement (Appendix R) at the various locations had been sent to the owners, but no responses were received and no advertisements were thus placed at any of the locations.
- Once permission had been obtained, the researcher travelled to the various locations and approached some potential participants directly.
- The researcher explained what the study entailed and what would be required of the respondents, after which the interested mountain bikers were given the opportunity to ask questions.
- Those who had been approached and agreed to participate were given the letter of information (Appendix S) to read and the informed consent letter (Appendix T) to sign.
- Each willing respondent was given a printed copy of the questionnaire (Appendix Q) to complete.
- IsiZulu copies of the information letter (Appendix U), informed consent letter (Appendix V), and questionnaire (Appendix W) were also available should a respondent request them.
- The researcher was present while the respondents completed the questionnaire to answer any questions they might have.
- The completed questionnaires (Appendix Q) were placed in a sealed box with a small opening on top. This box was marked A and kept safe to ensure that all the

completed questionnaires remained secure in the sealed container until data analysis.

- The signed informed consent forms (Appendix T) were placed in a separate sealed box with a small opening on top and was marked B so that the forms were kept confidential until the research was completed.
- The boxes were unsealed in a safe space only after the completion of data collection. Only after all the letters of information (Appendix S), informed consent forms (Appendix T) and questionnaires (Appendix Q) had been completed were the boxes unsealed. A register on the outside of each box was also completed as a checking mechanism that the questionnaires and letters tallied.
- After the boxes had been unsealed, the documents were stored safely throughout the process of data capturing, recording, analysis, and during the report writing process. The data will remain anonymous as each respondent was allocated code.

3.5 DATA ANALYSIS

Data were captured on an Excel spreadsheet and SPSS Statistics version 27 (IBM Corporation, Armonk NY) was used to analyse the data. Based on the statistical analyses, the prevalence of injuries is reported as percentages with 95% confidence intervals. Associations between risk factors and injuries were assessed at univariate level using chi square tests for categorical predictors and t-tests for continuous variables. Where applicable, multivariable logistic regression models were constructed to assess independent effects of the predictors for injury whilst adjusting for confounding. Adjusted odds ratios and 95% confidence intervals are reported in this dissertation, as proposed by Esterhuizen (2020).

3.6 ETHICAL CONSIDERATIONS

- IREC approval was acquired before data collection was initiated (Appendix B).
- Autonomy was ensured by complete voluntary participation and participants and respondents were able to refuse to take part or withdraw from the study at any point. All the participants/respondents were given a letter of information

(Appendix S) and an informed consent form (Appendix T) to read and sign prior to participating in the study.

- Non-maleficence was maintained by guaranteeing that no harm would come to any participant or respondent.
- Justice was maintained by ensuring that no participant or respondents was excluded from this study based on race, gender, religion, or occupation.
- Beneficence was ensured by the results of the study that facilitated an injury profile of mountain bikers, how the injuries they sustained affected their performance, and what treatment they used for those injuries. It is envisaged that the outcomes will assist the chiropractic profession and patients as valuable information has been added to the pool of knowledge that will direct management and treatment plans in the future.
- Anonymity was ensured by coding all the questionnaire respondents' data and not including any personal information of any of themt in the study. Only the researcher and research supervisor had access to the data. The research documents will be stored at the Chiropractic department at the Durban University of Technology and shredded after five years.

3.7 CONCLUSION

The research methodology that was used in this study was meticulously explained and justified in this chapter. Aspects such as the sampling and statistical methods and the approaches that were used to statistically analyse the data were clearly expounded. The conceptualisation and materialisation of the mountain biking questionnaire that was used to capture the data were also explained. This chapter was concluded with the presentation of the ethical considerations that were rigorously adhered to. The following two chapters will present the results and the discussion of the findings.

CHAPTER 4: RESULTS

4.1 INTRODUCTION

Chapter 4 is a representation of the results that were acquired during data collection.

4.2 SAMPLE SIZE AND RESPONSE RATE

The data for this study was obtained from participants meeting the inclusion and exclusion criteria of the study. Out of a sample size of N=175, a total of 175 participants completed the questionnaires, giving this study a 100% response rate.

4.3 STATISTICAL METHODS

Before being imported into SPSS version 28 for analysis, the data was captured in a Microsoft Excel spreadsheet. Due to the fact that a scrape is not considered as a musculoskeletal injury and that all of the participants amongst the total of 175 reported some form of injury, all of the injuries except scrapes were considered as musculoskeletal injuries and recorded. Participants who only reported scrapes as injuries (not in combination with any other type of injury) were considered as uninjured for this study. The prevalence of musculoskeletal injuries was described by using percentages and the data was described by using counts and percentages. Associations between the risk factors and musculoskeletal injuries were assessed using Pearson's chi square exact 2-sided significance values with a p value of <0.05, considered as statistically significant.

4.4 RESULTS

There were 175 mountain bikers who participated in this study and among these, the majority was shown to be white males in the 45 to 50 age group category. The results of the demographics from this study are presented in **Table 4.1**

Table 4.1 Demographics

		Count	Column N %
1.1. Age	18-24	19	10.9%
	25-29	15	8.6%
	30-34	25	14.3%
	35-39	28	16.0%
	40-44	27	15.4%
	45-50	61	34.9%
	Total	175	100.0%
1.2. Sex	female	45	25.7%
	male	130	74.3%
	Total	175	100.0%
1.3. Race	African	6	3.4%
	Coloured	6	3.4%
	Indian	15	8.6%
	White	148	84.6%
	Total	175	100.0%

4.4.1 Age

Among all the age group categories that was part of this study, the two most prominent age groups were 35 to 39 years and 45 to 50 years of age. The category of 45 to 50 years of age had the greatest number of participants with it being 34.9% of the total and following it was the category of 35 to 39 years with it being 16% of the total.

4.4.2 Gender

Out of all the participants, 74.3% were males and 25.7% were females, which shows a clear dominance of males in the sport.

4.4.3 Ethnicity

Regarding the ethnicity of the participants, the ethnic groups of African, Coloured, Indian, and White were represented. The White ethnicity seemed to be the predominant ethnic group, with it being 84.6% followed by Indian at 8.6% and African and Coloured having the same percentage at 3.4% of the total.

4.4.4 Period Prevalence

Objective one was to determine period prevalence of musculoskeletal injuries in mountain bikers in the eThekwini Municipality. Period prevalence was divided into the last seven days, the last six months, and the last 12 months. Overall, the period prevalence of musculoskeletal injuries was 159 (90.9%). Of these, 19 out of the 159 (12%) happened in the last seven days, while 40 out of the 159 (25%) happened in the last six months, and the remaining 100 (63%) happened in the last 12 months.

4.4.5 Selected Risk Factors

Objective two was to determine the selected risk factors (bike set-up, riding style, shoes, distance ridden, type of terrain) of musculoskeletal injuries in mountain bikers in the eThekwini Municipality. The only factors significantly associated with musculoskeletal injury were part of the preventative measures category of which, not using anything (p=0.024) where those who were not using anything were significantly more likely to have injury and using pain medicine (p=0.002), where those using pain medicine were less likely to have injury. The results for objective two are presented in **Table 4.2**.

Table 4.2 Determined Risk Factors for Mountain Bikers in the eThekwini Municipality

		MS injury						*p*-value
		no MS injury			MS Injury			
		Count	Row %	N	Count	Row %	N	
1.1. Age	18-24	1	5.3%		18	94.7%		0.907
	25-29	1	6.7%		14	93.3%		
	30-34	2	8.0%		23	92.0%		
	35-39	3	10.7%		25	89.3%		
	40-44	4	14.8%		23	85.2%		
	45-50	5	8.2%		56	91.8%		
	Total	16	9.1%		159	90.9%		
1.2. Sex	female	4	8.9%		41	91.1%		1.000
	male	12	9.2%		118	90.8%		
	Total	16	9.1%		159	90.9%		
1.3. Race	African	0	0.0%		6	100.0%		0.674
	Coloured	0	0.0%		6	100.0%		
	Indian	1	6.7%		14	93.3%		
	White	15	10.1%		133	89.9%		
	Total	16	9.1%		159	90.9%		
2.1. Mountain biking time	<1	3	11.5%		23	88.5%		0.642
	2-4	5	14.3%		30	85.7%		
	4-6	1	6.3%		15	93.8%		
	6-8	2	11.8%		15	88.2%		
	8-10	2	15.4%		11	84.6%		
	10-12	0	0.0%		12	100.0%		
	>12	3	5.4%		53	94.6%		
	Total	16	9.1%		159	90.9%		
2.2. Training time	<1	1	8.3%		11	91.7%		0.071
	1	2	50.0%		2	50.0%		
	2	3	13.6%		19	86.4%		
	3	2	5.3%		36	94.7%		
	4	3	13.6%		19	86.4%		
	5	0	0.0%		19	100.0%		
	>5	5	8.6%		53	91.4%		
	Total	16	9.1%		159	90.9%		
2.3. Category ridden	Off road	13	11.4%		101	88.6%		0.538
	Tar	1	10.0%		9	90.0%		
	Downhill courses	0	0.0%		4	100.0%		
	Cross cycling	2	6.7%		28	93.3%		

	Endurance	0	0.0%	17	100.0%	
	Total	16	9.1%	159	90.9%	
2.4. Type of mountain bike	Rigid	2	25.0%	6	75.0%	0.176
	Hardtail	5	11.9%	37	88.1%	
	Soft tail	9	7.2%	116	92.8%	
	Total	16	9.1%	159	90.9%	
2.5. Rest days	Yes	15	9.6%	142	90.4%	0.707
	No	1	5.6%	17	94.4%	
	Total	16	9.1%	159	90.9%	
Have not used anything while training	no	9	17.0%	44	83.0%	0.024
	yes	7	5.7%	115	94.3%	
	Total	16	9.1%	159	90.9%	
Pain medication	No	7	5.1%	130	94.9%	0.002
	Yes	9	23.7%	29	76.3%	
	Total	16	9.1%	159	90.9%	
Bracing	No	16	9.6%	151	90.4%	0.615
	Yes	0	0.0%	8	100.0%	
	Total	16	9.1%	159	90.9%	
Strapping	No	14	9.0%	142	91.0%	1.000
	Yes	2	10.5%	17	89.5%	
	Total	16	9.1%	159	90.9%	
Splint	No	16	9.2%	158	90.8%	1.000
	Yes	0	0.0%	1	100.0%	
	Total	16	9.1%	159	90.9%	
2.7. Impact of assistive measures	Helped a bit	3	13.0%	20	87.0%	0.076
	Helped Moderately	2	13.3%	13	86.7%	
	Helped greatly	3	25.0%	9	75.0%	
	Did not help	1	33.3%	2	66.7%	
	Not answered	7	5.7%	115	94.3%	
	Total	16	9.1%	159	90.9%	
3.1. Racing category	Solo	12	9.9%	109	90.1%	0.585
	2 person team	3	15.0%	17	85.0%	
	3-4 person team	0	0.0%	7	100.0%	
	5+ person team	0	0.0%	5	100.0%	
	Not answered	1	4.5%	21	95.5%	
	Total	16	9.1%	159	90.9%	
3.2. Racing time	A few weeks	1	6.7%	14	93.3%	0.231
	6-12 months	5	20.8%	19	79.2%	
	>1 year specified	2	4.9%	39	95.1%	

	Not answered	1	4.5%	21	95.5%	
	>1 year not Specified	7	9.6%	66	90.4%	
	Total	16	9.1%	159	90.9%	
3.3. NORBA classification	Never raced	1	4.5%	21	95.5%	0.201
	Beginner	6	20.0%	24	80.0%	
	Sport	6	6.7%	83	93.3%	
	Semi pro	3	13.0%	20	87.0%	
	Pro	0	0.0%	7	100.0%	
	Expert	0	0.0%	4	100.0%	
	Total	16	9.1%	159	90.9%	
Helmet	Yes	16	9.1%	159	90.9%	-
	Total	16	9.1%	159	90.9%	
Gloves	No	1	7.1%	13	92.9%	1.000
	Yes	15	9.3%	146	90.7%	
	Total	16	9.1%	159	90.9%	
Hydration pack (camelback)	No	9	9.9%	82	90.1%	0.797
	Yes	7	8.3%	77	91.7%	
	Total	16	9.1%	159	90.9%	
Gel seat cover	No	13	9.0%	132	91.0%	1.000
	Yes	3	10.0%	27	90.0%	
	Total	16	9.1%	159	90.9%	
Padded cycling shorts	No	0	0.0%	23	100.0%	0.135
	Yes	16	10.5%	136	89.5%	
	Total	16	9.1%	159	90.9%	
Other equipment specified	Garmin power meter	0	0.0%	2	100.0%	-
	Knee pads	0	0.0%	7	100.0%	
	Elbow pads	0	0.0%	2	100.0%	
	Total	0	0.0%	11	100.0%	
5.2. Clip in shoes	Yes	14	10.1%	125	89.9%	0.530
	No	2	5.6%	34	94.4%	
	Total	16	9.1%	159	90.9%	
5.3. Clip in shoes injury	Yes	4	4.6%	83	95.4%	0.079
	No	9	15.3%	50	84.7%	
	Not answered	3	10.3%	26	89.7%	
	Total	16	9.1%	159	90.9%	
5.4. Pedals	Toe clip and strap	0	0.0%	5	100.0%	0.508
	Platform	2	5.9%	32	94.1%	
	Road clips	0	0.0%	9	100.0%	

	Mountain clips	14	11.0%	113	89.0%	
	Total	16	9.1%	159	90.9%	
5.5. Bike set up	Yes	12	11.2%	95	88.8%	0.289
	No	4	5.9%	64	94.1%	
	Total	16	9.1%	159	90.9%	

4.4.6 Impact of Musculoskeletal Injuries

Objective three was to determine the impact of musculoskeletal injuries on mountain bikers in the eThekwini Municipality. Among the participants who did have musculoskeletal injuries, most had felt an impact on their training in the last 12 months, which was recorded as 48%. However, the impact of the injury on their time-spent training tended to be short (under three weeks). It was also recorded that only 21% of the participants with musculoskeletal injuries, had an impact on their work and that tended to be less than a week. The results for objective three are presented in **Table 4.3**.

