A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality

By

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I, Wabo Dhlamini, certify that this dissertation is representative of my own work in both conception and execution, and I have acknowledged all material and resources used in its preparation.

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Abstract

Background

Weight training is an ancient practice that has been growing and evolving over time. It has gained more popularity in modern times due to its benefits for the musculoskeletal and cardiovascular systems. Although weight training has been associated with numerous benefits, there are also documented risks of injury associated with it. There are several gyms within the eThekwini municipality where people perform weight training exercises and possibly sustain injuries related to weight training. However, there is a paucity of literature relating to this group of individuals, some of whom are not professional athletes and could possibly be at higher risk of sustaining injuries. The aim of this research was to ascertain the musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality.

Methodology

This research was a quantitative cross-sectional survey; a questionnaire was used as the research tool. The questionnaire was administered to 322 participants who met the inclusion criteria. Individuals who read the letter of information and signed the consent form were allowed to participate in the research. Once completed, the consent forms and questionnaires were placed in different boxes by the researcher in order to maintain confidentiality. The results of the research were analysed using the Statistical Package for the Social Sciences (SPSS version 25) to determine statistical significance, wherein a p value of less than 0.05 was considered statistically significant. The logistics regression model was used to analyse the relationship between one dependent binary variable and independent nominal variables.

Results and discussion

There was a 100% response rate and of the 322 participants in the research, only 31.4% had sustained at least one injury related to weight training. The majority of the participants were males (90.4%). Furthermore, there was a higher number of injuries sustained when using free weights (88.1%) as compared to weight training machines (11.8%). Most injuries were sustained while performing the barbell shoulder press (18.8%). The shoulder was the anatomical location with the highest injury frequency (31.7%). Muscle strains (40.5%) were the most common types of injuries. Risk factors that were found to have a significant effect on injury were individuals within the age group 32-38 years who sustained 48.9% of the reported injuries. Individuals who had sustained injuries in the past ($p=0.017$) were also at higher risk of sustaining other injuries. The number of hours spent weight training ($p=0.017$) were also found to increase the risk of sustaining injuries.

Conclusion

The findings of this study show that there are certain anatomical locations that are more prone to injury than others. Weight training, just like any other type of exercise, can predispose one to injury, but the rate of injury due to weight training is generally low. The most prevalent types of injuries were muscle strains and joint sprains, with a few rare exceptions of serious injuries such as muscle tears and bone fractures.

Keywords: Weight training, musculoskeletal injury, injury profile

Dedication

I dedicate this dissertation to:

God, he made provision for me in tough times and grew me in his knowledge and wisdom. He sheltered me in times when I had no shelter, gave me bread to eat when I had no money to buy food. He showed me that he is my ultimate provider. ***Philippians 1 verse 6:*** *Being confident of this, that he who began a good work in you will carry it on to completion until the day of Christ Jesus.*

My mother Letta Ndzinisa, your support, prayers and encouragement have lifted me up and kept me going on days when I didn't feel good enough. Even on days when it felt like the whole world was against me, you were always there believing in me and praying for me night and day. If I was given a chance to relive life, I would still choose you to be my mother. I love you, Ndzinisa! Mzomba! Masibekela!

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1 Corinthians 2 verse 9: But as it is written, Eye hath not seen, nor ear heard, neither have entered into the heart of man, the things which God hath prepared for them that love him.

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%	Percentage sign
=	Sign meaning equals to
p	Indicates the statistical significance of the data
DUT	Durban University of Technology
IREC	Institutional Research and Ethics Committee
FR	Free weights
WTM	Weight training machines
IBM SPSS	Statistical Package for the Social Sciences
1RM	One-repetition maximum

Appendices

Glossary

Anterior view: A picture or demonstration of the front of the body (Sanders and Scanlon 2006).

Anthropometrics: This is the science of obtaining systematic measurements of the human body such as weight, height, etc. (Dictionary 2017b).

Assistant movers: These are also known as synergist muscles. they complement the action of prime movers by assisting them in executing the movement (Moore, Dalley and Agur 2014).

Barbell: Is a long metal rod where disks of varying weight can be attached on either end, some have fixed weights already attached. It is used for the purpose of weight training (Rippetoe and Kilgore 2007).

Cross-sectional survey: Studies carried out at one point in time or over a short period, providing a snapshot of the outcome and characteristics associated with it, at a specific point in time (Levin 2006).

Dumbbell: This is a short bar with two weights on either sides used during weight training (Dictionary 2020b).

Focus group: This is a small group of people, about six to nine, who are brought together by the researcher in order to explore their perception, feelings and ideas pertaining to the investigation tool (Dilshad and Latif 2013).

Free weights: These are weights or any training loads that are not connected to another apparatus or piece of gym equipment, such as dumbbells, barbells etc. (Fetters 2019).

Injury: A condition of pain or impairment in bodily function that affects training (Strömbäck *et al.* 2018).

Lateral view: A view from the side of the body, away from the midline (Sanders and Scanlon 2006).

Oblique view: A view from a slopping or tilting angle, neither parallel nor at a right angle (Stevenson and Waite 2011)**.**

Pain: An unpleasant sensory and emotional experience associated with actual or potential tissue damage (Aydede 2017).

Period prevalence: Is the percentage of a population who have the disease/phenomenon at any time within a stated period (Hunter and Risebro 2011).

Physical conditioning: Involves low-intensity training done with the intention to maintain flexibility and enhance the body's readiness for competition.

Pilot study: This is a smaller preliminary study that is conducted prior to the main study with the aim of assessing the effectiveness of the research methodology and procedure (Jairath, Hogerney and Parsons 2000).

Point prevalence: Is a single assessment of a diseases/phenomenon at a fixed point in time (Hunter and Risebro 2011).

Powerlifting: This a strength sport where the participants are challenged to do 3 lifts: the squat, the bench press and the deadlift (Stone *et al.* 2006).

Prevalence: Measures the amount of disease/phenomenon in a population at a given time and can be expressed as a percentage or shown as cases per population (Hunter and Risebro 2011).

Prime movers: These are also known as agonist muscles, which are responsible for producing a specific body movement through concentric contractions (Moore, Dalley and Agur 2014).

Pronated: This is a natural movement of the hand so that the palm faces the ground (Moore, Dalley and Agur 2014).

Rehabilitation: The use of clinic-based therapy techniques to restore range of motion, flexibility, muscular strength and endurance after an injury or illness (Beam 2002).

Resistance training: This is a specialized method of physical conditioning in which different modalities are used for training, such as free weights (barbells and dumbbells), weight machines, medicine balls, elastic bands and plyometric. These modalities are used progressively in a wide range of loads at different movements (Faigenbaum and Myer 2009).

Risk factors: This is any feature, characteristic or exposure of an individual that increases their probability of developing a disease or an injury (Organisation 2019).

Weightlifting: This is a power or strength sport in which the participants are challenged to do the snatch and clean and the jerk lift in their order of execution (Stone *et al.* 2006).

Weight training: Also known as strength or resistance training, it is a form of progressive resistance exercise with the use of free weights or machines. It is often performed to achieve fitness, strength or improve performance in other sports (Hamill 1994).

Weight training machines: These are resistance-based workout machines (Sundried 2019).

CHAPTER 1: INTRODUCTION

1.1 Introduction

The purpose of this chapter is to provide background information on weight training and orientate the study. Thereafter, the research aims and objectives, rationale, benefits and strengths will be presented. The overall flow of the dissertation will also be outlined.

1.2 Background

The musculoskeletal system is described as the primary power source of the body because it allows one to move and act, and in action, function (Cameron, Selig and Hemphill 2011). This system greatly benefits from physical exercise through bone strengthening, by increasing bone mass and the laying down of new trabecular patterns. Weight training also benefits the musculoskeletal system through increasing bone density and increasing the tensile strength of ligaments. Cameron, Selig and Hemphill (2011) iterate that an increase in muscle strength, endurance and power also results from weight training.

There are different forms of exercises that one can do, depending on the intended goal, namely: aerobic and weight training. These two forms also have different exercise variations that an individual can perform in order to achieve the desired outcome. Aerobic exercises can be defined as exercises that use the same muscle groups rhythmically for a period of fifteen minutes or longer while maintaining a heart rate of 60% to 80% (Dictionary 2020a). These types of exercises normally include running, cycling and swimming, which are commonly used for achieving rapid weight loss.

Weight training exercises on the other hand can be defined as exercises performed against a force or resistance. The resistance is normally created by using some type of equipment or weighted object (Keogh and Windwood 2016). These types of exercises are commonly used for the purpose of toning the body, with the main focus being placed on musculature.

Amongst the numerous benefits of weight training, the most predominant ones include strength conditioning for athletes, enhancing physical fitness, improving physical appearance, rehabilitation of injuries and prevention of injuries (Pediatrics 2001; Kraemer and Fleck 2005; Keogh, Hume and Pearson 2006; Lavallee and Balam 2010).

Weight training, also known as strength training, can be traced back thousands of years. Chinese soldiers had to pass feats of strength before being recruited by the army (Stone *et al.* 2006; Lavallee and Balam 2010). Evidence of its existence is also available in the ancient art and sculptures of the Greeks, where the lifting of large stones and weights is displayed. Illustrations of weight lifting and strength movement were also reported to be found on the tomb of Egyptian prince Baghti, with these illustrations dating back to approximately 2040BC (Stone *et al.* 2006; Lavallee and Balam 2010).

The examples above identify weight training as an ancient practice that has continued over the years and that evolved with time. According to Ratamess (2012), there are different styles of weight training, which include Strongmen, weightlifting, bodybuilding and powerlifting. Modern-day weight training in its recognisable form, which involves the use of metal rather than stones, can be traced back to the 1800s, where it began to spring up in Europe (Stone *et al.* 2006; Lavallee and Balam 2010).

Weight training has been growing in popularity not only for military or strength purposes, but also due to its various clinical advantages that are still being explored and discovered in the medical sector (Cameron, Selig and Hemphill 2011; Cardinale, Newton and Nosaka 2011). Medical use for resistance types of training is mostly for rehabilitation purposes, such as prescription in osteoporotic patients to increase bone mass and density. In arthritic patients, it is used to maintain activity by promoting joint range of motion, which helps improve the patient's self-management (Cameron, Selig and Hemphill 2011). Cameron, Selig and Hemphill (2011) assert that strength training is also used in conjunction with aerobic exercise under supervision to improve lung functional capacity, dyspnoea and exercise tolerance in pulmonary rehabilitation.

Both the young and old are being encouraged to participate in physical activity for various reasons and benefits, namely controlling hypertension, preventing cardiovascular disease, maintaining range of motion in arthritic patients, improving bone strength in osteoporotic patients etc. (Hootman *et al.* 2001; Haskell *et al.* 2007; Cameron, Selig and Hemphill 2011). Weight training, like any other form of physical activity, is not without risk, despite well-documented evidence of its benefits (Kolber *et al.* 2014). Sports-related injuries are reported to be amongst the leading causes of non-fatal injuries that can lead to impairment and physical disability (Michaud, Renaud and Narring 2001).

Several studies have been done on the weight training population to explore injury risk factors and epidemiology (Raske and Norlin 2002; Durall and Manske 2005; Keogh, Hume and Pearson 2006; Stone *et al.* 2006; Sutherland 2008; Kolber *et al.* 2010; Lavallee and Balam 2010; Gray and Finch 2014; Kolber *et al.* 2014; Aasa *et al.* 2016; Willick *et al.* 2016; Keogh and Windwood 2016 ; Golshania *et al.* 2018). The majority of weight training injuries reported above were found in studies conducted in Western countries. In these countries, the majority of the population is White in ethnicity and there is limited representation of the Black population. Research, however, has proven that genetic and cultural differences may influence disease risk factors and response to treatment (Jorde and Wooding 2004).

According to Risch *et al.* (2002), a race-oblivious approach to biomedical research is neither fair-minded nor advantageous and will not lead to the reduction of disease risk factors, or treatment efficacy between different population groups. The true effect of conditions on different races and ethnic groups and its treatment efficacy on them can only be addressed by researching these groups individually (Risch *et al.* 2002). Furthermore, Kerr, Collins and Comstock (2010) attest that a limited number of studies have investigated weight training-related injuries in the general population. Most weight training studies were conducted on athletes, with only a limited number of studies investigating weight training in the general population (Kerr, Collins and Comstock 2010). This research therefore aimed to investigate weight training injuries in the general population within the eThekwini Municipality.

1.3 Aims and Objectives

1.3.1 Aims

The aim of this research was to establish an injury profile of weight trainers within the eThekwini municipality in terms of the types of injuries incurred, their anatomical location and their severity. The research also aimed to determine possible risk factors of musculoskeletal injuries in relation to activity, demographics and anthropometrics.

1.3.2 Objectives

1. To determine the most predominantly occurring weight training-related injuries within eThekwini municipality;
2. To determine the anatomical locations with the highest injury frequencies; and
3. To determine musculoskeletal injury risk factors in relation to activity, demographics and anthropometrics.

1.4 Rationale and Benefits of the Research

Weight training has grown in popularity over the past decades, with approximately 64.5% more people than in 1998 participating in it (Kraemer and Fleck 2005; Kerr, Collins and Comstock 2010). This growth in popularity may be attributed to its beneficial effects, namely strength conditioning for athletes, enhancing physical fitness and improving physical appearance (Lavallee and Balam 2010). Its popularity has also grown amongst primary healthcare providers who prescribe it for the rehabilitation of injuries and the prevention of injuries in other sports (Lavallee and Balam 2010; Cameron, Selig and Hemphill 2011; Kolber *et al.* 2014). Despite its benefits, weight training, like other forms of physical fitness activities, exposes participants to possible risk of injury. As the number of people participating in weight training grows, so too does the number people at risk of injury due to weight training grow (Kerr, Collins and Comstock 2010).

Injuries resulting from weight training have been explored in other countries such as the United States of America, New Zealand and Britain, with the aim of reducing their prevalence (Raske and Norlin 2002; Gregory and Travis 2015; Golshania *et al.* 2018). There is a need for more research studies to determine the causes of injuries and establish injury preventative strategies (Ekegren *et al.* 2014; Aasa *et al.* 2016). This is essential because Michaud, Renaud and Narring (2001) iterate that sports injuries are reportedly amongst the leading causes of non-fatal injuries that can lead to impairment and physical disability.

There is still paucity in the literature on the weight training population of South Africa. This research aimed to establish an injury profile of weight trainers at gyms within the eThekwini municipality. This information will be of significant benefit to the primary healthcare service providers of this population group. These healthcare providers include: chiropractors, physiotherapists, biokineticists, fitness trainers and sports management personnel.

The chiropractic profession is an alternative healthcare profession which has a combined treatment approach of various manual therapies and therapeutic exercises (Pollard *et al*. 2007). It is also a profession that prides itself in delivering evidence-based injury treatment and management services. This is done through conducting research studies in the form of clinical trials, questionnaires and interviews aimed at ensuring that the best possible service is delivered to patients (Pollard *et al.* 2007). This research is therefore necessary as it will give chiropractors within the eThekwini Municipality a broad picture of the nature of the injuries that occur within gyms and their possible causes. This information will also assist other primary healthcare providers with regard to giving evidence-based advice and assistance to their patients thus assisting not only in injury management, but also in the provision of injury prevention measures as well.

1.5 Flow of the dissertation

This chapter serves as an introduction to the research where the background, rational, aims and objectives of the research are outlined. Chapter Two is a review of currently existing literature on weight training and weight training-related injuries. In the third chapter, the methodology of the research is discussed in detail. Chapter Four presents the results of the research. These results are further discussed in Chapter Five. The last chapter of this research is Chapter Six, which encompasses the conclusion, limitations and recommendations of the research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

According to Torraco (2005), a literature review is that part of the research which reviews, criticizes and synthesizes representative literature on a topic in an integrated manner in order to generate new frameworks and perspectives on the subject. Merriam and Simpson (2000) explain that the purpose of a literature review is to explore a topical area of research, as well as to develop a conceptual framework. This chapter assesses the literature in order to gain insight regarding the existing literature on the musculoskeletal injury profile of weight trainers in an attempt to fully understand the weight training population. The following concepts will be explored in this chapter: the musculoskeletal system; weight training injuries; types of weight training injuries and anatomical location; mechanisms of injuries; and risk factors.

2.2 The musculoskeletal system

The musculoskeletal system is a combination of the muscular system and the skeletal system in their corporate function. Cameron, Selig and Hemphill (2011) describe the musculoskeletal system as the primary machinery of life that allows humans to move, act and therefore function. Sugimoto et al. (2009) concur that all living organisms, including human beings and animals, achieve various movements by skilfully and cooperatively moving their redundant and complex musculoskeletal system. Most importantly, the musculoskeletal system supports and protects the body and its vital organs (Hedge 2013).

Beck (2018) describes the musculoskeletal system as composed of muscles, bones, tendons, ligaments, fascia, cartilage, joints and other tissues that are vital for everyday functioning. The various components of the musculoskeletal system are composed of different types of tissue that aid in the execution of their functions. Some of these components will be closely assessed to fathom the relationship between the musculoskeletal system and injury. This will be done by describing them in the context of the systems that make up the musculoskeletal system, namely the muscular and the skeletal systems.

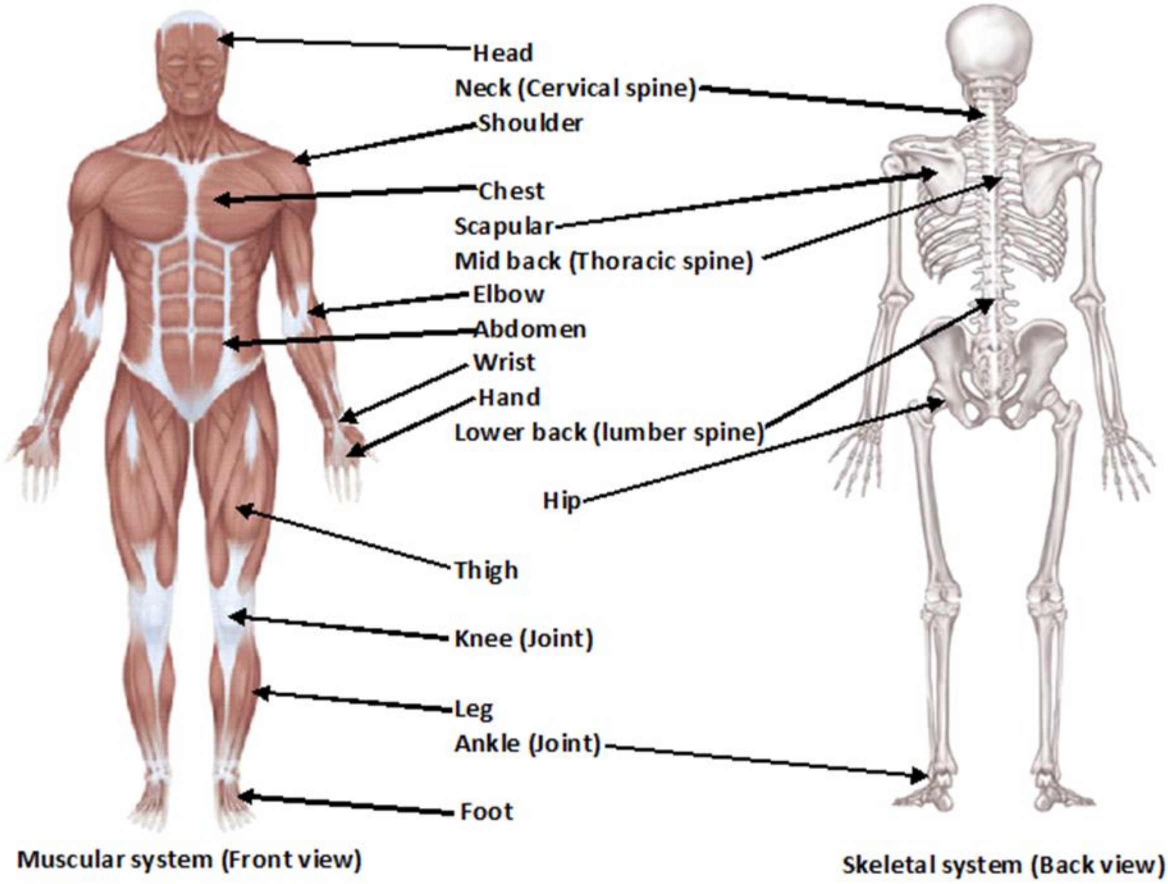


Figure 2.1 The Muscular and Skeletal Systems of an Adult Male

Source: Haff and Triplett (2016)

2.2.1 The muscular system

The muscular system has different types of muscles that are made of highly specialised cells designed to execute their specific functions (Moini 2012). There are three types of muscles found in the human body, namely skeletal muscles which are attached to bones and assist in moving the body; Cardiac striated muscles which make up most of the heart; and lastly, the smooth muscles which form the lining of blood vessels and internal organs such as the intestines and the urinary bladder (Moini 2012; Moore, Agur and Dalley 2015). For the purpose of this research, the primary focus will be on the skeletal muscles which are thin and long fibres that undergo a series of contractions resulting in movement at the joints (Moini 2012). These muscles are responsible for executing different forms of activities, from basic to complex activities such as sports or exercises.

Stoppani (2006) relates that the skeletal muscles may contract from tens to hundreds of times during strength training sessions in order to move the various body parts in the desired direction. These muscles, as described by Moore, Agur and Dalley (2015), are attached to the skeletal system in different ways. They can either attach through tendons, which are collagenous fibres that connect muscles to bones and help muscles to exert force on bones, enabling movement, muscles can also attach through aponeuroses that connect either directly to bones or via cartilage and through ligaments or other connective tissue. These connections are essential as the muscles usually work in groups to execute the desired movement in collaboration with the skeletal system.