Table 4.3 Impact of Musculoskeletal Injuries on Mountain Bikers in the eThekwini Municipality

		Count	Column N %
6.1. Injury impact on training	Yes (past 12 months)	76	47.8%
	No (past 12 months)	67	42.1%
	Yes (Last 7 days)	3	1.9%
	No (last 7 days)	13	8.2%
	Total	159	100.0%
6.2. Injury impact on time training	0-7 days	17	10.7%
	1-3 weeks	20	12.6%
	3-5 weeks	13	8.2%
	5-8 weeks	11	6.9%
	2-3 months	10	6.3%
	3-6 months	5	3.1%
	6-12 months	2	1.3%
	> 1 year	1	0.6%
	Not answered	80	50.3%
	Total	159	100.0%
6.3. Injury impact on work	Yes (past 12 months)	33	20.8%
	No (past 12 months)	110	69.2%
	No (last 7 days)	16	10.1%
	Total	159	100.0%
6.4. Injury impact on work missed	0-7 days	17	10.7%
	1-3 weeks	8	5.0%
	3-5 weeks	1	0.6%
	5-8 weeks	2	1.3%
	2-3 months	2	1.3%
	3-6 months	1	0.6%
	6-12 months	1	0.6%
	Not answered	127	79.9%
	Total	159	100.0%

4.4.7 Injury Profile

Objective four was creating an injury profile of mountain bikers in the eThekwini Municipality. The injury profile created from the results that were obtained mainly presents the body parts injured, the types of injuries, proposed causes of the injuries and if the injury was medically diagnosed as well as which type of medical professional was the most common to give the diagnosis.

4.4.7.1 Body Parts Injured

Among all of the areas that could sustain an injury, the shoulder was injured the most at 38% out of all those who were injured. After the shoulder, the other most common areas that were injured were the leg at 32%, the knee at 30% and the wrist at 30%. The results are presented in **Figure 4.1**.

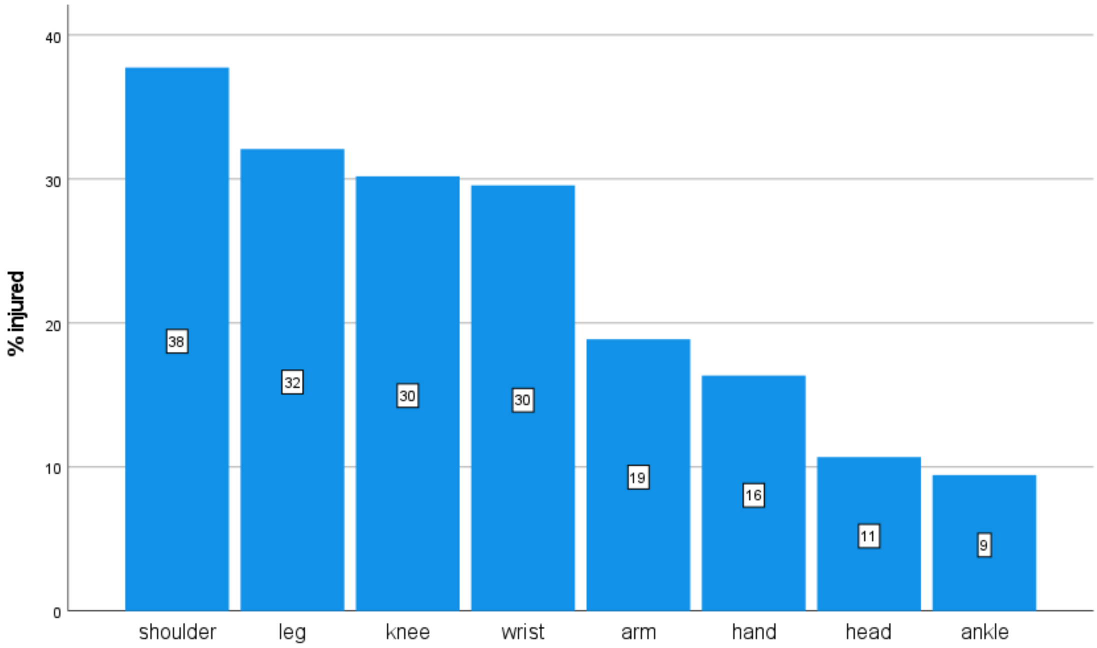

Figure 4.1 Body parts injured amongst mountain bikers in the eThekwini Municipality

4.4.7.2 Types of Injuries

A bruise was the most common form of injury, with a total of 38% among the injured participants which was followed by cuts and sprains. The more severe injuries like dislocations and fractures, strains and concussions were less common. The results are presented in **Figure 4.2**.

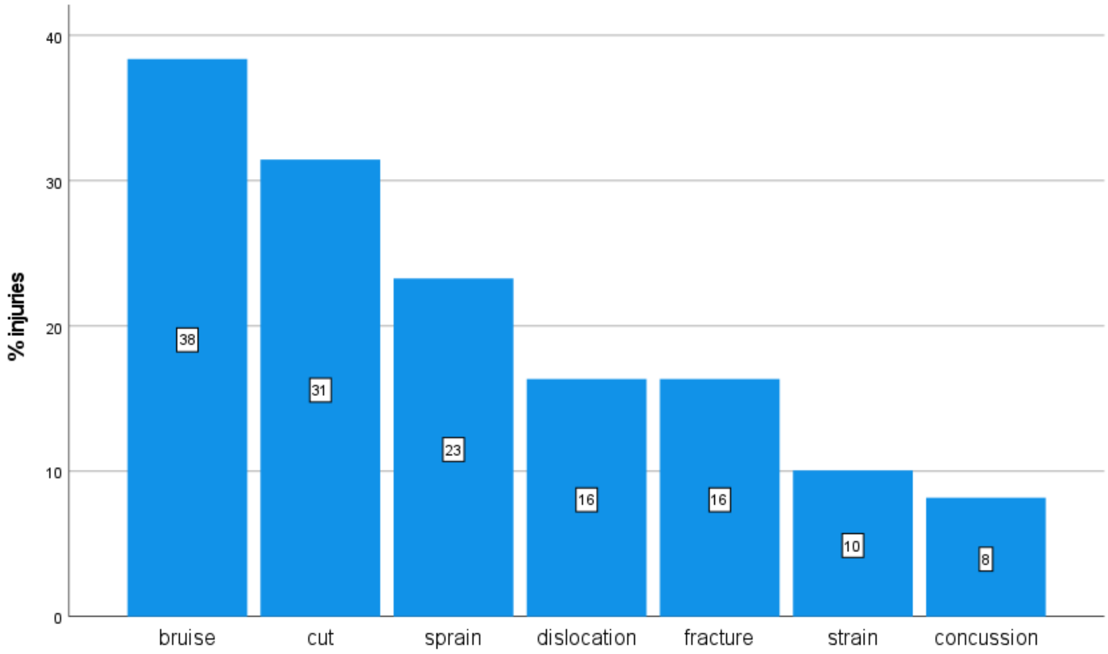

Figure 4.2 Types of injuries amongst mountain bikers in the eThekwini Municipality

4.4.7.3 Proposed Causes of the Injuries

Of the proposed causes of the injuries recorded by the participants, the main causes were a fall at 72% and contact with a stationary object at 23%. The results of the proposed causes of the injuries are presented in **Table 4.4**.

Table 4.4 Proposed Causes of Injuries amongst Mountain Bikers in the eThekwini Municipality

		Count	Column N %
Fall	No	45	28.3%
	Yes	114	71.7%
Contact with vehicle	No	156	98.1%
	Yes	3	1.9%
Contact with another bicyclist	No	142	89.3%
	Yes	17	10.7%
Contact with stationary object	No	123	77.4%
	Yes	36	22.6%
Incorrect posture	No	147	92.5%
	Yes	12	7.5%
Incorrect pedalling technique	No	146	91.8%
	Yes	13	8.2%
Overuse fatigue	No	145	91.2%
	Yes	14	8.8%
Playing another sport	No	157	98.7%
	Yes	2	1.3%
Fall from clip in shoes	No	137	86.2%
	Yes	22	13.8%
Unknown	No	155	97.5%
	Yes	4	2.5%
Other injury causes not listed	Bridge broke	2	40.0%
	Riding too fast	1	20.0%
	Wrong landing after a drop off	1	20.0%
	Not concentrating on track	1	20.0%

4.4.7.4 Medical Diagnosis of Injury

Out of the total number of injuries, 46.5% of participants had their injury diagnosed by a medical professional and 53.5% did not have it diagnosed. The results are presents in **Table 4.5** below:

Table 4.5 Percentage of Medical Diagnoses of Injuries

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	74	46.5	46.5	46.5
	No	85	53.5	53.5	100.0
	Total	159	100.0	100.0	

4.4.7.5 Medical Professional of Diagnosis

Among the various different medical professionals listed in the questionnaire, the most common practitioner that the participants went to for a diagnosis of their injury, was a general practitioner. This was followed by an orthopaedic surgeon and a physiotherapist respectively. Only 13% of the participants went to a Chiropractor for a diagnosis. The results are presented in **Figure 4.3**.

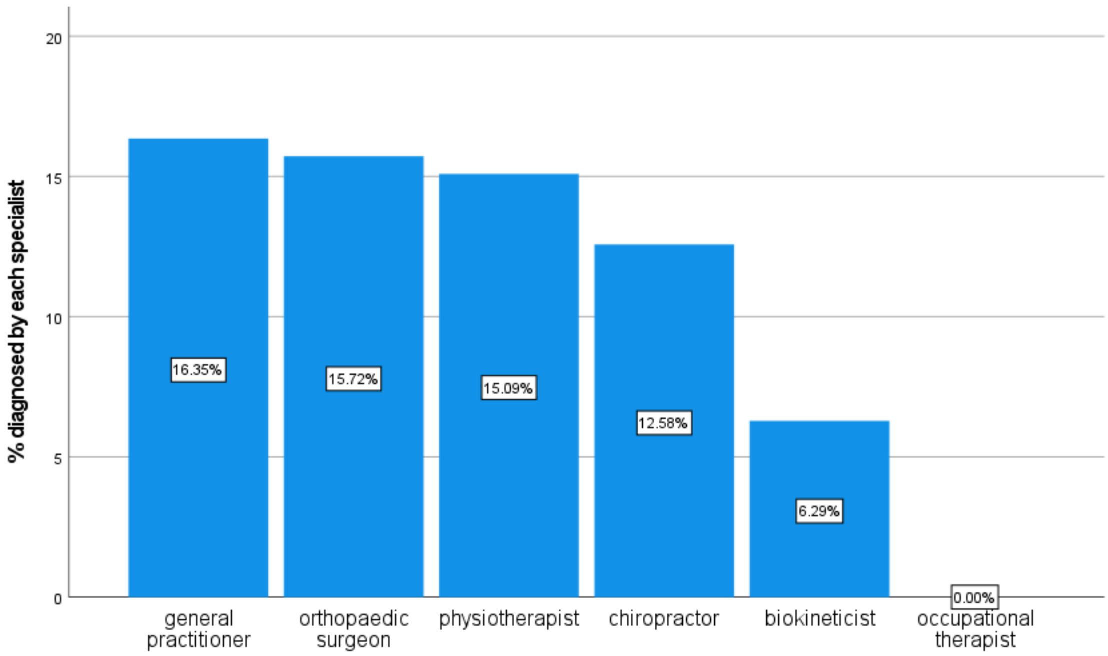

Figure 4.3 Medical Practitioners responsible for diagnoses of musculoskeletal injuries

4.5 CONCLUSION

As shown above, the results were presented adequately. It was found that not using any preventative measures was the most significant risk factor associated with musculoskeletal injuries. In the next chapter, the results will be discussed and a comparison will be made with the results found from previous studies.

CHAPTER 5: DISCUSSION

5.1 INTRODUCTION

The data and findings that were presented in Chapter 4 will be discussed and compared with those of earlier studies. The discussion will be underpinned by the sample size, response rate, demographics of the respondents, and the objectives of the study. These objectives included the point of injury and the period of the prevalence of musculoskeletal injuries in the responding mountain bikers, the risk factors related to accident incidences and resulting mountain biking-related injuries, and the impact of musculoskeletal injuries on mountain bikers.

5.2 SAMPLE SIZE AND RESPONSE RATE

The total number of respondents required for the sample was 175 (Esterhuizen, 2020). A 100% response rate was achieved because 175 of the targeted mountain bikers completed the questionnaire. Of the 175 respondents, 16 indicated that they had only sustained a scrape, which is not classified as a musculoskeletal injury. The 16 non-musculoskeletal injuries (those who had only sustained a scrape) were used as the control group to compare with those who sustained more serious musculoskeletal injuries.

The sample size of this study was considerably smaller than those of previous studies on mountain bikers. Quesada et al. (2019) looked at the elements related to injury as well as awareness of discomfort and pain among cyclists. The latter study used a sample size of 739 cyclists which was achieved by sending the questionnaire online. The current study utilised a sample of 175 cyclists with the aim of creating an injury profile of cyclists. The focus was on the risk factors associated with mountain bike injuries and not on the bikers' awareness of discomfort and pain. Lareau and McGinnis (2011) compared the prevalence of injuries between endurance mountain bike racers and cross-country mountain bike racers using a sample size of 448 cyclists. The envisaged comparison was eventually not possible as the study included endurance, cross cycling, downhill, off-road, and tarred road cyclists as respondents and it was thus too broad a sample to narrow the findings down to two groups. A general mountain biking injury profile was thus created with reference to all five the categories involved in the study. Lebec, Cook and Baumgartel (2014) surveyed 404 mountain bike cyclists to determine if single-speed mountain biking put cyclists at higher risk of developing overuse injuries. This study did not only look at single-speed mountain bikers as it did not specify the gears of the bikes used, but it did include the three main types of mountain bikes namely hard-tail, soft-tail, and rigid bikes.

A study done by Becker et al. (2013) on the injuries sustained by downhill mountain bike cyclists used a survey that was sent once a month for five months to 249 cyclists. These data were then compared with a single time frame of around 2 months. The study by Becker et al. (2013) only focused on downhill mountain bike injuries whereas the current study included multiple styles of mountain biking of which downhill mountain biking was one. The study that was conducted by Gaulrapp, Weber and Rosemeyer (2001) was similar to the current study as it also looked at risk factors, type, and site of injuries that were sustained by mountain bikers, but their study had a much larger sample size of 3 873 mountain bikers. Heesch, Garrard and Sahlqvist (2011) had a study population of 2 056 cyclists and they explored types of incidences and the severity of cycling injuries in Queensland, Australia, whereas the current study utilised a sample size of only 175 cyclists. The current study also explored incidences and the severity of injuries, but it focused only on mountain bikers and not on road cyclists as well. Kotlyar's (2018) study focused on the injuries that road cyclists sustained and compared these with trail riding (mountain biking) cyclists using a sample size of 304 respondents over a 3-year time frame. He also looked at the epidemiology of injuries that were sustained by cyclists over this period. In contrast, the current study did not compare road cyclist injuries to those of mountain bikers. This study did include the tarred or open road terrain (on-road cycling) with mountain bike cycling but it utilised a sample of 175 respondents over a much shorter period of time for data collection.

A total of 4 961 cyclists was surveyed to determine accident-related cycling injuries in road cyclists in a study that was conducted by Hollingworth, Harper and Hamer (2015). Although it utilised the largest cyclist sample thus far and focused on on-road cyclists, the results were similar to those of the mountain bike studies previously mentioned.

There were also notable similarities between the results of this latter study and the current study regarding the types of injuries that were sustained and the mechanisms of these injuries.

In general, the earlier studies that were referred to all focused mainly on risk factors, comparisons between different types of mountain biking and road cycling, bicycle setup, and incidences and severity of cycling-related injuries, whereas the current study not only looked at the risk factors, bike setup, and incidences of injuries, but it also aimed to create an injury profile of these injuries in mountain bikers.

5.3 DEMOGRAPHICS

5.3.1 Age

This study found that the majority of mountain bikers who sustained injuries was between the ages of 45 to 50 years **(Table 4.1)**. This is contradictory to a study done on mountain bikers in the United States of America by Nelson and McKenzie (2011), who found that the majority of cyclists sustaining injuries were adolescents between the ages of 14 and 19 years. In a similar study that was conducted on road cyclists by Useche et al. (2019), the average age of injured cyclists was 32.83 years. This contradiction in the findings can possibly be due to the fact that the latter researchers split their study population into two groups with the majority of cyclists being younger than 25 years and having much fewer respondents than the group of cyclists older than 25 years.

Stoop et al. (2019) did a study on male elite versus amateur mountain bikers and found that the elite cyclists were considerably younger than the amateur cyclists and were involved in much more riding per year than the amateur cyclists. The elite cyclists with injuries also accounted for more than half of the study population, indicating that the majority of injuries occurred in younger cyclists, which is also contradictory to the findings of the current study. This may be attributed to the fact that the sample of the earlier study comprised only males whereas this study included both male and female cyclists. Heesch, Garrard and Sahlqvist (2011) did a similar study but included both road cyclists and mountain bikers. They determined that age did not have an effect on injuries in general but that it correlated with more serious injuries. They showed that younger cyclists between the ages of 18 to 34 years reported fewer serious injuries whereas older cyclists between the ages of 45 and 54 years reported more serious injuries. They attributed this to the riding styles that differed between the two age groups. The findings of the Heesch, Garrard and Sahlqvist (2011) study correlated with those of the current study in the sense that both found that the older age group sustained more injuries than younger age groups. However, the findings of most previous studies of a similar nature contradicted the findings of this study, which could be attributed to a considerable difference in sample sizes and the different nature of the locations where the studies were conducted.

5.3.2 Gender

The results of this study revealed that males tend to be injured more often than females in mountain biking (males = 74.3%, females = 25.7%). In a study done by Stoop et al (2019) on male elite and amateur mountain bikers, the injury prevalence and the predictable factors of the injuries were researched by comparing the two groups with each other. They found that that the prevalence of injuries between the elite and amateur mountain bikers were the same and there were no predictable factors found for injuries in either one of the two. Although the majority of injuries occurred in male participants of this study, the findings of the Stoop et al. (2019) study is contradictory to the findings of this study in that this study found not using protective measures when riding as a predictive factor for injury.

In a study done by Heesch, Garrard and Sahlqvist (2011) on cyclists using on-road (road cycling) and off-road (mountain biking) routes, there were no differences found in the occurrence of injuries between male and female cyclists showing that they had an equal number of injuries occurring among the two genders per year. The study looked at both road and mountain bikers and even though both types were included, it does contradict the findings of this study of males having a higher rate of injury than females. Fiore, Fellows and Henner (2020) showed in their study, that cyclists with the most injuries tended to be younger males although trends seem to show that there is more interest among the older cyclists and female cyclists. Their study corresponds with this study in the sense that males are more likely to be injured than females.

Possible reasons for male cyclists being more likely to have injuries than female cyclists are that women have been shown to have a higher risk perception of danger and injury than men, cycling in general is more popular among men than women and women take less risks due to them being less daring than men in most cases. These findings correspond with the findings in both studies done by Prati et al. (2019) and Useche et al. (2019), even though these two studies were based on road cyclists.

5.3.3 Ethnicity

This study showed that the White ethnic group (84.6%) was dominant in mountain biking, followed by the Indian (8.6%) ethnic group and the African (3.4%) and Coloured (3.4%) ethnic groups. This correlates with the study by Bordelon and Ferreira (2019), who found that in the 2017 ABSA Cape Epic mountain bike race 90% of the race participants was White. This figure indicates that the mountain biking world is dominated by the White ethnic group.

5.4 PERIOD PREVALENCE

Quesada et al. (2019) did a study on the injuries of mountain bikers in the twelve months prior to their study and the results showed that the majority of the respondents (63,2%) had not sustained any injuries in that period. They found that 25.3% of the participants had sustained one injury while only 11.5% had sustained two or more injuries in the study period. In another study that was conducted by Hollingworth, Harper and Hamer (2015) over a period of five years, it was found that 54.3% of the respondents had sustained some injury while 12.5% had sustained more than two injuries in the study period. Compared to the previously mentioned studies, the period prevalence in this study could be divided into three categories: 12% of the respondents had sustained injuries in the seven days prior to the study, 25% had sustained injuries in the six months prior to the study, and 63% had sustained injuries in the 12 months (1 year) prior to the study. The study by Kronisch and Pfeiffer (2002) found that less than 1% of the responding mountain bikers had sustained any previous injuries. This finding by Kronisch and Pfeiffer (2002) coincides with that of the current study in the sense that it was found that the majority of mountain bikers had sustained injuries in the 12 months prior to the study, which can be seen as ‘past injuries’.

Aitken, Biant and Court-Brown’s (2011: 275) study showed that the overall injury rate was 1.54 injuries per 1 000 biker exposures (hours ridden). Their study determined that a 1 000 biker exposures indicated the number of hours ridden by the respondents and it was less than the total hours of 12 months, which indicates that injuries occurred over a period of 12 months. Compared with the current study, there is a correlation between the time frame in which the injuries occurred. This study looked at injuries that were more current, but still classified some as ‘past injuries’ that were sustained in the twelve months, six months, and the seven days prior to the study. The current study did not focus on past injuries that were older than 12 months. In this regard, the current study correlated with that of Quesada et al. (2019) in that the recorded period that injuries were sustained was similar, but it differed from the time frame studied by Hollingworth, Harper and Hamer (2015) who recorded injuries over a much longer period.

5.5 SELECTED RISK FACTORS

5.5.1 Cycling Experience

Kronisch and Pfeiffer (2002) found that common causes of injuries were inexperience, overestimating manoeuvring capabilities, and braking incorrectly. These rider errors are associated with the class or level of cyclists who categorise themselves as being beginner, intermediate, or expert cyclists. In the current study only four cyclists indicated that they were experts while the majority indicated that were in the ‘sport class’ (similar to intermediate), which is a level that leaves room for error in judgement and inexperience. This was indicative of the majority of the cyclists in this study as the majority could be categorised as belonging to a group at higher risk of injury than the expert group.

Cyclists who had been riding for less than a year had the same risk of getting injured than those who had been riding for longer than 12 years. Hollingworth, Harper and Hamer (2015) found that increased risk of injury was related to the distance ridden in a week. Although the current study looked at the number of hours ridden in a week as opposed to the distance ridden in a week, the results correspond with those of the earlier study mentioned in that both found that longer hours and distance increase the risk of sustaining injuries.

The study by Romanow et al. (2012) found that cyclists who tried going faster than is reasonable had a significantly higher risk of injury. This is contradicted by the results of the current study as only one cyclist indicated that the cause of the injury, he had sustained was riding too fast. When the results are compared to those of the earlier study referred to in the paragraph above, it is clear that the experience of the cyclist plays a significant role in the risk of sustaining an injury. Although the results in terms of cycling experience correlate with those of some previous studies, they also contradict those of one study. As these results indicate a discrepancy, it is suggested that further research be conducted in this field.

5.5.2 Terrain

In this study the type of terrain was determined by asking the respondents what type of mountain biking they participated in most. For example, they could indicate off-road, downhill, cross cycling (cross-country), endurance, or tarred surfaces (on-road). The results showed that the majority of cyclists who had sustained injuries did so when participating in off-road mountain biking. This biking style has unique characteristics in terms of the terrain that is used. Quesada et al. (2019) compared training on the road to training on trails in more remote areas and found that there was an increased risk of sustaining injuries on trails than on the road. They attributed this to increased vibrations and uneven terrain with a lot of obstacles that need to be negotiated. Due to the fact that tricky landscapes, loose gravel, and unfamiliar tracks are the characteristics of all off-road cycling (mountain biking) terrains, it is natural to assume that cyclists will incur injuries as they fall when the front wheel of the bike collides with a stationary object. Such results were recorded by Kronisch and Pfeiffer (2002) and correlate with the findings of the current study as most of the injuries that the respondents indicated had been caused by a fall due to contact with a stationary object.

Both the current and earlier studies thus found a clear correlation between the type of terrain and increased risk of injury.

5.5.3 Gear and Footwear

in this study, the cyclists wore helmets not only for their own safety, but because they were not allowed to use the mountain bike park tracks without wearing one. Even though four cyclists identified downhill courses as the most utilised terrain, only two cyclists indicated that they wore elbow pads and seven indicated that they wore kneepads. Using a gel seat cover was not very popular among the cyclists as only 27 of 159 cyclists indicated they use one, and of these the large majority was in the 'beginner' category. It was found that 125 cyclists did not use clip-in shoes and of these 83 indicated that they had sustained injuries when they started to learn how to ride using these.

Fiore, Fellows and Henner (2020) showed that traumatic brain injury was decreased by 65% to 88% in mountain bikers by wearing a proper helmet, but even then, the risk of sustaining a traumatic brain injury was between 5% to 15%. In the current study it was found that of all the cyclists who wore helmets only 8% (**Figure 4.2**) had sustained concussion, which is within the range of 5% to 15% as mentioned above. Another similar study done on younger mountain bikers by Caine, Young and Provance (2018) also found that wearing a helmet decreased the risk of serious head injury.

Ansari, Nourian and Khodaee (2017) argue that the cleats of clip-in shoes can result in meniscal as well as intra-articular knee problems. They suggest that, by adjusting the position of the cleat, these types of injuries can be improved. Although the current study did not ask the respondents to specify what type of injury had occurred as a result of clip-in shoes, the results are in line with those of Ansari, Nourian and Khodaee

(2017) as 52,2% (83 of 159 cyclists) (**Table 4.2**) indicated that they had sustained some type of injury due to using clip-in shoes.

5.5.4 Training Schedule

The current study found that training for more than five hours a week increased the risk of injury more than training for less than five hours a week. Quesada et al. (2019) reported that when cyclists implemented more than one type of sport into their training schedule that was not cycling related (such as running or swimming), it resulted in poor cycling technique which in turn increased the risk of injury. These findings coincide with the findings of this study, as the majority of cyclists in this study did not have any other extra sport in their training schedule. In fact, only two cyclists indicated that their injury had been caused by another sport. Visentini and Clarsen (2021) state that cyclists tend have more injuries after the 'load' (training frequency) has been increased suddenly to a longer period. This corresponds with this study in the sense that it also found that longer hours of training on a bicycle results in more injuries.