2.2.2 The skeletal system

The skeletal system forms the framework for the body, supporting the body to ensure that it performs its vital activities. It also forms protective barriers around vital organs (Moore, Agur and Dalley 2015). This system is composed of bone tissue, cartilage and ligaments. Moini (2012) explains that the bones are composed of living tissue and that they help support the weight of the body. Moreover, they work in coordination with the muscles to control movement and maintain the position of the body. He further states that there are 206 major bones in every adult's skeleton, which are linked with one another through joints.

A joint, on the other hand, is described by Moore, Agur and Dalley (2015) as an articulation between two or more bones. There are different classifications of joints according to their articulation, such that some bones have fibrous tissue between their articulation surfaces. Other bones, however, have cartilage between their articular surfaces, yet others have an articular cavity that contains synovial fluid. There are also ligaments found at the joint, which act as connective tissue. These ligaments are collagenous fibres that hold the bones of the joint together (Moore, Agur and Dalley 2015).

In addition, there are other important systems that work closely with the muscular and skeletal systems to ensure optimal function. Firstly, the vascular system which is composed of blood vessels is essential for keeping all the muscular and skeletal system structures alive by providing oxygenated blood (Moini 2012). Secondly, the nerves which are components of the nervous system, control all body functions and enable the body to respond to different stimuli (Moini 2012). It is essential that all the different systems function in unison for the body to optimally execute activities of daily living and more.

2.3 Exercise and the musculoskeletal system

Cameron, Selig and Hemphill (2011) explain that the musculoskeletal system greatly benefits from physical exercise through bone strengthening by increasing mass, the laying down of new trabecular bone patterns and increasing bone density. They further state that physical exercise also increases the tensile strength of ligaments when trained under load. Furthermore, physical exercise increases muscle strength, endurance and power. Lavallee and Balam (2010) mention the different forms of exercises that one can perform, depending on intended goals, namely aerobic, and weight training, which also have different variations. Pediatrics (2001) together with Keogh and Windwood (2016) add that weight training has gained popularity in modern times due to its benefits. It is used for strength conditioning by athletes, enhancing physical fitness and improving the physical appearance of the general population. Traditional practitioners treating musculoskeletal conditions such as chiropractors, physiotherapists and osteopaths are also exploring the use of weight training types of exercises for the rehabilitation and prevention of injuries.

2.4 Weight training

Weight training involves progressive resistance exercise with the use of free weights or weight machines to achieve fitness, strength or improve performance in other sports (Hamill 1994). A wide variety of weight training equipment can be used during training, ranging from simple equipment such as free weights to more complex equipment, such as weight training machines (Stoppani 2006). Free weights are the most commonly used types of equipment in homes and commercial gyms. This is due to their affordability and portability. The fact that they can be moved as a unit and be moved in different directions gives free weights an advantage over machines. Free weights are also more convenient as they can be used at home or at any other area not designed for training. However, this feature also acts as a disadvantage in some cases because it results in a non-restrictive effect on joint movement, which has been associated with predisposition to injury (Lavallee and Balam 2010; Golshania *et al.* 2018).

There are several variations of free weights used to achieve different fitness-related goals, namely: barbells, weight plates and dumbbells. Barbells are long steel bars designed to be held on both hands that weight plates are loaded onto. However, some barbells have fixed weighted plates on either side. Whereas, weight plates are rounded steel with a hole in the centre to enable loading onto a barbell (Stoppani 2006). Dumbbells, on the other hand, are similar to barbells but have shorter handles designed to be used with one hand. Like barbells, some dumbbells have solid weights on either side, while others have changeable weight plates that can be loaded on either side (Stoppani 2006; Baechle and Earle 2012).

Unlike free weights, weight training machines have been speculated to reduce weight training related injuries. The reason for this is that they result in controlled and limited movements at the joints (Stoppani 2006). Weight training machines can be classified into 2 types depending on their working mechanism. Some use a cable pulley system, while others are linear guided machines. The cable pulley machines have a cable that runs along a pulley and connects to a weight stack. This weight stack is pulled by the user during a lift. A pulley, as defined by Stoppani (2006), is a freely rotating wheel that is used to change the direction of the force applied by the user. A variety of cable handles can be attached at the end of the cable to execute different types of exercises. Linear guided machines on the other hand have two apparatus that move along two guide rods. They normally only allow linear movement and require a manual addition of weight plates to increase the resistance (Stoppani 2006). Machines such as the leg press, smith machine and the hack squat fall under linear guided machines. People normally incorporate both weight training machines and free weights in their weight training programmes. Both weight training machines and free weights possess certain advantages and disadvantages that the user must be aware of before using.

Mazur, Yetman and Risser (1993) caution that weight-training can cause significant musculoskeletal injuries such as fractures, dislocations, spondylolysis, spondylolisthesis, intervertebral disk herniation and meniscal injuries of the knee. Mohtasham and Salehi (2019) point out that the relationship between people who participate in weight-training types of exercises and musculoskeletal injuries has become a significant problem. They continue to explain that injuries related to weight training are of two kinds. The first and most common injuries occur when the lifter is moving weights and too much pressure is placed on the muscles, resulting in injury. The second types are weight room accidents, caused by weight-training participants being struck by falling weights or tripping over equipment on the floor. These types of accidents commonly occur while people are using free weights rather than weight training machines (Mohtasham and Salehi 2019).

Consequently, the majority of people tend to view weight-training machines as a safer option to use compared to free weights. The weight stacks of weight-training machines are also located away from the user, thus reducing the chances of weights falling on them. In addition, they have bars or weight stands/racks that are stationary, which helps users to safely travel around the workout space without tripping on weights. However, Stoppani (2006) warns against the perception that weight-training machines are safer. He states that weight training machines can also cause injuries due to inexperience in using the equipment or being overly confident and therefore loading more than one's capabilities.

Aasa *et al.* (2016) and Keogh and Windwood (2016) postulate that weight-training sports/activities are considered dangerous or of high risk because of the heavy loads used during training and competition. However, according to Keogh and Windwood (2016), weight training sports have lower rates of injury compared to other sports. This is in contrast to the perception that weight training sports are dangerous because of the heavy loads used in training (Keogh and Windwood 2016).

2.5 Injury

Although regular physical activity reduces the risk of premature mortality in general and also reduces the risk of diseases such as diabetes mellitus, hypertension etc. (Bahr and Krosshaug 2005). Participation in either recreational or competitive sports is not without possible risk of injury. Kumar (2001) suggests that if one could delineate the mechanisms of injury and the quantitative details of their relevant variables, a more effective intervention might be developed. He further emphasises that the long-term success of controlling injuries depends on understanding the causation factors. Therefore, examining facts and constructing musculoskeletal injury causation theories is a good starting point.

An injury as defined by Strömbäck *et al.* (2018) is a condition of pain or impairment in bodily function that affects training. The authors further explain it as a traumatic event in which the soft tissue involved is violated and its mechanical order is disturbed. The cause of injury can be, "a person, thing, event, state or action that produces effect''. Walker (2007) on the other hand defines sports injuries as injuries that are sustained as a result of sports, exercise or athletic activities. Both definitions were used in this study when defining injury.

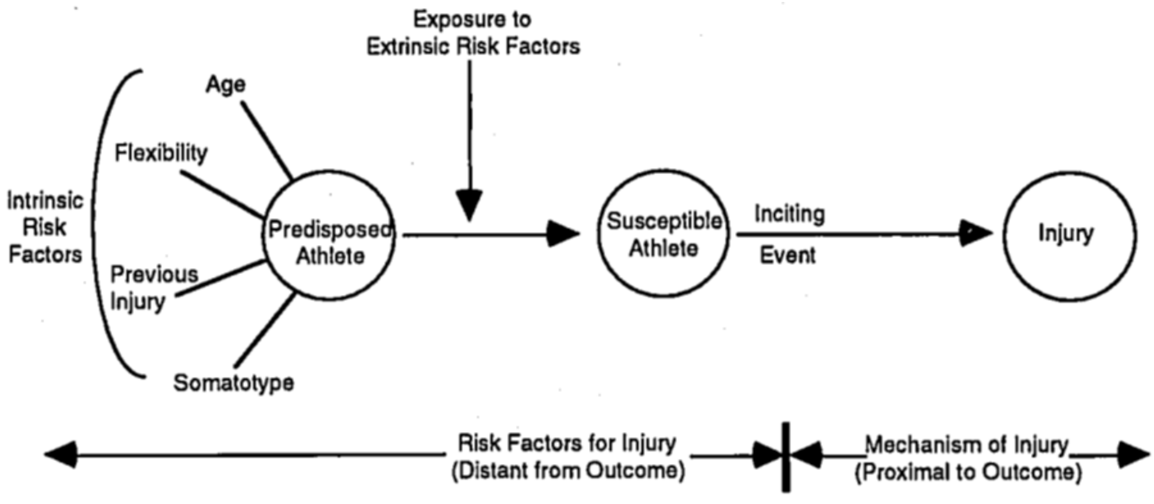
Kumar (2001) points out that several theories and models are used to describe the causation of musculoskeletal injuries. These theories and models will be briefly explained and emphasis will be placed on the multifactorial model, which is more specific to sports-related injuries. Firstly, there is a *multivariate interaction theory of musculoskeletal injury*. This theory considers genetics, morphology, psychosocial and biomechanical factors as possible contributory factors to musculoskeletal injuries. Second is the *differential fatigue theory* which states that loading muscles with different proportions of load results in muscles undergoing different amounts and rates of fatigue, thus predisposing them to injury.

The third theory is the *cumulative load theory* which suggests that prolonged increasing load results in normal wear and tear. However, the perpetuation of this process leads to a decrease in the stress-bearing capacity of the soft tissue, thus predisposing it to injury. Fourth is the *overexertion theory*, which suggests that excessive exertion of the musculoskeletal system over the tolerance limit leads to injury. This happens through the interaction of force, duration, posture and motion thus predisposing soft tissue to injury.

The final theory is the *multifactorial model of athletic injury* which suggests that there are many factors predisposing an individual to injury. These factors exist prior to the occurrence of the injury inciting event and are referred to as risk factors. These risk factors can be divided into intrinsic and extrinsic risk factors. Intrinsic risk factors are the things occurring within the individual's body, be it mental, physiological or otherwise (e.g. history of injury, age, flexibility) (Taimela, Kujala and Osterman 1990). Extrinsic factors, on the other hand, are things that have an impact "from without", such as the weather, equipment, etc. (McLeod *et al.* 2003). In this research, **the multifactorial model** is used to motivate the profiling of weight-training injuries within the South African eThekwini municipality because the multifactorial model of athletic injuries considers both intrinsic and extrinsic factors as possible injury precipitation culprits (Meeuwisse 1994; Bahr and Krosshaug 2005).

As stated earlier, most studies on weight training have been done in different countries around the world. The findings of these studies, when viewed in the context of the multifactorial injury model, cannot be assumed to apply to the South African eThekwini municipality population. This is because the multifactorial injury model suggests that there are several factors contributing to injury occurrence, some of which are specific to an individual or even a population group, meaning that injuries in sports do not only occur due to random accidents or unanticipated events (Meeuwisse 1994).

The diagram below shows the interaction of multiple factors leading to injury as explained in the multifactorial injury model (Meeuwisse *et al.* 2007).