In contrast to the above studies, Caine (2018) argues that mountain bikers tend to have a higher injury rate when racing than when training and that this is due to the fact that the pressure of performing is higher even though the training terrain can sometimes be the same as in the race. This finding correlates with this study, because of the 159 injured cyclists only 21 did not do any racing while 138 competed in races (**Table 4.2**).

5.6 INJURIES TO BODY PARTS

Althunyan et al. (2021) conducted a study on Achilles tendon pain in cyclists, and the results showed that 25% of the cyclists who participated in racing events experienced Achilles tendon pain while 60% of off-road cyclists (mountain bikers) experienced Achilles tendon pain. They focused on both road cyclists and mountain bikers and included professional and amateur cyclists. The current study also included professional and amateur mountain bikers and found that the body part that was predominantly injured was the shoulder while the ankle was injured the least. This result is contradictory to what Althunyan et al. (2021) found.

A similar study that was done by Seyhan et al. (2020) on road tourist cyclists in the Princess Islands found that 63.2% of injuries occurred in the upper or lower extremities while 21% of injuries occurred on the head. More specifically, the main areas where injuries had been sustained were 22.5% wrist/hand and 10.1% knee. Their sample size was 1 582 compared to the 175 participants who responded to the questionnaire in this study. However, the results of this study are contradictory to those of the Seyhan et al. (2020) study in that it was found that the most common area of injury was the shoulder, while the wrist (30%) and hand (16%) that were fourth and sixth most common areas respectively. The number of head injuries in this study was also lower than the number of head injuries in the former study, but these contradictory results may be attributed to the large difference in sample size.

When comparing the outcomes of this study to those of similar studies mentioned in the paragraph above, there is a general correlation regarding the regions of the body that are prone to cycling injuries. However, some studies focused on a specific injury or established other areas of injury as the most predominant than the shoulder.

5.7 TYPES OF INJURIES

In a study done by Clarsen, Krosshaug and Bahr (2010) on road cyclists, they focused on overuse injuries in professional road cyclists. The results showed that the most common overuse injuries in road cyclists were low back pain and knee. The current study did not solely focus on overuse injuries as it also included traumatic (more sever) injuries. However, it showed some similarity to the study by Clarsen, Krosshaug and Bahr (2010) in that 30% of the total injuries occurred in the knee, although these were not necessarily due to overuse. According to a study that was conducted in England on mountain bikers by Jeys et al. (2001), the majority of injuries could be classified as traumatic, with clavicle fractures the most common at 13% and other shoulder-related injuries at 12%, distal radial fractures at 11%, and soft tissue injuries at 10%. These findings coincide with the results of the current study in this section as it also found the shoulder to be the most commonly injured area in mountain bikers. However, there is also a contradiction as this study found that soft tissue injuries (bruises) were the most common type of injury (38%) while fractures (16%) were low on the list. Although the percentage of fractures indicated in the current study is higher than the percentage indicated by the Jeys et al. (2001) study, the percentage of soft tissue injuries is still higher than that of fractures, which is contrary to the findings of the earlier study.

Quesada et al. (2019) also showed that the most common injuries were inflammatory conditions, sprains/strains, and contusions (bruises). The results of a study done by Stoop et al. (2019) showed that 66.5% of the injuries were severe (fractures at 39.9% and joint injuries at 26.6%), with 36.6% of injuries in amateurs being soft tissue injuries. These results correlate with the results of this study that found that bruises were the most common type of injury sustained by the respondents.

5.8 CAUSES OF INJURIES

Roberts et al. (2013) found that the causes of the majority of injuries in mountain bikers were incorrect riding technique when confronted with obstacles like jumps, trying to do tricks with the mountain bike, and falls. This study showed that falls were the main cause of injury followed by contact with a stationary object, but it also showed that inexperience and poor technique were causes of injury among the respondents. The findings by Roberts et al. (2013) therefore correlate with those of the current study in this regard, but the earlier study also focused on a comparison between injuries sustained by road cyclists and those sustained by mountain bikers, whereas this study solely focused on mountain bikers. Although it was not specified how falls occurred, the most common cause of injuries in this study was due to a fall, which is similar to a finding by Ansari, Nourian and Khodaee (2017), who stated that the most common cause of injury in their study was falling forward off the bike.

According to a study done by Buchholtz, Lambert and Burgess (2020) on mountain bikers, the excessive vibrations due to the rough terrain that mountain bikers negotiate cause these cyclists to diminish their hand grip force (or strength), which heightens the risk of injury. Although this did not emerge as a finding in the current study, it still has relevance as decreased grip strength is well known as a factor that will result in the cyclist losing control and falling. Therefore, as falling emerged as the main cause of injury in this study, it is logical to assume that diminished hand grip, amongst other variables, was involved. In general, the most common cause of injuries as mentioned in similar studies occurred as a result of falling, which corresponds with the results of this study.

5.9 IMPACT OF INJURIES

Pratt, Primrose and Fulcher (2019) studied injuries among endurance mountain bikers and showed that 55% of the respondents had sustained injuries resulting in the inability to go to work for a minimum of one week. For some respondents this period of leave was longer than a week. This finding coincides with the results of the current study as it was also found that injuries impacted the period that cyclists were not able to go to work. However, the rate of such absences differed as only 21% of the respondents indicated that they had been unable to go to work for a week or less. Although the studies were relatively similar, the earlier study only focused on endurance mountain bikers and excluded various types of mountain biking, which this study included.

A study that was conducted by Heesch, Garrard and Sahlqvist (2011) found that, of the total number of participants who were injured, 114 needed to go to the hospital and 36 (5%) were admitted for a minimum of one day up to 30 days. This resulted in time off work as well as diminished training time. The rate of 5% is much lower than the rate of 21% found by the current study, but both studies concur that cycling injuries have some effect on cyclists' work attendance.

5.10 MEDICAL DIAGNOSIS OF INJURIES

There is very little information on who the medical practitioners were that diagnosed the injuries of respondents in previous studies as the majority of the studies mention on-site paramedics but not specific medical practitioners. This being said, the study that was conducted by Heesch, Garrard and Sahlqvist (2011) showed that the cyclists' injuries were diagnosed by either a general medical practitioner, an allied health practitioner, or practitioners in hospital emergency departments. This coincides with the results of the earlier as well as this study because both found that general practitioners were the most predominant medical professionals who diagnosed cyclists' injuries. Conversely, Peterson and Renstrom (2017: 1) found that both physicians and physiotherapists were predominantly involved in the diagnosis and treatment of athletes' injuries. Based on the data, this study could rank the involvement of medical care of cyclists' injuries as follows: general practitioners (16.35%), orthopaedic surgeons (15.72%), physiotherapists (15.09%), chiropractors (12.58%), and bio-kineticists (6.29%). The findings are related to those of the studies mentioned above as both showed that medical practitioners (doctors) and physiotherapists are commonly used medical professionals to treat cycling injuries.

5.11 CONCLUSION

In this chapter the results of the study were discussed and compared with the results of earlier studies that had a relatively similar focus. Even though the results of this study showed that not using any preventative measures was significantly associated with musculoskeletal injuries, other risk factors were also indicative or potentially sustaining cycling injuries. These are: an older age, being of the male gender, not using specific cycling gear and footwear or having footwear adjusted incorrectly, an excessive training schedule, lack of cycling experience or adequate cycling experience, and the type of terrain. All of these were shown to have a relatively large impact on the risk of acquiring musculoskeletal injuries.

In the next chapter the limitations and recommendations will be presented while this dissertation will be concluded with pertinent remarks.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

In this chapter the limitations that impacted the study will be acknowledged and recommendations based on the outcomes of the study will be offered.

6.2 LIMITATIONS

An obvious limitation of this study was the prominent presence of the White ethnicity population at the various locations of data collection, which means that a true representation of the various race groups in the eThekwini Municipal area was not possible.

The sample size of this study was relatively small in comparison to similar studies mentioned in Chapter 5. Future studies should utilise larger sample sizes to obtain more comparative results.

Although the participants were asked if they had sustained any injuries due to mountain biking, the data pertaining to these injuries were of a current nature and only extended as far back as 12 months prior to the study. Therefore it was not possible to determine if the participants' injuries were due to a previous injury.

This study did not include any participants under the age of 18 years or older than 50 years. Potentially, a future study could look at an injury profile to compare the injuries of the youth with those of older cyclists, with particular focus on mountain biking.

Another limitation was that this study did not have enough questions on bike fit and overuse injuries.

6.3 RECOMMENDATIONS

It is recommended that a study on mountain bikers be conducted across the different provinces of South Africa for comparative purposes. Aspects such as the injuries that are sustained and the nature of the terrain that is accessed in each province could be explored.

A gender-specific study can be done as the majority of the cyclists in this study was male and the data may have been slightly skewed by the limited number of female respondents. A study that specifically explores injuries among female mountain bikers is also recommended.

It is also recommended that an injury profile of mountain bikers is created based on a study that is limited to cyclists younger than the age of 18 years.

A study that compares the injury profiles of amateur mountain bikers to that of professional mountain bikers in South Africa.

A recommendation could be to do a study that focusses more on the actual bike set-up of a mountain biker and how it attributes to overuse injuries.

A study that focuses on the nature of the terrain and the level of expertise/experience of cyclists who are required to manoeuvre specific obstacles in off-road cycling, and how these factors influence the risk of injury, is recommended.

6.4 CONCLUSION

To address the objectives of this study, the period prevalence of musculoskeletal injuries was 90.9% which could be divided into three categories: seven days, six months, and 12 months prior to the study. The area that was predominantly injured was found to be the shoulder followed by the leg, knee, and wrist. The most common injury was bruises followed by cuts and sprains, whereas the most prominent mechanism of injury was falling due to contact with a stationary object.

Based on the results that were presented in Chapter 4, it was found that the main risk factors for sustaining injuries among mountain bikers were gender (i.e., being male), age (being between the ages of 41 to 50 years), ethnicity (being of the White ethic group), training/participation frequency (cycling for 10 to 12 hours a week), experience (mountain biking for five years), and kit or equipment (not using any preventative measures while cycling).

Regarding the objective to determine the impact of musculoskeletal injuries on mountain bikers, it was determined that the impact could be quite severe as mountain bikers have to halt their training due to injuries. Some also have to take time off work which may have a negative impact on their work performance. However, generally the cyclists (48%) felt that the impact of their injury was for a short period only (less than three weeks). The impact on their work time was also less than one week, as indicated by 21% of the cyclists. The most pronounced predictors of developing an injury due to mountain biking were being a member of the White ethnic group, training for 10 to 12 hours, and having been involved in the mountain biking sport for five years.

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APPENDIX A: PERMISSION LETTER TO PLACE ADVERTISEMENT ON PREMISES

01 June 2021

Dear Sir/Madam

<u>Request for Permission to Disseminate Advertisements</u>

My name is Rochelle van Eck and I am a registered Master's student at the Durban University of Technology. The title for my Master's study is "An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality."

I am writing to seek your consent to leave copies om my advertisement for dissemination to recruit participants for my study at your cycling club. I have provided you with a copy of my proposal which includes copies of the data collection tools and consent forms to be used in the research process, as well as a copy of the approval letter which I received from the Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me (082 817 9098, rochellevaneck96@gmail.com). Thank you for your time and consideration in this matter.

Yours sincerely

Rochelle van Eck
Durban University of Technology

APPENDIX B: IREC APPROVAL LETTER

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

P O Box 1334, Durban, South Africa, 4001

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

www.dut.ac.za

13 August 2021

Ms R Van Eck
42 North Beach Road
31 Lazy Lizard
Umdloti
4319

Dear Ms Van Eck

An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality
Ethics Clearance Number: 069/21

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.

In addition, the IREC acknowledges receipt of your gatekeeper permission letters.

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

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the 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,

[redacted]

APPENDIX C: PERMISSION LETTER TO CONDUCT RESEARCH ON PREMISES

03 March 2020

Dear Sir/Madam

<u>Request for Permission to Conduct Research</u>

My name is Rochelle van Eck, and I am a registered Master's student at the Durban University of Technology. The title for my Master's study is "An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality."

I am writing to seeking your consent to do my data collection at your cycling club.
I have provided you with a copy of my proposal which includes copies of the data collection tools and consent forms to be used in the research process, as well as a copy of the approval letter which I received from the Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me (082 817 9098, rochellevaneck96@gmail.com). Thank you for your time and consideration in this matter.

Yours sincerely

Rochelle van Eck
Durban University of Technology

APPENDIX D: PERMISSION LETTER FROM HOLLA TRAILS

28 April 2020

Request for Permission to Conduct Research

Dear Sir/Ms

My name is Rochelle van Eck, and I am a registered Masters student at the Durban University of Technology. The title for my Masters study is "An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality."

I am hereby seeking your consent to do my data collection on your premises.

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

If you require any further information, please do not hesitate to contact me (082 817 9098, rochellevaneck96@gmail.com). Thank you for your time and consideration in this matter.

Yours sincerely,

Rochelle van Eck
Durban University of Technology

Jasper van Vessem, Holla Trails

Name and Surname

29 April 2021

Date signed

[redacted]

APPENDIX E: PERMISSION LETTER FROM GIBA GORGE

28 April 2020

<u>Request for Permission to Conduct Research</u>

Dear Sir/Ms

My name is Rochelle van Eck, and I am a registered Masters student at the Durban University of Technology. The title for my Masters study is "An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality."

I am hereby seeking your consent to do my data collection on your premises.

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

If you require any further information, please do not hesitate to contact me (082 817 9098, rochellevaneck96@gmail.com). Thank you for your time and consideration in this matter.

Yours sincerely,

Rochelle van Eck
Durban University of Technology

JOANNE H[illegible]
Name and Surname

12/5/21
Date signed

[redacted]
Signature

APPENDIX F: PERMISSION LETTER FROM FOAM COFFEE SHOP

28 April 2020

Request for Permission to Conduct Research

Dear Sir/Ms

My name is Rochelle van Eck, and I am a registered Masters student at the Durban University of Technology. The title for my Masters study is "An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality."

I am hereby seeking your consent to do my data collection on your premises.

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

If you require any further information, please do not hesitate to contact me (082 817 9098, rochellevaneck96@gmail.com). Thank you for your time and consideration in this matter.

Yours sincerely,

Rochelle van Eck
Durban University of Technology

TANYA LA GRANGE
Name and Surname

12/5/21
Date signed

[redacted]
Signature

APPENDIX G: PERMISSION LETTER FROM SELECTION COFFEE SHOP

28 April 2020

Request for Permission to Conduct Research

Dear Sir/Ms

My name is Rochelle van Eck, and I am a registered Masters student at the Durban University of Technology. The title for my Masters study is "An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality."

I am hereby seeking your consent to do my data collection on your premises.

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

If you require any further information, please do not hesitate to contact me (082 817 9098, rochellevaneck96@gmail.com). Thank you for your time and consideration in this matter.

Yours sincerely,

Rochelle van Eck
Durban University of Technology

Brittany Rothwell
Name and Surname

29/04/2021
Date signed

[redacted]
Signature

APPENDIX H: PRE-FOCUS GROUP QUESTIONNAIRE

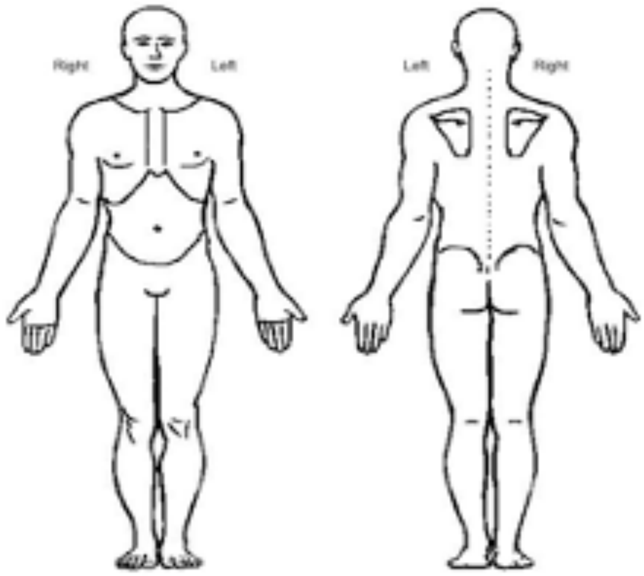
SECTION A						
1. **Demographics:** (Participant: Please fill in or mark with a "X" where relevant)						
1.1. Age						
1.2. Gender	Female		Male		Other	
1.3. Race (for statistical purposes)	African	Coloured	Indian	White	Other	
1.4. Occupation						
1.5. Height ____________m	1.6. Weight ____________kg					

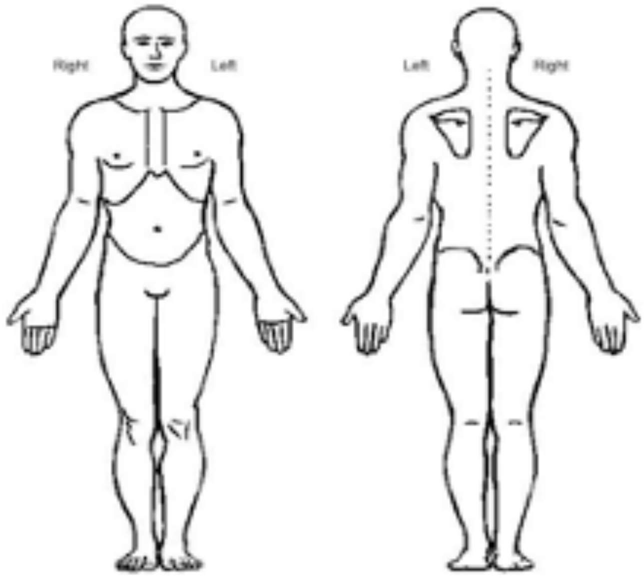
SECTION B - Training and competition history						
2.Training History						
2.1. How long have you been mountain biking?	________Days/Months/Years					
2.2. How many hours a week do you spend training?						
2.3. Which terrain do you ride on more often?	Off-road	Tarred surfaces	Downhill courses	Cross cycling		
2.4. Do you incorporate rest days in your training?	Yes	No				
2.5. Have you or are you currently using any pain medication and/or bracing/strapping; splint/brace when training?	Yes (please specify)	No (ignore question 2.6)				
2.6. Has the above (question 2.5.) helped you continue with your training after the injury occurred?						
3.Competition History						
3.1. In what category do you race?	Solo	2 person team (tandem or separate)	3 person team	5 + person team		
3.2. How long have you been racing in mountain bike events?						
3.3. According to the NORBA classification that's used in mountain biking, which class do you classify yourself as?	Never raced	Beginner	Sport	Semi-Pro	Pro	Expert

<table>
<tr><td colspan="7">SECTION C</td></tr>
<tr><td colspan="7">4.Musculoskeletal injury (Injury – discomfort, pain, or damage to a part which may or may not stop training)</td></tr>
<tr><td>4.1 Have you had an injury due to mountain biking?</td><td colspan="3">Yes</td><td colspan="3">No (You have now completed Section C, kindly hand in your form)</td></tr>
<tr><td>4.2 Has your injury/s been diagnosed by a medical professional?</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>4.3. If "Yes" please state the diagnosis of your injury (In the case of multiple injuries, please state the diagnosis of the WORST injury)</td><td colspan="6"></td></tr>
<tr><td>4.4. How many times in the past year have you been injured whilst mountain biking?</td><td colspan="6"></td></tr>
<tr><td rowspan="8">4.5. Please mark the box with an "X" of which body part you sustained an injury to in the last 6 months that prevented you from training for 1 week, and circle the type of injury associated with that body part</td><td>Wrist</td><td colspan="5">Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Arm</td><td colspan="5">Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Shoulder</td><td colspan="5">Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Leg</td><td colspan="5">Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Ankle</td><td colspan="5">Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Knee</td><td colspan="5">Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Head</td><td colspan="5">Concussion, fracture, cut, scrape</td></tr>
<tr><td>Hand</td><td colspan="5">Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td></td><td colspan="3">Past injury (In the last 12 months)</td><td colspan="3">Current injury (In the last 7 days)</td></tr>
<tr><td>4.6. How did you sustain your injury?

(Please mark the most appropriate box with an "X")</td><td>Trauma (e.g. a crash or a fall resulting in a sprain or fracture)</td><td>Overuse (e.g. a stress fracture)</td><td>Unknown</td><td>Trauma (e.g. a crash or a fall resulting in a sprain or fracture)</td><td>Overuse (e.g. a stress fracture)</td><td>Unknown</td></tr>
</table>

5.Injury Consequence	Past Injury (in the last 12 months)		Current Injury (in the last 7 days)	
5.1. Has your injury resulted in you not being able to train?	Yes	No (Please ignore question 5.2. and 5.3)	Yes	No (Please ignore question 5.2. and 5.3)
5.2. If "Yes" please state the length of the time you were unable to train	________ Days/months/years (please circle the appropriate response)		________ Days/months/years (please circle the appropriate response)	
5.3. What do you think caused the injury? (Please mark the relevant choice with an "X")	Fall		Fall	
	Contact with vehicle		Contact with vehicle	
	Contact with other bicyclist		Contact with other bicyclist	
	Contact with pedestrian		Contact with pedestrian	
	Contact with stationary object		Contact with stationary object	
	Incorrect posture		Incorrect posture	
	Incorrect pedaling technique		Incorrect pedaling technique	
	Overuse fatigue		Overuse fatigue	
	Playing another sport		Playing another sport	
	Unknown		Unknown	
	Other		Other	

6. Past Injury (in the last 12 months)	
Please indicate with an "X" on the model where you have experienced pain or an injury in the last 12 months	

7.Current Injury (In the last 7 days)	
Please indicate with an "X" on the model where you have experienced pain or an injury in the last 7 days	

<table>
<tr><td colspan="5">SECTION D</td></tr>
<tr><td colspan="5">8.Cycling Gear</td></tr>
<tr><td rowspan="5">8.1. Please mark with an "X" whether you use any of the following when mountain biking. You may choose more t7han one.</td><td colspan="2">Helmet</td><td colspan="2"></td></tr>
<tr><td colspan="2">Gloves</td><td colspan="2"></td></tr>
<tr><td colspan="2">Hydration pack (camelback)</td><td colspan="2"></td></tr>
<tr><td colspan="2">Gel seat cover</td><td colspan="2"></td></tr>
<tr><td colspan="2">Padded cycling shorts</td><td colspan="2"></td></tr>
<tr><td>8.2. Do you wear clip-in shoes?</td><td colspan="2">Yes</td><td colspan="2">No (ignore question 8.3.)</td></tr>
<tr><td>8.3. Have you had any injuries from when you started to learn how to use clip-in shoes?</td><td colspan="4"></td></tr>
<tr><td>8.4. What type of pedals do you have on your mountain bike?</td><td>Toe clip and strap
</td><td>Platform
</td><td>Road clips
</td><td>Mountain clips
</td></tr>
<tr><td>8.5. Do you have a cutaway saddle? (a saddle with a hole in the middle)
</td><td colspan="2">Yes (please specify why)</td><td colspan="2">No</td></tr>
<tr><td>8.6. Does your saddle cause any pain or numbness while riding?</td><td colspan="2">Yes (please specify)</td><td colspan="2">No</td></tr>
</table>

<table>
<tr><td colspan="4">SECTION E</td></tr>
<tr><td colspan="4">9. Mountain Bike set up</td></tr>
<tr><td>9.1. Do you know what the proper mountain bike set up is?</td><td colspan="2">Yes</td><td>No</td></tr>
<tr><td>9.2. Have you had your mountain bike set up by a professional?</td><td colspan="2">Yes</td><td>No (ignore question 9.3.)</td></tr>
<tr><td>9.3. Have you noticed a change in your riding after getting a professional bike set up done?</td><td>Yes</td><td>No</td><td>I do not know</td></tr>
<tr><td>9.4. Do you know how to properly use the gears on your mountain bike?</td><td colspan="2">Yes</td><td>No</td></tr>
</table>

APPENDIX I: LETTER OF INFORMATION – FOCUS GROUP

LETTER OF INFORMATION
FOCUS GROUP

Title of the Research Study:
An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality

Principal investigator/s/researcher:
Rochelle van Eck, B.Tech: Chiropractic

Co-investigator/s/supervisor/s:
Dr Desiree Varatharajullu, M.Tech: Chiropractic

Brief introduction to and purpose of the study:
The purpose of this study is to determine what the common risk factors are for musculoskeletal injuries in mountain bikers of various mountain biking clubs in the eThekwini Municipality as well as the injury profile and how these injuries affect the cyclists and their cycling.

Greeting:
Good day, I hope you are well.

I am a 6th year student currently completing my Master's Degree in Chiropractic at Durban University of technology.
I would like to welcome you to my research study and thank you for your participation and co-operation.

What is research:
Research is a systematic search or enquiry for generalized new knowledge. I aim to acquire new knowledge about the injuries that most commonly occur in mountain bikers and in order to accomplish this I require your assistance. Throughout the process you are free to ask any and as many questions as you wish.

Outline of the procedures:
You will be asked to read the following: a Letter of Information (Appendix H), the Confidentiality Agreement (Appendix I), the Informed Consent form (Appendix J) and the Code of Conduct form (Appendix C). After you have read them, you will be given the opportunity to sign the documents and ask questions regarding the procedures to follow. Once all questions have been answered and forms have been signed, the focus group will proceed to discuss the questionnaire. The researcher will act as chair of the meeting

and read the questions out loud, then the focus group will be asked to discuss the relevance of these questions in terms of the aims and objectives of the study and whether it is understandable to the target population of this study. For any questions to be included or excluded from the questionnaire, the focus group needs to be unanimous in their decision to include or exclude any questions. For the questions that remain undecided, a majority vote will be taken to decide what will happen to it.

Risks or discomforts to the participant:
There will be no risk or foreseeable discomfort to you for participating in the focus group.

Reason/s why the participant may be withdrawn from the study:
If you are a potential participant for the pilot study or the main study the researcher will withdraw you from the focus group. Participation in this discussion is completely voluntary, and you may withdraw at any given time without and explanation. There will be no adverse consequences should you decide to withdraw.

Benefits:
Participation in the pilot study is voluntary with no benefits.

Remuneration: You will not receive any remuneration for participating in the focus group discussion.

Costs of the study: You will not be expected to cover any costs during the focus group session.

Confidentiality:
All patient information is confidential. The results of this study will be used for research purposes only. Only individuals that are directly involved in this study (Dr D Varatharajullu, M.Tech: Chiropractic) and myself will be allowed to access these records.

Results:
The results of this study will be made available on the Durban University of Technology online intuitional repository and in the form of a hard copy dissertation.

Research-related injury:
You as the participant will not sustain any research-related injuries, as filling out the questionnaire is all that is expected of you.

Storage of all electronic and hard copies including tape recordings:
All data will be stored at the Chiropractic Department at the Durban University of Technology for five years, when it will be shredded.