(Meeuwisse et al. 2007)

Figure 2.2 **A multifactorial model of athletic injury aetiology**

2.6 Types of weight training injuries, their anatomical locations and types of treatment received

2.6.1 Anatomical location

Anatomical location describes the site of a body part in relation to its anatomical position. The *anatomical position* is the standard term used for describing the anatomy of an organism. The term makes it is easy to understand what part of the body is being referred to, irrespective of where the body parts are positioned or what direction they are moving in (Dictionary 2017a). When the body is in anatomical position, it is standing upright facing forward, with arms positioned at the sides, palms facing forward and feet slightly apart (Sanders and Scanlon 2006). When viewing the body in relation to the musculoskeletal system and sports-related injuries, one finds several areas that are more prone to injury due to their location or position during exercise.

Keogh and Windwood (2016) posit that there are different types of weight training sports which tend to cause a subtle difference in the injury epidemiology in terms of the anatomical location, onset and severity of the injuries. Additionally, Lavallee and Balam (2010) suggest that weight training injuries vary depending on the type of weight training the individual participates in. Nevertheless, there are anatomical locations that have been found to be commonly affected in the case of weight training injuries, namely: the knees, lower back, shoulders, elbows, wrists and hands (Keogh and Windwood 2016). Following a systematic review of studies, Aasa *et al.* (2016) report several other anatomical locations in addition to the ones mentioned above, such as the chest, arms, cervical spine, thoracic spine, thighs, hips, ankles, groin and abdomen. The anatomical locations with the highest injury frequency amongst these were found to be the shoulders, lower back and knees (Aasa *et al.* 2016). Lavallee and Balam (2010) highlighted that powerlifters commonly injure shoulders; weightlifters commonly injure elbows and knees; while people who do both tend to get lower back muscle strains.

2.6.2 Types of injuries

There is currently no doubt that regular structured exercise yields several benefits for the body although it has also resulted in the rise of exercise-related injuries (Walker 2007). There are certain injuries associated with regular sporting or exercising activities. Common weight training- related musculoskeletal injuries include the following joint sprains, muscle strains, ligament sprains, ligament tears, tendon tears, muscle tears, contusions, dislocations, fractures, tendonitis, meniscal injury, disc bulges, bursitis and pinched nerves (Walker 2007; Keogh and Windwood 2016).

A joint sprain injury is an injury caused by overstretching or twisting of either a ligament or a joint, whilst more severe sprains can also cause tearing of ligaments (Williams 2018). The most commonly sprained anatomical locations are the ankle, wrist, knees and thumbs. A muscle strain, on the other hand, involves overstretching of a muscles or tendons, which may result in minor tears. According to Williams (2018), anatomical locations that commonly get strained are the back, legs, knees and feet .

Tears can be defined as the ripping of fibrous or soft tissue, which can occur in ligaments, tendons or muscles (University 2017). This normally occurs as a result of the fibrous or soft tissue being overstretched. Tendonitis injuries, on the other hand, are inflammations or irritations of the tendon. This irritation is often caused by repetitive, minor impacts on the affected area, or due to a sudden more serious injury. Bursitis, unlike tendonitis, refers to inflammatory injuries of the bursar. The bursar are fluid-filled sacs found around the joints, which can be irritated due to sports related injury (Boskey 2020). Finally, contusions are a medical term for bruising. They occur when an injured capillary or blood vessel leaks blood into the surrounding area. This can happen either on the skin, muscles or on the bones, causing pain over the affected area.

Amongst the more serious sports injuries are meniscal injuries. These injuries take place in the knee meniscus as a result of suddenly twisting or rotating the knee. This causes meniscal injury, especially when the individual is putting their full weight on the knee while rotating or twisting it. Another serious injury is disc bulging, which happens when the nucleus pulposus moves beyond its normal position inside the disc and materializes when there is damage or weakening to the structure of the annulus. Disc bulging is associated with poor posture during heavy lifting and vertebral column degeneration (Chiropractic 2017). Lastly is a pinched nerve, a term used when referring to damage or injury to a nerve or set of nerves. This may be due to compression, constriction or stretching of the nerve or set of nerves in question. It normally causes numbness, a sensation often described as "pins and needles" or burning sensations, and pain often radiates outwards from the injured area (WebMD 2020).

In a study by Lavallee and Balam (2010), injuries occurring amongst weight lifters were divided into either acute or chronic. Acute injuries were described as occurring rapidly following a traumatic incident. They were further divided into emergent and non-emergent, where acute emergent injuries required immediate medical attention and would consequently result in a significant time off from lifting. Furthermore, acute emergent types of injuries were noted to be less common and include herniated discs, spontaneous pneumothorax, myocardial infarction, fractures and dislocations (Lavallee and Balam 2010).

Acute non-emergent injuries, on the contrary, often do not result in a need for immediate medical attention or significant time off from lifting. These injuries include lacerations, muscle strains and ligament sprains, which have been reported as the most commonly occurring types of weight training-related injuries (Lavallee and Balam 2010). Non-emergent injuries reportedly account for approximately 46% of weight training-related injuries. Conversely, chronic injuries were described as the types of injuries that occur due to repeated stress on tissue, with insufficient recovery time. Examples of chronic injuries include tendinopathies, shoulder impingement syndrome, arthritis and stress fractures (Kolber *et al*. 2014). Tendinopathies are the most commonly occurring chronic type of injuries, accounting for 12-25% of strength training injuries (Lavallee and Balam 2010).

2.6.3 Types of treatment

There are several treatment options that injured athletes can receive for their aches and pains. These treatment options can be attained from various practitioners, namely general practitioners, physiotherapists, chiropractors, orthopaedics, biokineticists, traditional Zulu healers, homeopaths and some self-medicate with over-the-counter drugs.

General practitioners are community doctors who do not specialise in any particular medical field but rather treat a wide variety of minor medical conditions (Stevenson and Waite 2011),while chiropractors as defined earlier are alternative healthcare professionals that focus on ensuring optimal alignment. They achieve this through careful manipulation of the joints and soft tissue to bring about pain relief from numerous conditions (Natalie 2020). Similarly, physiotherapists are also manual therapists. However, they encompass a broader scope of practice than chiropractors and they work on restoring function in various areas of the body through the use of various treatment modalities, intensive soft tissue treatments and joint manipulation.

Orthopaedics on the other hand involves treating deformities that result from diseases or damage to the bones and joints of the skeleton. Biokineticists are professionals that treat 'amongst other things' chronic diseases of lifestyle with the use of exercise as a treatment modality. Traditional Zulu healers are a popular treatment alternative in the eThekwini municipality. They are herbalists who use traditional herbs for treating a wide range of diseases (du Toit 1971). Ratini (2019) explained that homeopaths are similar to traditional healers because they use small amounts of natural substances, such as plants and minerals, for the treatment of pain and diseases.. Some people attempt to self-medicate before going to a medical practitioner this using over-the-counter drugs and ointments.

2.7 Mechanisms of weight training injuries

Mohtasham and Salehi (2019) explain that as the number of people participating in weight training progressively increases, the number of people at risk of injury also increases. Thus, it is essential to understand the mechanism of weight training injuries. Dropping of weights accounts for the most frequent cause of acute weight-training injuries (Lavallee and Balam 2010; Golshani *et al.* 2017). The lifting technique in terms of grip, posture and joint movement during weight-lifting was also noted as a risk factor for injury (Bengtsson, Berglund and Aasa 2018). Furthermore, in close association with the lifting technique is the amount of load, such that high load and improper technique are more likely to cause injury when done in combination (Bengtsson, Berglund and Aasa 2018). Free weights were reported to be the highest cause of injury, accounting for more than 90% of weight training injuries compared to weight training machines (Lavallee and Balam 2010; Golshania *et al.* 2018).

Heavy loading when using free weights with joints in extreme positions has also been suggested to cause injury (Lavallee and Balam 2010; Aasa *et al.* 2016). An example lies in how the shoulder complex has been reported as the most frequently injured anatomical location in weight-training. In the same way, Keogh and Windwood (2016) state that due to loading in awkward positions, the knee joint has been subject to ligamentous ruptures.(Lavallee and Balam (2010) purport that these raptures are a result of inappropriate movement and misplacement of the foot. The predominant causes of weight training injuries are reflected in both intrinsic (joint flexibility) and extrinsic factors (dropping of weights). This shows that both intrinsic and extrinsic factors contribute to the overall rate of injury amongst weight trainers.

2.8 Risk factors

Several factors can contribute to or increase the risk of injury during sports or exercising, namely: Age, where children below the age of eighteen and adults above the age of forty have a higher rate of injury, thus making age a possible injury risk factor (Faigenbaum and Myer 2009; Lavallee and Balam 2010). Factors such as biological maturity, body size, poor coaching and a history of injury further fuel the fire. There are also other hypothesised and investigated risk factors of injury such as poor nutrition, poor physical conditioning, muscle imbalances, poor exercising techniques and a lack of supervision or coaching. Muscle enhancing products such as human growth hormones, creatine monohydrate and anabolic steroids have also been associated with a higher frequency of tendon ruptures (Lavallee and Balam 2010). Strömbäck *et al.* (2018) found the following to be associated with high injury risk: the deadlift and the bench-press exercises, high training frequency, the consumption of alcohol and dietary issues.

The risks of musculoskeletal injuries mentioned above can be divided into 2 categories: intrinsic risk factors and extrinsic risk factors (Meeuwisse 1994; Bahr and Krosshaug 2005). Intrinsic risk factors such as age, gender and body composition may influence or predispose one to the risk of sustaining an injury (Meeuwisse 1994; Bahr and Krosshaug 2005; Bengtsson, Berglund and Aasa 2018). Extrinsic risk factors such as lifting heavy, use of certain equipment, types of exercises performed and training environment are suspected to cause the majority of weight training-related injuries as well (Kerr, Collins and Comstock 2010; Bengtsson, Berglund and Aasa 2018; Strömbäck *et al.* 2018).

2.8.1 Intrinsic risk factors

In this research, the relationship between the intrinsic factors ‘listed below’’ and musculoskeletal injury were analysed. Intrinsic factors have to do with the individual’s body type, biomechanics, maturation state and conditioning (Meeuwisse 1994). Ethnicity, age, gender, height, weight and BMI were closely inspected in relation to risk factors for weight training injuries. The risk factors listed above will be deliberated on briefly, exploring existing literature on them and their inclusion in this research.

2.8.1.1 Ethnicity

Physical fitness is a complex phenotype that is influenced by countless environmental and genetic variables which can ultimately influence performance and injury predisposition (MacArthur and North 2005). Research has proven that genetic and cultural differences may influence disease risk factors and response to treatment (Jorde and Wooding 2004). In this research, ethnicity was evaluated to assess possible links or differences amongst different races in terms of injury frequency because the human population is not homogeneous in terms of injury (Risch *et al.* 2002). There is therefore a need to assess populations in relation to *the multifactorial injury causation model*, which takes into account both intrinsic and extrinsic factors (Meeuwisse 1994; Kumar 2001). The eThekwini Municipality in South Africa is mostly comprised of black people who make up 73.8% of the population (Metropolitan Municipality 2011). Black people were a minority in previous similar studies on weight training, hence this research will assist in filling this gap (Kerr, Collins and Comstock 2010; Winwood *et al.* 2014; Keogh and Windwood 2016).