Persons to contact in the event of any problems or queries:
Please contact the researcher, Rochelle van Eck on 082 817 9098, my supervisor, Dr Desiree Varatharajullu on 031 373 2533, or the Institutional Research Ethics Administrator

on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

Thank you for participating in this research study.

Rochelle van Eck

(Research student)

APPENDIX J: LETTER OF INFORMED CONSENT – FOCUS GROUP

CONSENT

Full title of the study: An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality

Name of Researcher: Rochelle van Eck

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Rochelle van Eck, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: IREC 069/21,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Full Name of Participant/ Thumbprint	Date	Time	Signature/Right Thumbprint
____________	________	_____	__________

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

Full Name of Researcher	Date	Signature
Full Name of Witness (If applicable)	Date	Signature
Full Name of Legal Guardian (If applicable)	Date	Signature

APPENDIX K: CONFIDENTIALITY AGREEMENT

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

CONFIDENTIALITY STATEMENT AND CODE OF CONDUCT: Expert group

1. All information contained in the research documents and any information discussed during the focus group meeting must be kept private and confidential. This is especially binding to any information that may identify any of the participants in the expert group.

2. None of the information shall be communicated to any other individual or organisation outside of this specific focus group as to the decisions of this expert group.

3. The information from this focus group will be made public in terms of a dissertation and later journal publications, which will in no way identify any of the participants involved in this expert group.

4. The returned questionnaires will be coded and kept anonymous in the research process.

5. The expert group may be either voice or video recorded, as a transcript of the proceedings will need to be made. The data will be stored securely under password protection.

6. All data generated from this expert group (including the recording) will be kept for five years in at the Chiropractic Department at Durban University of Technology and will then be destroyed.

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

Please print in block letters:

Focus Group Member: __________________________Signature: _____________

Witness Name: ________________________________Signature: _____________

Researcher's Name: ____________________________Signature: _____________

Supervisor's Name: ____________________________Signature: _____________

APPENDIX L: CODE OF CONDUCT FORM

DUT DURBAN UNIVERSITY OF TECHNOLOGY

Code of conduct during meetings

Behaviour during Meetings
It is expected of all the members of the expert group, the researcher and supervisor to adhere to the basic rules and regulations of an expert group meeting. Any comments may be raised during the procedure should a participant feel the need to address any of the expert group members or the researcher and supervisor of the study.

Every participant of the meeting must:

- Act appropriately and treat all participants of the meeting with respect.
- Make no derogatory comments either through speech or action.
- Act in a manner that is unbiased and fair.
- Be open and honest about any action or comments and give a reason for them.
- Be clear and honest when giving a personal view of any part of the meeting or questionnaire.
- Participants should not interrupt a member when he or she addresses the group

Declaration of interest:
Should any of the participants have a financial, personal or other material interest in the outcome of the study, it is expected that this standing will be raised to the researcher and/or supervisor.

Confidentiality:
In conjunction with the letter of information and informed consent and confidentiality agreement, it is noted that all information discussed during the expert group meeting will be kept confidential.

Breach of code of conduct:
Any participant not adhering to the above speculated rules may be asked to leave the expert group meeting with no discrimination for future attendance to meetings as such.

Please print in block letters:

Expert Group Member: __________________________ Signature: _____________

Witness Name: ________________________________ Signature: _____________

Researcher's Name: _____________________________Signature: _____________

Supervisor's Name: _____________________________Signature: _____________

APPENDIX M: LETTER OF INFORMATION – PILOT STUDY

LETTER OF INFORMATION – PILOT STUDY

Dear Participant

Thank you for taking the time to participate in this study. It is greatly appreciated.

Title of the research study:
An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality

Principal investigator/s/researcher:
Rochelle van Eck, B.Tech: Chiropractic

Co-investigator/s/supervisor/s:
Dr Desiree Varatharajullu, MTech: Chiropractic

Brief introduction to and purpose of the study:
The purpose of this study is to determine what the common risk factors are for musculoskeletal injuries in mountain bikers of various mountain biking clubs in the eThekwini Municipality as well as the injury profile and how these injuries affect the cyclists and their cycling.

Greeting:
Good day, I hope you are well.

I am a 6th year student currently completing my Master's Degree in Chiropractic at Durban University of technology. I would like to welcome you to my research study and thank you for your participation and co-operation.

What is research: Research is a systematic search or enquiry for generalized new knowledge. I aim to acquire new knowledge about the injuries that most commonly occur in mountain bikers and in order to accomplish this I require your assistance. Throughout the process you are free to ask any and as many questions as you wish.

Outline of the procedures:
You will be required to give your input about this study in order to determine any logistical problems with the main study. You will be required to read and complete the Letter of

Information (Appendix K) and Informed Consent (Appendix L). Thereafter you will be required to complete the questionnaire. Once you have completed the post-focus group questionnaire, you will need to complete a questionnaire evaluation form (Appendix M) in which you should identify any problems with the questionnaire

Risks or discomfort for the participant:
There will be no risk or foreseeable discomfort to you during the pilot study.

Reason/s why the participant may be withdrawn from the study:
If you were a participant of the focus group or a potential participant for the main study the researcher will withdraw you from the pilot study. Your participation in this study is completely voluntary, and you may withdraw at any given time without an explanation and there will be no adverse consequences should you decide to withdraw.

Benefits:
Participation in the pilot study is voluntary with no benefits.

Remuneration:
You will not receive any remuneration for participating in the pilot study.

Costs of the study:
You will not be expected to cover any costs during the pilot study.

Confidentiality:
All patient information is confidential. The results of this study will be used for research purposes, Only individuals that are directly involved in this study (Dr D Varatharajullu, M.Tech: Chiropractic) and myself will be allowed to access these records.

Results:
The results of this study will be made available on the online intuitional repository and in the form of a hard copy dissertation.

Research-related injury:
You as the participant will not sustain any research-related injuries, as filling out the questionnaire is all that is expected of you.

Storage of all electronic and hard copies including tape recordings:
All data will be stored at the Chiropractic Department at the Durban University of Technology for five years, when it will be shredded.

Persons to contact in the event of any problems or queries:
Please contact the researcher, Rochelle van Eck, on 082 817 9098, my supervisor, Dr Desiree Varatharajullu, on 031 373 2533, or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

Thank you for participating in my research study.

Rochelle van Eck

(Research student)

APPENDIX N: LETTER OF INFORMED CONSENT – PILOT STUDY

DUT DURBAN UNIVERSITY OF TECHNOLOGY — INSTITUTIONAL RESEARCH ETHICS COMMITTEE

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Rochelle van Eck, about the nature, conduct, benefits, and risks of this study - Research Ethics Clearance Number: IREC 069/21
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis, will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and, of my own free will, declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

____________________ __________ ______ _______________

Full Name of Participant **Date** **Time** **Signature/Right Thumbprint**

I, Rochelle van Eck 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**

APPENDIX O: POST-FOCUS GROUP QUESTIONNAIRE

SECTION A											
1. Demographics: (Participant: Please fill in or mark with a "X" where relevant)											
1.1. Age (years)	18-24		25-29		30-34		35-39		40-44		45-50
1.2. Sex	Female						Male				
1.3. Race (for statistical purposes)	African		Coloured		Indian		White		Other		
1.5. Height (m)	<1,55	1,55-1,59	1,6–1,64	1,65–1,69	1,7–1,74	1,75–1,79	1,8-1,84	1,85-1,89	1.9-1,94	1,95-1,99	>2m
1.4. Weight (kg)	<55	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	94-99	>100

SECTION B - Training and competition history							
2.Training History							
2.1. How long have you been mountain biking?	<1year	2-4 years	4-6 years	6-8 years	8-10 years	10-12 years	>12 years
2.2. How many hours a week do you spend training?	<1	1	2	3	4	5	>5
2.3. Which category do you ride in most often?	Off-road	Tarred surfaces	Downhill courses	Cross cycling (cross country)	Enduro		
2.4. What type of mountain bike do you use?	Rigid (no shocks)	Hardtail (front shocks only)	Softtail (front and back shocks)				
2.5. Do you incorporate rest days in your training?	Yes	No					
2.6. Have you or are you currently using any of the following when training? (you may tick more than one)	Pain medication	Bracing	Strapping	Splint	Other (please specify)	Have not used anything (please move on to 3.1.)	
2.7. The above (question 2.6.) helped you continue with your training after the injury occurred?	Yes, it helped a bit	Yes, it helped moderately	Yes, it helped greatly	No, it did not help			
3.Competition History							
3.1. In what category do you race?	Solo	2 person team (tandem or separate)	3-4 person team	5 + person team			
3.2. How long have you been racing in mountain bike events?	A few weeks	6-12 months	More than 1 year (please specify)				
3.3. According to the NORBA classification that's used in mountain biking, which class do you classify yourself as?	Never raced	Beginner	Sport	Semi-Pro	Pro	Expert	

SECTION C

4.Musculoskeletal injury (Injury – discomfort, pain, or damage to a part which may or may not stop training)

4.1 Have you had an injury due to mountain biking?	Yes	No (You have now completed Section C, kindly hand in your form)

4.2 How many times in the past year have you been injured whilst mountain biking?	Once	2-3 times	4-5 times	More than 5 times

4.3 Has your injury/s been diagnosed by a medical professional? If "Yes" please tick the appropriate box	Yes							No
	Chiropractor	Physio - therapist	Occupational-therapist	Biokineticist	General Practitioner	Orthopaedic Surgeon	Other (please specify)	

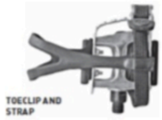
4.4. If "Yes" please state the diagnosis of your injury (In the case of multiple injuries, please state the diagnosis of the WORST injury)	

4.5. Please mark the box with an "X" of which body part you sustained an injury to and when you sustained the injury that prevented you from training. Then circle the type of injury associated with that body part	Wrist	In the last 7 days	In the last 6 months	In the last 12 months	Sprain/strain, fracture, cut, scrape, bruise, dislocations
	Arm	In the last 7 days	In the last 6 months	In the last 12 months	Sprain/strain, fracture, cut, scrape, bruise, dislocations
	Shoulder	In the last 7 days	In the last 6 months	In the last 12 months	Sprain/strain, fracture, cut, scrape, bruise, dislocations
	Leg	In the last 7 days	In the last 6 months	In the last 12 months	Sprain/strain, fracture, cut, scrape, bruise, dislocations
	Ankle	In the last 7 days	In the last 6 months	In the last 12 months	Sprain/strain, fracture, cut, scrape, bruise, dislocations
	Knee	In the last 7 days	In the last 6 months	In the last 12 months	Sprain/strain, fracture, cut, scrape, bruise, dislocations

	Head	In the last 7 days	In the last 6 months	In the last 12 months	Concussion, fracture, cut, scrape
	Hand	In the last 7 days	In the last 6 months	In the last 12 months	Sprain/strain, fracture, cut, scrape, bruise, dislocations

	Current injury (in the last 7 days)		**Past injury (in the last 6 months)**		**Past injury (in the last 12 months)**	
4.6. What do you think caused the injury? (Please mark the relevant choice with an "X")	Fall		Fall		Fall	
	Contact with vehicle		Contact with vehicle		Contact with vehicle	
	Contact with other bicyclist		Contact with other bicyclist		Contact with other bicyclist	
	Contact with stationary object		Contact with stationary object		Contact with stationary object	
	Incorrect posture		Incorrect posture		Incorrect posture	
	Incorrect pedaling technique		Incorrect pedaling technique		Incorrect pedaling technique	
	Overuse fatigue		Overuse fatigue		Overuse fatigue	
	Playing another sport		Playing another sport		Playing another sport	
	Fall from clip in shoes		Fall from clip in shoes		Fall from clip in shoes	
	Unknown		Unknown		Unknown	
	Other (please specify)		Other (please specify)		Other (please specify)	

SECTION D		
5.Cycling Gear and Bike set up		
5.1. Please mark with an "X" whether you use any of the following when mountain biking. You may choose more than one.	Helmet	
	Gloves	
	Hydration pack (camelback)	
	Gel seat cover	
	Padded cycling shorts	
	Other (please specify)	
5.2. Do you wear clip-in shoes?	Yes	No (please move on to 5.4.)
5.3. Have you had any injuries from when you started to learn how to use clip-in shoes?	Yes	No

5.4. What type of pedals do you have on your mountain bike?	Toe clip and strap 	Platform 	Road-clips 	Mountain-clips 
5.5. Have you had your mountain bike set up by a professional?	Yes		No	

Section E								
6. Impact of injury on Rider								
	Past Injury (in the last 12 months)				**Current injury (in the last 7 days)**			
6.1. Has your injury resulted in you not being able to train?	Yes		No (Please move on to question 6.3.)		Yes		No (Please move on to question 6.3.)	
6.2. If "Yes" please state the length of time you were unable to train.	0-7 days	1-3 weeks	3-5 weeks	5-8 weeks	2-3 months	3-6 months	6-12 months	>1 year
6.3. Has your injury (past/current) resulted in missing days at work?	Yes		No (you have completed the questionnaire)		Yes		No (You have completed the questionnaire)	
6.4. If "yes" please state how long you missed work for?	0-7 days	1-3 weeks	3-5 weeks	5-8 weeks	2-3 months	3-6 months	6-12 months	>1 year

APPENDIX P: QUESTIONNAIRE EVALUATION FORM

Pre-test Evaluation

1. What is your opinion of the subject presented in this questionnaire? (Please mark the most appropriate box)
   1.1 Extremely interesting
   1.2 Interesting
   1.3 Average
   1.4 Boring
   1.5 Very boring

2. Do you think the topics raised in this questionnaire were adequately covered?
   2.1 Yes
   2.2 No

3. What is your opinion about the covering letter? (Please mark one box only)
   3.1 Very clear
   3.2 Clear
   3.3 Adequate
   3.4 Unclear
   3.5 Needs revising

4. How would you describe the instructions accompanying each of the questions? (Please mark one box only)
   4.1 Very clear
   4.2 Clear
   4.3 Adequate
   4.4 Unclear
   4.5 Needs revision

5. <u>Please comment on the length of the questionnaire.</u> (Do you think the questionnaire is too long?)