2.8.1.2 Age

There is age group injury association amongst athletes, such that athletes in a particular age group will sustain unique age-associated injuries during training. Lavallee and Balam (2010) categorised age groups into two main groups, namely the skeletally immature (pre-adolescents 8-12 year olds and adolescents 13-19 year olds) and the Master Athletes (65-70 year olds). According to Lavallee and Balam (2010), the prevalence of tendinopathies and tendon ruptures increases with age amongst Master athletes. Bengtsson, Berglund and Aasa (2018) on the other hand established no difference in the injury rate between the young and the Master Athletes.

The skeletally immature age group was however reported to be at greater risk of developing injury due to a lack of supervision, accidents or improper technique (Faigenbaum and Myer 2009; Lavallee and Balam 2010). Willick *et al.* (2016) found that when comparing age groups, 26-34 year olds had the highest injury rate, followed by 13-25 year old athletes; whilst the age group 35-67 year olds had the lowest injury rate. However, these differences were allegedly not statistically significant, which warrants further investigations into age as a possible injury risk factor.

2.8.1.3 Gender

Males and females differ in their musculoskeletal and metabolic features. Firstly, woman have relatively smaller and shorter bones, with less bone density compared to males (Mohtasham and Salehi 2019). These characteristics might predispose woman to bone fracture. Secondly, females have a wider pelvis which increases the valgus angle at the hips. This makes them more prone to hip injuries, trochanteric bursitis and iliotibial tendonitis (Mohtasham and Salehi 2019). Thirdly, female hormones are also noted to cause looser ligaments, resulting in an increase in their Q-angle, thus predisposing them to knee injuries (Mohtasham and Salehi 2019). The Q-angle also known as the quadriceps angle, is formed by the quadriceps muscle and the patella tendon (Khasawneh 2019:1).

Bengtsson, Berglund and Aasa (2018) found that gender seems to impact the anatomical location of injuries. Other studies found that woman frequently injured their neck, thoracic spine, wrist and hand more than males (Bengtsson, Berglund and Aasa 2018; Strömbäck *et al.* 2018). On the other hand, Quatman *et al.* (2009) observed that females frequently reported foot injuries. Interestingly, males were recognized to have a higher rate of chest and thigh injuries than women (Bengtsson, Berglund and Aasa 2018). Furthermore, the injury locations associated with females in the hypothesis by Mohtasham and Salehi (2019) all do not concur with the injury locations reported in the studies mentioned above.

In a comparison between males and females, Quatman *et al.* (2009) support that females have higher odds of accidental strength training-related injuries than males. Willick *et al.* (2016) however, found that there was no significant difference in the injury rates between males and females. Furthermore, other studies found that males had sustained the largest percentage of weight training-related injuries, at about 82.3% (Kerr, Collins and Comstock 2010; Mohtasham and Salehi 2019). Gray and Finch (2014) also report males as the gender with the highest injury rate, accounting for 78.0% of overall injury cases. These findings may nevertheless be due to the fact that weight training has been historically a male-dominated activity. The weight training injury rate therefore may seem higher in males than females, despite the female body's anatomical predisposition to injury (Mohtasham and Salehi 2019).There also appears to be an increase in the incidence of injury amongst female rather than male weight lifters. This observed increase may perhaps imply an increase in the number of woman participating in weight training (Kerr, Collins and Comstock 2010).

2.8.1.4 Height, weight and Body mass

Alabbad and Muaidi (2016) state that body components play a role in weight training, such that athletes with shorter height and limb length present a mechanical advantage when it comes to lifting heavy loads. According to Stone *et al.* (2006), although the maximum strength and muscle cross-section area share a near-linear relationship , strength per (kg) of body mass and body size are not linear. Relative strength tends to decrease markedly with body size ,such that there is a decrease in maximum strength linked to an increase in body size (Alabbad and Muaidi 2016). Shorter athletes therefore have greater muscle force generating capacity due to their greater muscle cross section area (Stone *et al.* 2006). This statement raises the question of whether body size could possibly influence injury occurrence as well.

Keogh, Hume and Pearson (2006) found that body mass did not have a significant influence on the injury profile of powerlifters. This led them to conclude that all people participating in powerlifting would have the same risk of injury irrespective of their BMI. However, weight is noted to be amongst the additional intrinsic factors that may influence injury occurrence, although it has only been analysed in a few studies by (Bengtsson, Berglund and Aasa 2018). Weight results in increased BMI, which is associated with higher injury predisposition (Chassé, Fergusson and Chen 2014).

2.8.1.5 Stretching and warm up

According to McMillian *et al.* (2006), theoretically, warm-up activities help with neural activation. Therefore, this will better prepare muscles to absorb force that might otherwise be transmitted to ligaments, tendons and the muscle cytoskeleton. When an individual participates in weight training, much force due to the resistance created by the weights is transmitted through the muscles. It would therefore be in the athlete's interest to warm up before weightlifting, when considering the report by

McMillians *et al.* (2006) on warm-up. Furthermore, warm-up is observed routinely as an injury prevention strategy (McMillian *et al.* 2006). While stretching is commonly used to increase the range of motion around the joint, the increased range of motion around the joint is considered to have an injury prevention effect.

Conversely, Behm *et al.* (2004) found that stretching has a negative effect on reaction time, movement time and balance. Although these changes are small, they could result in serious consequences. Some athletes and individuals for to this reason chose not to stretch nor warm up either before or after their workout. Herbert and Gabriel (2002) also report that stretching before exercise does not confer a practically useful reduction in injury. The literature around stretching seems to be controversial in terms of whether it is useful in the reduction of injury rate or not. Recently, movements that incorporate both warm-up and stretching (dynamic stretches) are being increasingly explored because the static stretch is suspected to cause reductions in performance by reducing power output (Fletcher and Jones 2004). This research seeks to explore the existence of any possible relationship between stretching and warming up, either before or after a workout, and the risk of injury.

2.8.2 Extrinsic risk factors

Extrinsic factors can be defined as the external environment, the weather, equipment and anything influencing the individual "from without" or outside (Meeuwisse 1994). The following extrinsic risk factors will be discussed briefly: the use of certain equipment and types of exercises performed during weight training. These are amongst the extrinsic risk factors suspected to cause the majority of weight training-related injuries as highlighted earlier (Kerr, Collins and Comstock 2010; Bengtsson, Berglund and Aasa 2018; Strömbäck *et al.* 2018).

2.8.2.1 Equipment

As stated earlier, free weights are associated with the highest injury frequency, accounting for more than 90% of weight training injuries compared to weight training machines (Lavallee and Balam 2010; Golshania *et al.* 2018). The most common cause of injuries while using free weights is the dropping of weights (Lavallee and Balam 2010; Golshani *et al.* 2017). Dropping of weights is associated with lifting beyond one's capabilities and carelessness. Although free weights allegedly cause most weight training-related injuries, this does not imply that using weight lifting machines is the safer option. Stoppani (2006) states that weight-training machines can also cause injuries due to overloading and being overly confident that there is a decreased risk of injury associated with them. This research examined both free weight and weight training machines to determine injury association.

2.8.2.1 Exercises

The positions assumed by the joints during weight training makes some of the exercises more likely to cause injury than others. The squat is noted to cause about 22%-32% of weight-training injuries; the bench press reportedly causes 18%-46% of weight-training injuries; while the deadlift purportedly causes about 12%-31% of weight-training injuries (Bengtsson, Berglund and Aasa 2018). Different types of exercises have been associated with certain injuries. The bench press is reportedly the most frequent cause of pectoralis major rupture, triceps tendon ruptures and clavicular osteolysis "weightlifter's shoulder" (Lavallee and Balam 2010; Bengtsson, Berglund and Aasa 2018). The bench press is also noted to cause insertional tendinopathies, anterior and posterior shoulder dislocations (Bengtsson, Berglund and Aasa 2018).

The squat was noted to predispose the knee joints to patella tendon injuries (Lavallee and Balam 2010). In addition to this, Bengtsson, Berglund and Aasa (2018) also connected avulsion injuries, spiral fractures of the tibia and fibular and anterior cruciate ligament tear to the squat. However, according to Strömbäck *et al.* (2018), there was a significant negative association between squat training and current injuries, such that there were more current injuries amongst the athletes who squatted less frequently as compared to those who squatted more frequently. The deadlift has been associated with mostly lower back injuries and a few cases of hamstring muscle ruptures, avulsion of the anterior superior iliac spine and meniscal injuries (Bengtsson, Berglund and Aasa 2018). There are many other exercises done during weight training as shown above. However, these were the top three with high injury risk association in literature.

2.9 Types of weight training exercises

Different types of exercises are incorporated into a workout program. Some of these exercises involve the use of free weights, while others involve the use of weight training machines. The most performed types of exercises in commercial gyms and weight training sports will be described briefly. The prime and assistant movers during each exercise will be identified. Prime movers are the muscles that produce most of the force against the resistance, while assistant movers generate force to help the prime movers push against a resistance (George 2016). It is important to take cognisance of the fact that these exercises can be performed in different modifications, depending on the desired outcomes. In this research, they will therefore be described in their simplest form.

2.9.1 The bench press

This is a popular chest exercise where the lifter lies supine on a flat or 45-degree inclined weight bench. The weightlifter grabs the barbell with a closed, pronated grip and hands a little wider than shoulder with apart. He/she then takes the weighted barbell from the rack, positioning it directly over the upper chest with the elbows fully extended. The barbell is then slowly lowered to about 8 or 10 centimetres above the nipples. An upward pressing movement is then used to push the barbell back up, while the back is kept flat on the bench, to avoid arching (Ratamess 2012; George 2016). This movement is repeated for the required number of sets/repetitions (see **Figure 2.3)**.

This exercise involves the pectoralis major as a prime mover and the triceps and anterior deltoids as assistant movers (George 2016). The pectoralis major muscles and tendons are prone to both minor and severe tears during this exercise. Individuals who tend to also extend their elbows at the end of the pressing movement tend to develop inflammation after a while due to repeated micro-trauma at the elbow joint. A variation of this exercise can also be done using dumbbells instead of barbells (Delavier 2010).

1) Starting position   2) End position

(Raske and Norlin 2002)

Figure 2.3 The Bench Press (Oblique views)

2.9.2 The squat

The squat is a popular lower body exercise mostly used for straightening and building the quadriceps and gluteal muscles. On the other hand, it also recruits the erector spinae and core muscles, thus making it a more advanced exercise. It can be performed using either a barbell or dumbbells. When using a barbell, the lifter steps under the bar and grabs it with a closed pronated grip. The weight can either be placed in front of the lifer (front squat) or behind the lifter (back squat) depending on the lifter's preference and intended goal (Delavier 2010).