6. What is your opinion of the wording of the questionnaire? (Please mark the appropriate box/es)

   6.1 The meaning of all questions is absolutely clear
   6.2 The meaning of most questions is clear
   6.3 There is too much chiropractic/medical jargon

6.4 The questions will not be understood by lay persons
6.5 The questionnaire needs to be revised because it is unclear

If you had any difficulty answering any question/s, please write the number/s of the question/s in the space below with a suggestion on how the question/s can be improved.

____

____

Thank you for your most valuable time in helping me with my research project.

Rochelle van Eck

APPENDIX Q: FINAL QUESTIONNAIRE (MAIN STUDY)

SECTION A											
1. Demographics: (Participant: Please fill in or mark with a "X" where relevant)											
1.1. Age (years)	18-24		25-29		30-34		35-39		40-44		45-50
1.2. Sex	Female						Male				
1.3. Race (for statistical purposes)	African		Coloured		Indian		White		Other		
1.5. Height (m)	<1,55	1,55-1,59	1,6–1,64	1,65–1,69	1,7–1,74	1,75–1,79	1,8-1,84	1,85-1,89	1.9-1,94	1,95-1,99	>2m
1.4. Weight (kg)	<55	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	94-99	>100

SECTION B - Training and competition history							
2. Training History							
2.1. How long have you been mountain biking?	<1year	2-4 years	4-6 years	6-8 years	8-10 years	10-12 years	>12 years
2.2. How many hours a week do you spend training?	<1	1	2	3	4	5	>5
2.3. Which category do you ride in most often?	Off-road	Tarred surfaces	Downhill courses	Cross cycling (cross country)	Enduro		
2.4. What type of mountain bike do you use?	Rigid (no shocks)	Hardtail (front shocks only)	Softtail (front and back shocks)				
2.5. Do you incorporate rest days in your training?	Yes	No					
2.6. Have you or are you currently using any of the following when training? (you may tick more than one)	Pain medication	Bracing	Strapping	Splint	Other (please specify)	Have not used anything (please move on to 3.1.)	
2.7. The above (question 2.6.) helped you continue with your training after the injury occurred?	Yes, it helped a bit	Yes, it helped moderately	Yes, it helped greatly	No, it did not help			
3. Competition History							
3.1. In what category do you race?	Solo	2 person team (tandem or separate)	3-4 person team	5 + person team			
3.2. How long have you been racing in mountain bike events?	A few weeks	6-12 months	More than 1 year (please specify)				
3.3. According to the NORBA classification that's used in mountain biking, which class do you classify yourself as?	Never raced	Beginner	Sport	Semi-Pro	Pro	Expert	

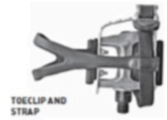
<table>
<tr><td colspan="9">SECTION C</td></tr>
<tr><td colspan="9">4.Musculoskeletal injury (Injury – discomfort, pain, or damage to a part which may or may not stop training)</td></tr>
<tr><td>4.1 Have you had an injury due to mountain biking?</td><td colspan="4">Yes</td><td colspan="4">No (You have now completed Section C, kindly hand in your form)</td></tr>
<tr><td>4.2 How many times in the past year have you been injured whilst mountain biking?</td><td colspan="2">Once</td><td colspan="2">2-3 times</td><td colspan="2">4-5 times</td><td colspan="2">More than 5 times</td></tr>
<tr><td rowspan="2">4.3 Has your injury/s been diagnosed by a medical professional? If "Yes" please tick the appropriate box</td><td colspan="7">Yes</td><td rowspan="2">No</td></tr>
<tr><td>Chiropractor</td><td>Physio - therapist</td><td>Occupational- therapist</td><td>Biokineticist</td><td>General Practitioner</td><td>Orthopaedic Surgeon</td><td>Other (please specify)</td></tr>
<tr><td>4.4. If "Yes" please state the diagnosis of your injury (In the case of multiple injuries, please state the diagnosis of the WORST injury)</td><td colspan="8"></td></tr>
<tr><td rowspan="6">4.5. Please mark the box with an "X" of which body part you sustained an injury to and when you sustained the injury that prevented you from training.

Then circle the type of injury associated with that body part</td><td>Wrist</td><td>In the last 7 days</td><td>In the last 6 months</td><td>In the last 12 months</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Arm</td><td>In the last 7 days</td><td>In the last 6 months</td><td>In the last 12 months</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Shoulder</td><td>In the last 7 days</td><td>In the last 6 months</td><td>In the last 12 months</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Leg</td><td>In the last 7 days</td><td>In the last 6 months</td><td>In the last 12 months</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Ankle</td><td>In the last 7 days</td><td>In the last 6 months</td><td>In the last 12 months</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td>Knee</td><td>In the last 7 days</td><td>In the last 6 months</td><td>In the last 12 months</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
</table>

	Head	In the last 7 days	In the last 6 months	In the last 12 months	Concussion, fracture, cut, scrape
	Hand	In the last 7 days	In the last 6 months	In the last 12 months	Sprain/strain, fracture, cut, scrape, bruise, dislocations

	Current injury (in the last 7 days)		**Past injury (in the last 6 months)**		**Past injury (in the last 12 months)**	
4.6. What do you think caused the injury? (Please mark the relevant choice with an "X")	Fall		Fall		Fall	
	Contact with vehicle		Contact with vehicle		Contact with vehicle	
	Contact with other bicyclist		Contact with other bicyclist		Contact with other bicyclist	
	Contact with stationary object		Contact with stationary object		Contact with stationary object	
	Incorrect posture		Incorrect posture		Incorrect posture	
	Incorrect pedaling technique		Incorrect pedaling technique		Incorrect pedaling technique	
	Overuse fatigue		Overuse fatigue		Overuse fatigue	
	Playing another sport		Playing another sport		Playing another sport	
	Fall from clip in shoes		Fall from clip in shoes		Fall from clip in shoes	
	Unknown		Unknown		Unknown	
	Other (please specify)		Other (please specify)		Other (please specify)	

SECTION D		
5.Cycling Gear and Bike set up		
5.1. Please mark with an "X" whether you use any of the following when mountain biking. You may choose more than one.	Helmet	
	Gloves	
	Hydration pack (camelback)	
	Gel seat cover	
	Padded cycling shorts	
	Other (please specify)	
5.2. Do you wear clip-in shoes?	Yes	No (please move on to 5.4.)
5.3. Have you had any injuries from when you started to learn how to use clip-in shoes?	Yes	No

5.4. What type of pedals do you have on your mountain bike?	Toe clip and strap 	Platform 	Road-clips 	Mountain-clips 
5.5. Have you had your mountain bike set up by a professional?	Yes		No	

Section E								
6. Impact of injury on Rider								
	Past Injury (in the last 12 months)				**Current injury (in the last 7 days)**			
6.1. Has your injury resulted in you not being able to train?	Yes		No (Please move on to question 6.3.)		Yes		No (Please move on to question 6.3.)	
6.2. If "Yes" please state the length of time you were unable to train.	0-7 days	1-3 weeks	3-5 weeks	5-8 weeks	2-3 months	3-6 months	6-12 months	>1 year
6.3. Has your injury (past/current) resulted in missing days at work?	Yes		No (you have completed the questionnaire)		Yes		No (You have completed the questionnaire)	
6.4. If "yes" please state how long you missed work for?	0-7 days	1-3 weeks	3-5 weeks	5-8 weeks	2-3 months	3-6 months	6-12 months	>1 year

APPENDIX R: ADVERTISEMENT

Are you a Mountain Biker?

Do you LOVE Mountain Biking?

BUT . . .

Have you suffered any injuries

related to Mountain Biking?

Then become a part of a research

study!

Contact:

Rochelle van Eck – 082 817 9098

rochellevaneck96@gmail.com

APPENDIX S: LETTER OF INFORMATION – MAIN STUDY

LETTER OF INFORMATION

Title of the research study:
An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality

Principal investigator/s/researcher:
Rochelle van Eck, B.Tech: Chiropractic

Co-investigator/s/supervisor/s:
Dr Desiree Varatharajullu, MTech: Chiropractic

Brief introduction to and purpose of the study:
The purpose of this study is to determine what the common risk factors are for musculoskeletal injuries in mountain bikers of various mountain biking clubs in the eThekwini Municipality as well as the injury profile and how these injuries affect the cyclists and their cycling.

Greeting:
Good day, I hope you are well.

I am a 6th year student currently completing my Master's Degree in Chiropractic at Durban University of technology. I would like to welcome you to my research study and thank you for your participation and co-operation.

What is research:
Research is a systematic search or enquiry for generalized new knowledge. I aim to acquire new knowledge about the injuries that most commonly occur in mountain bikers and in order to accomplish this I require your assistance. Throughout the process you are free to ask any and as many questions as you wish.

Outline of the procedures:
You will be required to read the Information Letter (Appendix A) and, if you agree, then you must sign the Informed Consent letter (Appendix B), and you will then be included in the study. You will also be responsible for completing the questionnaire that same day. The questionnaire will be handed out after completion of an event or upon response to the advertisement. After the study and all its related procedures have been explained, the venue of this meeting will either be at the club or it will be determined by the Club Manager and relayed to you.

No chiropractic treatment will be given during the study. Time required will be 10 to 15 minutes to complete the questionnaire. You are expected to be truthful and honest when completing the questionnaire and to fully complete all questions in the questionnaire before I collect it from you.

Risks or discomfort to the participant:
You will not be exposed to any foreseeable risks or discomfort.

Reason/s why the participant may withdraw from the study:
If you do not actively participate mountain biking 3 to 5 times a week or fail to return the completed questionnaire to the researcher, it will result in you being withdrawn from this study. Participation in this study is completely voluntary and you may withdraw at any given time without an explanation and there will be no adverse consequences should you decide to withdraw.

Benefits:
You will indirectly benefit from this study in terms of healthcare providers gaining more insight into the injuries affecting mountain bikers and this may enhancing the overall management of mountain biking as a sport in your area.

Remuneration:
You will not receive any remuneration for participating in the study.

Costs of the study:
You will not be expected to cover any costs during the study.

Confidentiality:
You will remain completely anonymous in the study and will be represented as a number in the results. No names or personal information will be revealed. Only the researcher, her supervisor, and the participant will have access to the information.

Results:
The results of this study will be made available on the Durban University of Technology online intuitional repository and in the form of a hard copy dissertation.

Research-related injury:
You will not obtain any research-related injuries, as filling out the questionnaire is all that is expected of you.

Storage of all electronic and hard copies including tape recordings:
All data will be stored at the Chiropractic Department at the Durban University of Technology for five years, thereafter it will be shredded.

Persons to contact in the event of any problems or queries:
Please contact the researcher Rochelle van Eck on 082 817 9098, my supervisor, Dr Desiree Varatharajullu, on 031 373 2533 or the Institutional Research Ethics Administrator

on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

Thank you for participating in my research study.

Rochelle van Eck

(Research student)

APPENDIX T: LETTER OF INFORMED CONSENT – MAIN STUDY

CONSENT

Full title of the study:

An injury profile of musculoskeletal injuries in mountain bikers in the eThekwini Municipality

Name of Researcher:

Rochelle van Eck

Statement of Agreement to Participate in the Research Study:

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

Full Name of Participant **Date** **Time**

Signature/Right Thumbprint

I, Rochelle van Eck 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**

APPENDIX U: LETTER OF INFORMATION TRANSLATED INTO ISIZULU

ISIHLOKO SOKWAZISA

Mhlanganyeli othandekayo,

Ngifisa ukunemukela esifundweni sami sokucwaninga futhi ngiyabonga ngokubambisana kwenu.

Isihloko Sesifundo Sokucwaninga:

Isifo sokulimala kokulimala kwemisipha ezindaweni ezihamba ngezinyawo kuMasipala weTheku

Umphenyi / umphenyi omkhulu: URochelle van Eck, B.Tech: Chiropractic

Umphenyi / s / umphathi / abagadi: UDkt Desiree Varatharajullu, MTech: Chiropractic

Isingeniso esifushane nenhloso yocwaningo:

Inhloso yalolu cwaningo ukuthola ukuthi yiziphi izinto ezivame ukuba sengozini zokulimala kwe-musculoskeletal in the boarders of Mountain Amakilabhu ahlukene ezintabeni kuMasipala weTheku kanye nephrofayili yokulimala nokuthi lokhu kulimala kubathinta kanjani abahamba ngamabhayisekili kanye nokuhamba kwabo ngebhayisekili.

Uhlaka lwezinqubo:

Wena njengomhlanganyeli, kuzodingeka ukuthi ufunde incwadi yolwazi (Isithasiselo A) futhi uma uvuma, khona-ke kufanele usayine incwadi yemvume enolwazi (Isithasiselo B) futhi uzobe usufakwa esifundweni. Uzoba nesibopho sokuqedela uhlu lwemibuzo ngalo lolo suku. Uhlu lwemibuzo luzonikezwa ngesikhathi somhlangano nabo bonke abahlanganyeli ekilabhini yamabhayisekili kanye nomcwaningi ekhona. Ngemuva kokuthi ucwaningo nazo zonke izinqubo ezilandelanayo zichaziwe, indawo yalo mhlangano izoba sekilabhu uqobo noma inqunywe yimenenja yekilabhu bese idluliselwa kuwe.