When performing the back squat, the lifter places the barbell across his/her shoulders at the base of the neck, over the trapezius and deltoid muscles, while in the front squat, the weighted barbell is placed on the anterior deltoids and clavicles. The lifter is required to assume an upright and flat back position with feet at shoulder width apart. The lifter then slowly squats until the thighs are parallel to the floor, keeping the heels planted on the floor. The hips and keens are then extended at the same time in order to move back upwards to a standing position. This is done by pushing through the legs while keeping the heels on the ground and the back flat (Delavier 2010; Gregory and Travis 2015). See **Figure 2.4**.

The prime movers during the squat are the gluteal and the quadriceps muscles. The assistant movers are the hamstrings, adductors, abs and erector spinae muscles (Arroyo 2011). When performed with poor form and heavy load, this exercise is associated with back pain and injuries (Delavier 2010). Strömbäck *et al.* (2018) also report a positive association between hip injury and the squat amongst women such that women who performed the squat frequently, had a hip injury, while those who performed it less had no hip injury.

1) Starting position

2) Lowest position

1) Starting position

1) Lowest position

(Gregory and Travis 2015)

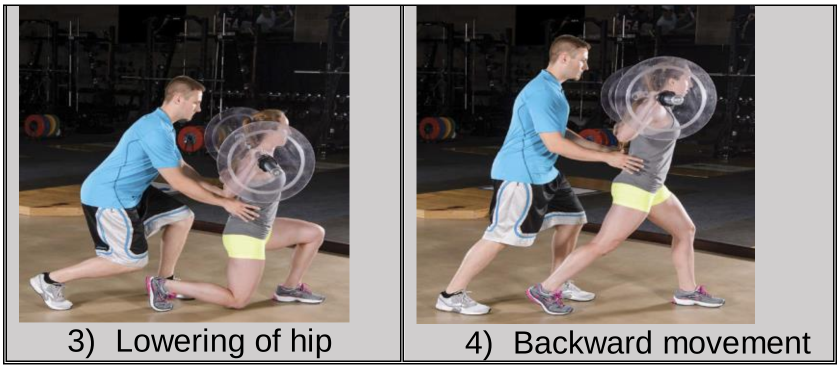
Figure 2.4 The Front and Back Squat (Oblique views)

2.9.3 Lunges

Lunges can be performed with the use of either dumbbells or a weighted barbell. In this exercise, the lifter stands erect, eyes facing straight forward with the barbell placed across the shoulders (upper trapezius muscles). In the case of dumbbells, one is held in each hand, using a closed neutral grip. The feet should be shoulder width apart and a forward exaggerated step is taken, keeping the torso erect. The lifter then lowers their hips until the top of the forward thigh is parallel to the floor. This needs to be done without the knees crossing over the toes (see **Figure 2.5**). The trailing knee should be lowered to about 3 to 5 cm above the floor. The lifter can then push up through the front heel back to the starting position (Haff and Triplett 2015). This exercise involves the gluteus Maximus and quadriceps as the prime movers and the hamstrings, iliopsoas and rectus femoris of the back leg as assistant movers. During the lunge, if the knee is extended too quickly, the meniscus might not return to its position fast enough and get stuck between the condyles, which can lead to meniscal injury (Delavier 2010).

1) Starting position

2) Forward step

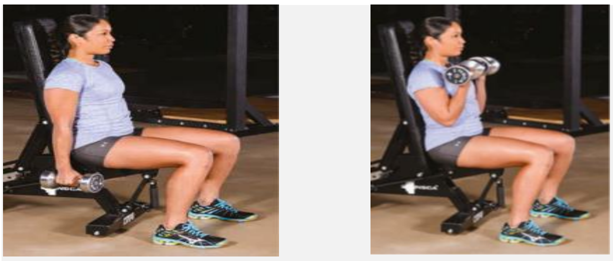


(Haff and Triplett 2015)

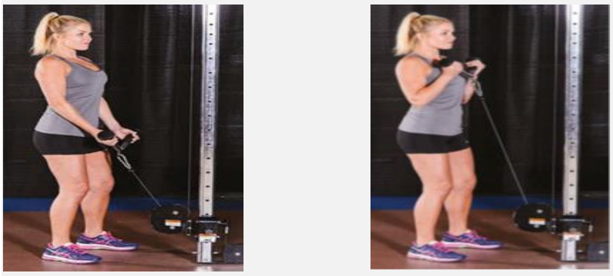
Figure 2. 5 The Lunge (Lateral views)

2.9.4 Biceps curl

Amongst the exercises that can be performed with the use of both free weights and weight training machines are biceps curl. This exercise can be performed either seated or standing, where the barbell or curl bar (weight training machine) is held with fully extended elbows and palms facing forward and resting on the lifter's thighs, while the hands start off in a neutral position with palms facing each other when using the dumbbells (see **Figure 2.6**). The body is held in an erect position, squeezing the upper arms against the torso, with eyes facing forward. The knees are slightly bent and the bar is curled upwards, towards the shoulders and returned to the starting position (Delavier, Clémenceau and Gundill 2010; Delavier and Gundeill 2014). The biceps brachii and brachialis are the prime movers, while the brachioradialis and supinator act as assistant movers (George 2016).



1. Starting position 2. End position



1. Starting position 2. End position

(Haff and Triplett 2015)

Figure 2.6 Dumbbell and Cable Biceps Curls (Oblique views)

2.9.5 Reverse barbell curl

This exercise is reportedly good for strengthening the wrist, which is often weak due to muscular imbalance. Apart from muscle imbalance, it is weak due to wrist extensors being used more than the wrist flexors in daily activities. When performing the reverse barbell curl, the lifter stands with legs slightly bent and arms fully extended. The bar is grasped with a pronated hand grip, with thumbs facing each other (**Figure 2.7**). The lifter must keep the back straight with eyes focusing straight ahead and the arms held against the trunk. The bar is then lifted towards the deltoids by bending at the elbows. The bar is then lowered back to the starting position in a slow and controlled motion (Delavier 2010). This movement can be repeated for the desired number of sets/repetitions. The prime movers during this exercise are the wrist extensors and the assistant movers are the brachioradialis and brachialis muscles (George 2016).

3. Starting position 2. End position

(Rippetoe and Kilgore 2007)

Figure 2.7 Reverse Barbell curls (Oblique View*)*

2.9.6 The triceps extension

The triceps extension exercise can be done in both sitting and standing positions, using either free weights or weight training machines. When using free weights, the arms start at a fully extended position above the head and about 20 centimetres apart. The lifter then slowly lowers the weights, keeping the elbows pointed forward. At the lowest position, the lifter then pauses and pushes the bar back to full extension. This movement is repeated until the set is completed. However, when this exercise is done on a weight training machine, the lifter stands in front of the machine (**Figure 2.8**). The elbows are placed at the sides of the body and bent to approximately 90 degrees. The lifter then grabs the handle, with the thumb wrapping around it. The lifter then pushes the arms into extension while squeezing the upper arms against the ribs (Brown 2017). This exercise recruits the triceps brachii as the prime movers and the anconeus as the assistant mover. Poor form such as arching of the back during this exercise has been associated with causing back pain (Delavier 2010).

4. Starting position 5. End position

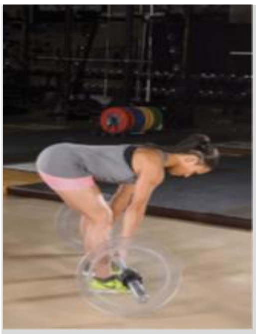
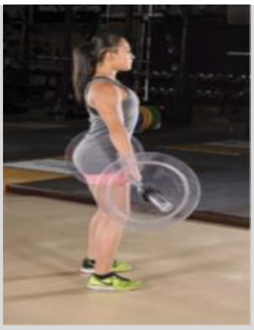
6. Starting position 7. End positon

(Brown 2017)

Figure 2.8 Triceps Extension (Oblique views)

2.9.7 The deadlift

This exercise is amongst the exercises that can be performed in different variations and it is identified as having the most carryover to daily life (Poliquin group 2013). The deadlift is also commended for strengthening the whole body and teaching the body how to move properly. The lifter stands with feet slightly apart in front of the bar as it rests on the ground. The bar is held in a closed pronated grip, keeping the torso in a neutral position. The knees are slightly flexed and the lifter extends back at the hips, lifting the weight. The lifter must be careful not to jerk the torso backwards or flex the elbows. On reaching full extension, the lifter can then return to a starting position by flexing at the hips to lower the bar in a slow and controlled manner (Haff and Triplett 2016; George 2016). The lifter must keep the back straight or slightly arched, the knees slightly bent and the elbows fully extended when lowering the bar (**Figure 2.9**). The prime movers of this exercise are the gluteal, hamstring and quadricep muscles. The assistant movers are the erector muscles and other muscles may be involved, depending on which deadlift variation is being performed (George 2016).

8. Starting position 9. End position

(Haff and Triplett 2016)

Figure 2.9 The Deadlift (Lateral view)

2.9.8 The chest fly

The chest fly can be executed using either a weight training machine or free weights. This exercise can be performed either supine (laying on the back) or seated. The dumbbell fly is recommended for more experienced weight lifters. When performed supine, the dumbbells are held in a neutral position with the palms of the hands facing the body. The head, shoulders and buttocks are placed on the weight training bench, with knees flexed to 90 degrees. The elbows are slightly flexed and the dumbbells are moved in an arc and lowered back to chest height. The lifter needs to be careful not to twist or arch the body during these movements (Ratamess 2012).

When using the machine, the seat height needs to be adjusted so that the arms are at shoulder level when holding the vertical handles. The lifter needs to keep the elbows slightly bent when gripping the vertical handles and maintain an upright posture (**Figure 2.10**). The arms are then brought together in a controlled motion until the handles almost touch. The arms are then slowly returned to a starting position without allowing the resistance weight to rest on the weight stack between repetitions. This exercise recruits the Pectoralis major muscle as the prime mover and the anterior deltoids and pectoralis minor as assistant movers (Ratamess 2012; Brown 2017).

10. Starting point

11. End point

12. Starting point

13. End point

(Ratamess 2012; Brown 2017)

Figure 2.10 Machine and Dumbbell Chest Fly (Oblique Views)

2.9.9 The Dumbbell lateral raise

This exercise has several variations: it can be done with one arm at a time or both arms simultaneously. It is executed with dumbbells held with a closed pronated grip, one in each hand. The arms are initially on either side of the hips, with elbows slightly flexed and arms rotated such that the elbows point outwards. The feet are shoulder width apart, knees slightly flexed, back straight and eyes facing straight ahead (**Figure 2.11**). The dumbbells are then lifted up laterally without using momentum until the wrist and elbows are parallel to the floor. The dumbbells are then lowered back to a starting position in a controlled manner. The prime movers during this exercise are the deltoid muscles and the assistant movers are the upper trapezius and the supraspinatus muscles (George 2016 ; Brown 2017).

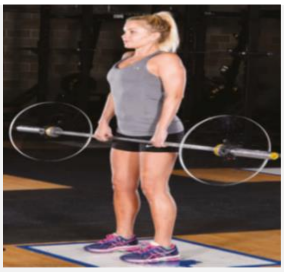
14. Starting position 15. End position

(Ratamess 2012)

Figure 2.11 Lateral Raise (Anterior views)

2.9.10 The shoulder shrug

The shoulder shrug can be done with either a barbell or dumbbells on either side. This is done by holding the barbell or dumbbells in a closed pronated grip. The feet are slightly wider than shoulder width apart and the knees are slightly bent. The weight is then lifted by elevating the shoulders as high as possible while keeping the back straight. The shoulders are returned to the starting position in a slow and controlled manner (**Figure 2.12**). The prime movers during this movement are the upper trapezius and the rhomboids are the assistant movers (George 2016).



1. Starting position 2. End position

1. Starting position 2. End position

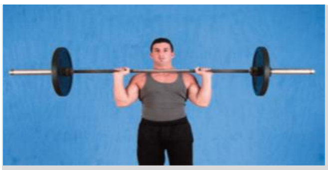
(Brown 2017; *Dumbbell Shrug* 2020)

Figure 2.12 Shoulder Shrugs with Barbell and Dumbbells (Oblique and Anterior views)

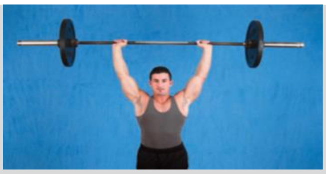
2.9.11 The shoulder press

This exercise can be done using either weight training machines or free weights, in either a seated or standing position. When using a bar, the bar is lifted from a squat rack, grasping the bar with hands equi-distant from the centre of the bar. The elbows are positioned under the bar with the wrists extended, while the bar rests on the shoulders and clavicle. The lifter then pushes the bar straight up, keeping the torso erect and returns to a starting position until the set is complete (Haff and Triplett 2015).

When using a machine, the lifter adjusts the seat height so that the handles are aligned with or slightly above shoulder height. The lifter then grasps the handles with palms facing forward, with the feet placed flat on the floor. The lifter then pushes up until the elbows are in full extension, keeping the torso erect and the head and shoulders against the back pad (**Figure 2.13**). The handles are returned to a starting position in a controlled motion without allowing the resistance to rest back in the rack until the set is complete (Haff and Triplett 2015). This exercise primarily recruits the deltoid muscles as the prime movers and the trapezius and triceps as assistant movers (George 2016). The shoulder press and other weight-training exercises that focus on building the deltoids are associated with overuse injuries such as tendonitis or shoulder capsule strains (Delavier 2010).



1. Starting position



2. End position

1. Starting position

2. End position

(Ratamess 2012; Brown 2017)

Figure 2.13 Machine and Barbell Shoulder Press (Anterior and Oblique views)

2.9.12 The Pelvic Thrust

The pelvic thrust, also known as the hip thrust, is a popular gluteal muscles exercise. It can be done with dumbbells, one on each side or with a weighted barbell. The barbell is placed on the floor in front of the bench or 2 dumbbells are placed one on each side of the bench. The lifter then sits on the floor with his or her back against the bench, which should be secured to the floor in order to prevent it from moving during the exercise. The lifters legs should then be placed beneath the barbell, and the bar should be rolled up until it is positioned across the hips, above the hip crease (**Figure 2.14)** (Brown 2017).

A pad can be placed below the bar to reduce possible discomfort caused by the bar over the hip crease. The knees should then be bent to 90 degrees, placing the feet firmly on the ground. The shoulders must be firmly planted on the bench so that the lifter can thereafter elevate the body off the floor, pushing through the gluteal muscles. This is done by fully extending the hips and squeezing the gluteal muscles, being careful to keep the spine in a neutral position and feet firmly on the ground. On reaching full extension, the lifter can then lower him/herself back to the staring position in a controlled manner. The prime movers during this exercise are the gluteal muscles and the assistant movers are the hamstrings and the quadriceps muscles (Brown 2017).

1. Starting position

2. End position

(Hitchko 2017)

Figure 2.14 The Pelvic Thrust (Lateral Views)

2.9.13 Rowing

Row exercise can be performed in multiple variations, such as the bent over row, upright row and machine row. The basic movements involved in the row are grasping the resistance (bar/handle) and pulling the weight towards the chest. This must be done without using the torso to pull the weight. The shoulder blades must be squeezed together at the end of the motion. This can be done either in a bent over, seated or standing position. When performed on a machine, the seat height must be adjusted to align the mid chest with the top of the chest pad (Haff and Triplett 2015).

The lifter must also ensure that the chest pad is adjusted to allow for full arm extension and then grab the handle with palms facing each other. When doing the bent over row with a barbell or dumbbells, the lifter must stand with feet shoulder width apart and knees slightly bent (**Figure 2.15**). The weight must be firmly grabbed with the palms facing the body and thumb wrapped around the bar. The basic moves stated above can then be performed to finish off the exercise. The prime movers during this exercise are the rhomboids, latissimus dorsi, teres major, mid trapezius and the posterior deltoid. The assistant movers on the other hand are the biceps and brachioradialis muscles. Injuries of the lower back can occur due to the rounding of the back (improper form) when performing this exercise (Delavier 2010; Brown 2017).

1. Starting position

2. End position

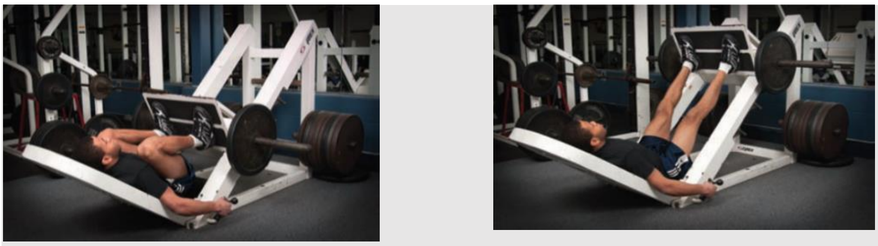
1. Starting position 2. End position

(Ratamess 2012; Haff and Triplett 2015)

Figure 2.15 Rowing Machine and Barbell row (Oblique and Anterior views)

2.9.14 Leg Press

Some exercises are mainly done on weight training machines. These include the leg press, knee extension, knee curl, the pec deck and the cable machine exercises. When performing the leg press exercise, the lifter sits erect with their back pressed against the seat. The seat is then adjusted so that the legs of the lifter are at a 90-degree angle. The lifter then places their feet on the pedals, pointing them outwards slightly and wider than shoulder width apart (**Figure 2.16**). The pedals are pushed away by extending the knees without locking them on full extension. The weightlifter thereafter slowly returns the legs to the starting position in a controlled motion. This is repeated for the desired number of sets. This exercise involves the quadriceps and gluteal muscles as the prime movers and the adductors and hamstrings as assistant movers. When performed with heavy loads, in some instances it can cause a hinge on the sacroiliac joints, resulting in painful muscle spasms (Delavier 2010; Ratamess 2012).



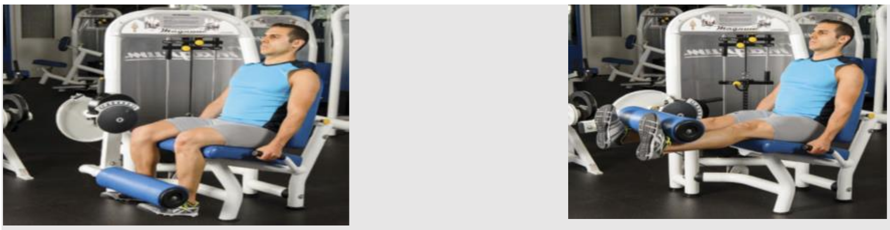
1. Leg press starting position 2. Leg press end position

(Ratamess 2012)

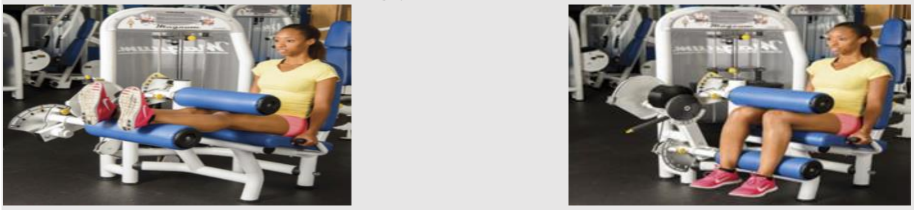
Figure 2.16 Leg Press Machine (Oblique view)

2.9.15 Knee extensions and knee curls

The knee extension and knee curl machines work in a similar manner, but use opposing motions as they focus on muscles with opposing actions (**Figure 2.17**). The knee extension exercise is done in an erect seated position. The lifter places his ankles behind the pads that are attached to the weight plates and grips the machine handles. The knees are then slowly extended, held in an extended position for a while and then returned to the starting position. The knee curl, on the other hand, is done with the lifter laying on the bench facing down with ankles under the pads that are attached to the weight plates. The lifter then slowly flexes the knees until the end of their range motion. The lifter pauses briefly in the flexed position before returning to the starting point (Haff and Triplett 2015).



1. Knee extensions starting position 2. Knee extensions end position



1. Knee curls starting position 2. Knee curls end position

(Haff and Triplett 2015)

Figure 2.17 Knee Extension and Knee Curl Machine (Oblique views)

2.9.16 The pec deck machine

This machine is also known as the seated fly. The lifter sits on the machine bench with the head, shoulders and back in contact with the bench. He/she then grabs the handles with a closed gip (**Figure 2.18**). The lifter’s forearms are placed on the pads of the machine, with the elbows held at 90 degrees. The lifter’s forearms and seat must be parallel to the floor. The forearms are then squeezed together to bring the arm pads in front of the chest and are thereafter returned to the starting position. This movement is then repeated for the desired number of sets/repetitions. The prime movers during this exercise are the pectoralis major and the deltoid muscles, while the assistant movers are the coracobrachialis and biceps bracii (Delavier 2010; Brown 2017).

1. Starting position 2) End position

(Mind 2011)

Figure 2.18 Pec Deck Machine (Oblique View)

2.9.17 The cable machine

The cable machine is used for a variety of exercises in different styles. Some of the exercises have already been mentioned and described, such as the biceps curls, triceps extensions and others. These exercises can either be done seated or standing and in different planes to strengthen different muscles. For example, standing/kneeling cable kickbacks or cable crossovers. The cable kickbacks would require the lifter to stand in front of the machine with one leg attached to the ankle strap of the low pulley (**Figure 2.19**). The lifter's pelvis must face forward as the lifter holds onto the machine handle for support. The hip is then extended, pulling the leg backwards. This movement is limited by tension of the iliofemoral ligament. The gluteus Maximus is the prime mover during this exercise and the hamstrings are assistant movers. When executed incorrectly, this exercise has been associated with lower back pain (Delavier 2010).

The cable crossover exercise has several variations, depending on the lifter's target muscles. The basic movements involve the lifter standing at the centre of the machine with feet shoulder width apart, grabbing the machine handles on both sides. The torso must be slightly bent forward keeping the back straight and the elbows slightly bent. The lifter then inhales, pulling both handles across the body (**Figure 2.19**). At the end of the contraction, the lifter can then exhale while slowly reversing back to starting position keeping the bend at the elbows throughout. The prime movers during this exercise are the pectoralis major muscles. The assistant movers are the pectoralis minor, rhomboids, levator scapulae, anterior deltoids and the latissimus dorsi muscles (Delavier 2010).