Akukho ukuphathwa okuzonikezwa esifundweni sonke. Isikhathi esidingekayo kuzoba imizuzu eyi-10 kuye kweli-15 ukuqeda uhlu lwemibuzo. Kulindeleke ukuthi ube neqiniso futhi uthembeke lapho ugcwalisa uhlu lwemibuzo futhi ugcwalisa ngokuphelele yonke imibuzo kwiphepha lemibuzo ngaphambi kokuqoqa uhlu lwemibuzo.

Ubungozi noma ukungahambi kahle kuMhlanganyeli:

Wena njengomhlanganyeli ngeke uboniswe kunoma yiziphi izingozi noma ukuphazamiseka okubonakalayo.

Izinzuzo:

Ngeke uzuze kulolu cwaningo, kepha umcwaningi uzohlomula kulolu cwaningo ngokuthola iziqu zakhe futhi kungenzeka nokuthi ucwaningo lushicilelwe.

Izizathu / izizathu zokuthi kungani Umhlanganyeli Angahoxiswa esifundweni:

Uma ungakhuthazi ukuhamba ngebhayisekili izikhathi ezi-3 kuye kweziyi-5 ngesonto futhi ukwehluleka ukubuyisela iphepha lemibuzo eligcwalisiwe kumcwaningi kuzoholela ekutheni ukhishwe kulolu cwaningo. Lolu cwaningo lukhona ngokuzithandela ngokuphelele, futhi ungahoxa nganoma yisiphi isikhathi ngaphandle kwencazelo edingekayo futhi ngeke kube nemiphumela emibi uma unganquma ukuhoxa.

Umholo: Ngeke uthole noma yimuphi umholo ngokubamba iqhaza ocwaningweni.

Izindleko Zokufunda: Ngeke ulindelwe ukuthi ukhokhe izindleko ngesikhathi sokufunda.

Imfihlo:

Wena njengomhlanganyeli uzohlala ungaziwa ngokuphelele ocwaningweni futhi uzonikezwa inombolo emiphumeleni yocwaningo, akukho magama noma imininingwane yomuntu uqobo ezokwenzeka ocwaningweni. Umcwaningi kuphela, umphathi wakhe kanye nalowo obambe iqhaza yena uqobo onokwazi ukuthola imininingwane yabo.

Ukulimala okuhlobene nocwaningo:

Wena njengomhlanganyeli ngeke uthole ukulimala okuhlobene nokucwaninga, ngoba ukugcwalisa uhlu lwemibuzo yikho konke okulindelwe kuwe.

Abantu Ongathintana Nabo Uma Izinkinga Nezinkinga:

Sicela uthinte umcwaningi uRochelle van Eck kule nombolo 082 817 9098, umphathi wami uDkt Desiree Varatharajullu kule nombolo 031 373 2533 noma ku-Institutional Research Ethics Administrator ku-031 373 2375. Izikhalazo zingabikwa kwa- Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

Ngiyabonga ngokubamba iqhaza ocwaningweni lwami locwaningo.

URochelle van Eck

(Umfundi ocwaningayo)

APPENDIX V: LETTER OF INFORMED CONSENT TRANSLATED INTO ISIZULU

ISIVUMELWANO

Isitatimende sesivumelwano sokubamba iqhaza esifundweni sokucwaninga:

- Ngiyaqinisekisa ukuthi ngitshelwe ngumcwaningi, uRochelle van Eck, mayelana nohlobo, ukuziphatha, izinzuzo kanye nobungozi balolu cwaningo - Ucwaningo Lokuziphatha Olucacile
  Inombolo: _______________,
- Ngithole futhi, ngafunda futhi ngayiqonda imininingwane ebhalwe ngaphezulu (Incwadi ebambe iqhaza)
  Yeyolwazi) mayelana nocwaningo.
- Ngiyazi ukuthi imiphumela yocwaningo, kufaka phakathi imininingwane yomuntu maqondana nobulili bami, iminyaka yami, usuku lokuzalwa, izinhloso zokuqala nokuxilongwa zizocutshungulwa ngokungaziwa ngombiko wokucwaninga.
- Ngokubheka izidingo zokucwaninga, ngiyavuma ukuthi imininingwane eqoqwe ngalesi sifundo ingacutshungulwa ohlelweni olwenziwe ngekhompyutha ngumcwaningi.
- Ngingathi, ngasiphi isigaba, ngaphandle kokubandlulula, ngingahoxisa ukuvuma kwami kanye nokuzibandakanya ocwaningweni.
- Ngithole ithuba elanele lokubuza imibuzo futhi (ngokwenkululeko yami yokuzikhethela) ngizazise ngilungele ukubamba iqhaza ocwaningweni.
- Ngiyaqonda ukuthi ukutholwa okusha kuqhamuke phakathi nalolu cwaningo ingahlobene nokuzibandakanya kwami kuzokwenziwa kutholakale kimi.

______________________ _______ _______ _____________________

Igama eligcwele Lokubamba qhaza Kwesikhathi Isiginesha / Kwesokudla Isithonjana

Mina, uRochelle van Eck ngalokhu ngiyaqinisekisa ukuthi umhlanganyeli ongenhla unolwazi oluphelele mayelana nohlobo, ukuziphatha kanye nengozi yocwaningo olungenhla.

______________________	_______	_________
Igama eligcwele Lomsayenzi	Usuku	Isiginesha
___________________	_________	______
Igama Egcwele Lofakazi (Uma kusebenza)	Isiginesha	yosuku
_______________________	______	____________
Igama eliphelele Lezisiginesha Lwezomthetho (Uma kukhona)	Usuku	

APPENDIX W: FINAL QUESTIONNAIRE TRANSLATED INTO ISIZULU

<table>
<tr><td colspan="8">SECTION C (ISAHLUKO C)</td></tr>
<tr><td colspan="8">4.Musculoskeletal injury (Injury – discomfort, pain, or damage to a part which may or may not stop training)</td></tr>
<tr><td>4.1 Wake walimala engozimi yesithuthuthu</td><td colspan="3">Yebo</td><td colspan="4">Cha (manje qedela isahluko o njengokubhalili ephephem</td></tr>
<tr><td>4.2 Sekuka ngaki eminyakeni ellule ulimala emdlalweni wesithuthuthu</td><td>Sekukanye</td><td colspan="2">Sekuklambili kaya kwezintathu izikhati</td><td colspan="2">Kunye kuyakwezinhlanu izikhathi</td><td colspan="2">Sekuyizikhathi ezingaphezulu kwezinhlanu</td></tr>
<tr><td rowspan="2">4.3 Masu-ulimele ukulimala kwakho ubudingeka yini ukuthatha ukuhlolwa kwabaphezulu bezempilo yebo sicela uthikhe</td><td colspan="3">Yes</td><td colspan="4">No</td></tr>
<tr><td>Chiropractor</td><td>Physio - therapist</td><td>Occupational-therapist</td><td>Biokineticist</td><td>General Practitioner</td><td>Orthopaedic Surgeon</td><td>Other (please specify)</td></tr>
<tr><td>4.4. Uma uthi "yebo" chaza ngokulimala kiwakho owawubuzwa</td><td colspan="7"></td></tr>
<tr><td rowspan="8">4.5. Ingalo insuku eziyisikhombisa eziyisithu noma ezigishum linambi Ehlombe, eziyisikhombisa eziyisithupha, unyaka</td><td colspan="2">Umlenze</td><td colspan="2">Eziyisikhombisa</td><td>Eziyisithupha</td><td>Unyaka</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td colspan="2">Iqakala</td><td colspan="2">Eziyisikhombisa</td><td>Eziyisithupha</td><td>Unyaka</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td colspan="2">Idolo</td><td colspan="2">Eziyisikhombisa</td><td>Eziyisithupha</td><td>Unyaka</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td colspan="2">Ikhanda</td><td colspan="2">Eziyisikhombisa</td><td>Eziyisithupha</td><td>Unyaka</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td colspan="2">Isandla</td><td colspan="2">Eziyisikhombisa</td><td>Eziyisithupha</td><td>Unyaka</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td colspan="2">Kekelezela</td><td colspan="2">Eziyisikhombisa</td><td>Eziyisithupha</td><td>Unyaka</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
<tr><td colspan="2">Ukuzukile</td><td colspan="2">Eziyisikhombisa</td><td>Eziyisithupha</td><td>Unyaka</td><td>Concussion, fracture, cut, scrape</td></tr>
<tr><td colspan="2">Uphukile</td><td colspan="2">Eziyisikhombisa</td><td>Eziyisithupha</td><td>Unyaka</td><td>Sprain/strain, fracture, cut, scrape, bruise, dislocations</td></tr>
</table>

	Ukulimala		Eizinsukwini		Eziyisikhombisa	
4.6. Yini ocabainga yabangela ukuwa	Ukuwa		Ukuwa		Ukuwa	
	Ukushayisana nemoto		Ukushayisana nemoto		Ukushayisana nemoto	
	Ukushayisana Abhayisikili		Ukushayisana Abhayisikili		Ukushayisana Abhayisikili	
	Ukulinyazwa izinto ezicijile zokufunda		Ukulinyazwa izinto ezicijile zokufunda		Ukulinyazwa izinto ezicijile zokufunda	
	Ukungami Kahle		Ukungami Kahle		Ukungami Kahle	
	Ukuhamba endaweni engafanele		Ukuhamba endaweni engafanele		Ukuhamba endaweni engafanele	
	Ukudlala omunye umdlalo		Ukudlala omunye umdlalo		Ukudlala omunye umdlalo	
	Ukuwiswa zicathulo		Ukuwiswa zicathulo		Ukuwiswa zicathulo	
	Ukungami kahle		Ukungami kahle		Ukungami kahle	
	Awazi		Awazi		Awazi	
	Eziyishumi nambili		Eziyishumi nambili		Eziyishumi nambili	

SECTION D (Okuqukethwe ngu D)				
5. Amagiye esithuthuthu				
5.1. Sicela ufake "X" ukulandela izinto ozisebenzisa uma uqhuba	Umakalabha			
	Amagilavu			
	Amanzi			
	Isikhindi sokushova sesithuthu			
	Sokushova			
	Amanzi			
5.2. Uyaziggoka izicathulo zokushova?	Yebo		Cha	
5.3. Unakho ukulimala owakuthola ugola ukufunela ukushova?	Yebo		Cha	
5.4. Iziphinizinzimbi onazo esithuthuthwini salsha sasentabeni?	Toe clip and strap 	Platform 	Road-clips 	Mountain-clips 
5.5. Isithuthu sakha sasentabeni wake wasilungiselwa yini Usolwazi?	Yebo		Cha	

Section E (Isahluko Ku E)							
6. Ukulimala Ugibele							
	Dlulela komunye umubazo				Ukuziqeqesha		
6.1. Ukulimala kwakho kwabangela ukuthi ungakwa	Yebo	Cha Ngicela ubuyele umbino 6.3			Yebo	Cha Ngicela ubuyele umbino 6.3	
6.2. Uma kunjalo yisho ukuthi isikhati esingakanani	ungakwazi	ukuzilolonga	izinzuku	eziyisikhombisa	Noma isonto nohafu	Amasonto ayisihlanu kuya kwayisishagalombil	Izinyanga ezimbili kuya kwezintatha	Kweziyisithupha eziyisithupa kuya kweziyishumi nambiliunyaka
6.3. Ukulimalakwakha a kwakha kwaholela ekutheni kube nezinsuku ongagi ngazo emsebenzini?	Yebo	Cha			Yebo	Cha		
6.4. Cha wuyiqedile imibuzo uma kuwu Yebo Sicela Usho Ukuthi isikhathiesingakanani ungayi emsembenzini?	Sonto elilodwa kuya kwamatha the	Amathathu kuya kwayisihlanu	Amahlanu kuga kwayi sishiyagalombili	Izinyanga ezimbili kuya kwezintathu	Ezintathu kuya kweziyisithupha	Eziyisithu pha kuya kweziyishumi nambil		Kweziyisithupha eziyisithupa kuya kweziyishumi nambiliunyaka

APPENDIX X: PERMISSION LETTER FROM MAXINE MILLAR

BAY LIFE CLINIC

LIFE CLINIC

MAXINE MILLAR REGISTERED CHIROPRACTOR

PRACTICE NO. 0788031

Telephone No: 041-581 6368

60 VILLIERS ROAD (cnr. 3rd Ave) WALMER PORT ELIZABETH 6070

07 January 2020

To whom it may concern

I hereby give full permission to Ms Rochelle Van Eck to use the questionnaire from my study to conduct her research.

Kind regards

Dr Maxine Millar

APPENDIX Y: PERMISSION LETTER FROM STEPHANIE LEREAU

November 2, 2020

Dear Ms. Rochelle Van Eck,

You have permission to use my survey from my paper entitled "Injuries In Mountain Bike Racing: Frequency of Injuries In Endurance Versus Cross Country Mountain Bike Races".

Sincerely,

[redacted]

Stephanie Lareau, MD, FACEP, FAWM
Associate professor, Virginia Tech – Carilion School of Medicine
Wilderness Medicine Fellowship Director
Department of Emergency Medicine
Carilion Roanoke Memorial Hospital
1906 Belleview Ave.
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