1. Starting position 2. End position

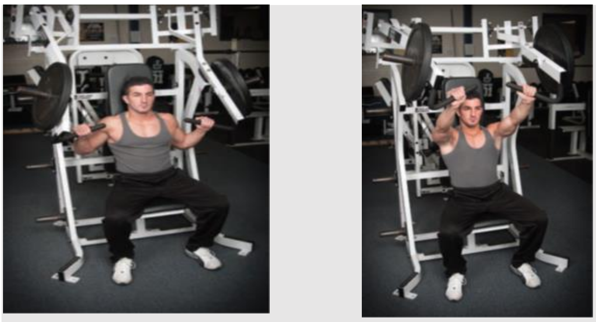
1. Starting position 2) End position

(Warner 2019; *Cable Glute Kick-Back* 2020)

Figure 2.19 Cable Kickbacks and Cable Crossovers (Oblique Views)

2.9.18 The chest press

The chest press is almost similar to the bench press exercise. However, the chest press is done on a machine. The chest press machine requires the lifter to be seated with their head, shoulders and buttocks in direct contact with the bench and their feet flat on the floor. The lifter grips the bar handles, aligning the grip with their nipples. The bar handle is then pushed away from the chest to full extension (**Figure 2.20**). The lifter must be careful not to arch the lower back or forcefully lock out the elbows. The handles are then slowly returned to starting position in a controlled manner. The prime movers during this motion are the pectoralis major and the anterior deltoids, while the assistant movers are the pectoralis minor (Haff and Triplett 2015).



1. Starting position 2. End position

(Ratamess 2012)

Figure 2.20 Chest Press Machine (Oblique views)

2.9.19 The latissimus dorsi pulldown machine

The latissimus dorsi pull down machine is popularly used for strengthening the latissimus dorsi and the teres major muscles. It can be performed in two ways: the lifter can either sit or kneel, leaning back slightly. The lifter can then fully extend the elbows to grip the bar, keeping their elbows out and away from the body. The bar is then pulled past the chin, towards the upper chest (**Figure 2.21**). This must be done with feet flat on the ground and the torso stationary. The shoulder blades must also be squeezed together while maintaining square shoulders. The lifter can thereafter slowly return their arms to the starting position and then repeats the motion for the desired number of sets/repetitions. This exercise can also be performed by seating or kneeling in front of the machine. The bar is grabbed with a wide overhead grip and pulled down the back of the neck instead of the front, bringing the elbows alongside the body. The pulldown behind the neck is however not recommended because it causes rotation of the shoulder joint. The possible contact of the bar and spine is also suspected to probably lead to injuries. The prime movers during this exercise are the latissimus dorsi and teres major muscles. The assistant movers are the medial and lower fibres of the trapezius muscle, the rhomboids and biceps (Delavier 2010; Brown 2017).

1) Starting position 2) End position

(Brown 2017)

Figure 2.21 Latissimus Dorsi Pulldown (Oblique view)

2.7 Conclusion

Extant literature on the risk factors and other factors associated with the weight training population clearly shows that possibilities of injury exist during exercise. Moreover, some anatomical locations are more prone to injury than others and some injuries are more prevalent than others. The environment and other internal factors have also been demonstrated to determine injury occurrence to a certain extent. The specific focus on the eThekwini municipality population in this study will therefore give insight into any similarities or differences in weight training injuries compared to previous studies. The majority of non-professional individuals looking to improve their physical health and body image will also gain awareness of the possible unforeseen consequences of weight training.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The aim of this chapter is to provide clarification on how the research was executed and insight into the different research techniques that were implemented in the process. The methodology and objectives of the research will be discussed in detail. This includes the target population, sampling, focus group, pilot study, the data collection tool, administration of the questionnaire and data analysis. The limitations and ethical considerations of conducting the research will also be deliberated upon.

3.2 Research design

The current research study is a quantitative cross-sectional survey which was conducted with the aim of establishing an injury profile of weight trainers at gyms within the eThekwini municipality. Approval to conduct the research was granted by the Durban University of Technology's Institutional Research Ethics Committee.

3.3 Total population

The research population encompassed weight trainers within eThekwini municipality gyms. It included both males and females who were willing to participate in the research.

3.4 Sample size

A sample size of 322 participants who met the selection criteria was used in order to allow a maximum generalisation of results. The sample was calculated using estimated values of weight trainers per gym ranging from 20 to 1000 consistent weight trainers, depending on the gym. These estimates were obtained from the fitness managers in the various gyms. A minimum number of participants was then estimated per gym, depending on the number of weight trainers they have per week. The total minimum number of participants required per gym were then added up to derive the final sample size of the research (Matthews 2018).

3.5 Recruitment

Participants were recruited through an advertisement (Appendix H) that was sent to the managers of the gyms to distribute via email to gym members. In some gyms, the advertisement was pinned on the gym noticeboard at the entrance, depending on the gym's advertisement rules and preferences. Other participants were recruited by word-of-mouth through other participants that had participated in the research. The researcher explained the research aims and assessed the willingness of the weight trainers to participate in the research. Willing participants were given a letter (Appendix A) of information about the research and a consent form (Appendix B) to sign before participating in the research.

3.5.1 Inclusion criteria

1. Individuals over 18 years of age, enabling them to sign their own consent form.
2. Individuals that were registered with a gym within the eThekwini municipality during the data collection period.
3. Individuals who have weight training experience of more than 3 months.
4. Only individuals who had signed the Consent form of the research (Appendix B).

3.5.2 Exclusion criteria

1. Questionnaires that had only one section completed of the three sections in the questionnaire.
2. Individuals who had participated in the pilot study or focus group.

3.6 Measurement tool

A questionnaire was used to collect information from willing participants who met the inclusion criteria of the study. The questionnaire (Appendix C) used in this research was designed by the researcher using guidance from previous similar research studies (Kerr, Collins and Comstock 2010; Gray and Finch 2014; Doesburgh 2016; Pendock 2018). Questions investigating history of injuries, demographics and activity profile were incorporated from various other sources (Calfee and Fadale 2006; Robb and Mansfield 2007; Cardinale, Newton and Nosaka 2011; Brown 2017). Face validity of the questionnaire (Appendix C) was determined through the assistance of a focus group and a pilot study following the approval of the research by the Institutional Research Ethics Committee at the Durban University of Technology.

3.7 Focus group

A focus group is described by Dilshad and Latif (2013) as a small group of six to nine people brought together in order to explore their understanding, perception and interpretation of a topic .The main purpose of a focus group is to use group interviews to provide information and insight to the researcher through interactions within the group (Krueger 2002). Information that would have been inaccessible to the researcher was obtained through the focus group discussions. The discussions were based on the research questionnaire, with the researcher playing the role of a moderator. The selection of focus group participants was based on the following inclusion and exclusion criteria:

3.7.1 Inclusion criteria

1. Participants were above the age of 18 years old.
2. Individuals with knowledge and expertise in the field of research. These included 2 chiropractic lecturers with experience in questionnaire studies; 2 students who had done questionnaire research; and 2 individuals who have been weight training for over 5 years.
3. Only individuals who had read and understood the Letter of information (Appendix F) and signed the Consent form (Appendix G) and Letter of confidentiality (Appendix I).

3.7.2 Exclusion criteria

1. Potential main research participants.
2. People who might want to participate in the pilot study.

3.7.3 Focus group procedure

The date, time and venue of the focus group discussion was established first. Potential participants were then identified and contacted by the researcher. A total number of six participants were contacted. On the day of the Focus group meeting, the researcher acted as a moderator of the meeting, welcomed participants and handed out letters of information (Appendix F).

After reading and understanding the letter of information (Appendix F), the focus group participants were given Informed Consent forms (Appendix G) and Confidentiality forms (Appendix I) to read and sign before proceeding. The researcher then addressed questions regarding the proceedings and the consent forms. The researcher presented an overview of the topic, set ground rules for discussions and distributed the Questionnaire (Appendix C) to be discussed.

The questionnaire was then discussed by the focus group, with the researcher moderating the discussion, recording, taking notes and monitoring logistics (Krueger 2002). After complete discussion of the Questionnaire (Appendix C), the researcher implemented some of the focus group recommended changes and established a Post-focus group questionnaire (Appendix K).

3.8 Pilot Study

A pilot study was then conducted using the post-focus group questionnaire (Appendix K). This was essential to identify any potential barriers in the methodology of the research so that they could be addressed to ensure the success of the larger scale research (Jairath, Hogerney and Parsons 2000). A sample size of 4 participants was used in the pilot study, which was justified based on both feasibility and precision (Matthews 2018).

3.8.1 Inclusion criteria

1. Individuals were above the age of 18 in order to sign their own consent forms.
2. Only people who had read the Letter of information (Appendix D) and signed the Consent form (Appendix E).
3. Only registered members of the Durban University of Technology gym who participated in weight training.

3.8.2 Exclusion criteria

1. Potential main research study participants.
2. Members of the focus group.

3.8.3 Pilot study procedure

Participants who were used for the pilot study only included students who were registered at the Durban University of Technology gym. Permission to conduct the pilot study at the University gym was granted by the Durban University of Technology's Sports department and research gatekeepers. The approach that was going to be used in the main research for data collection was tested in the pilot study in order to evaluate its effectiveness. The pilot study participants were given the post-focus group questionnaire (Appendix K) after having signed a consent form (Appendix E). On completion of the questionnaire (Appendix K), they were given pilot study questionnaire evaluation sheets. The feedback from the evaluation sheets was used to make other adjustments to the questionnaire, leading to the establishment of the final questionnaire (Appendix L).

3.9 Research procedure

Permission to conduct the research was sought from the various gym managers (Appendix J). Ethical clearance was granted by the Research Ethics Committee (IREC) of the Durban University of Technology. Data collection commenced on the days agreed upon with the gym managers in the various gyms. Advertisements of the research study were placed in the different gyms according to the preferences of the gym. Some gyms preferred emailing the advertisement to their members, whilst others preferred displaying the advertisement at the entrance of the gym.

The approach towards potential participants also varied according to the gyms' preference. The researcher was granted permission to approach potential participants and personally hand them the letter of information (Appendix A), consent form (Appendix B) and the questionnaire (Appendix L).

The researcher had two separate boxes, one marked A and the other marked B. These were used for inserting the completed questionnaire forms (Appendix L) and consent forms (Appendix B). This was done in order to maintain confidentiality. Box A was used to place the signed consent forms (Appendix B), while box B was used for placing the completed questionnaires (Appendix C). After data collection, all the boxes were sealed and information was only accessed by the researcher during data capturing for statistical analysis and reporting. Once the data had been captured, statistically analysed and reported, the boxes were sealed yet again and kept in safe storage. They will remain in storage for a duration of 5 years within the chiropractic department, following which the information will then be destroyed through shredding.

3.10 Data processing and analysis

The data was analysed using IBM SPSS (Statistical Package for the Social Sciences) version 25 to determine statistical significance, where a p value of less than 0,05 was considered statistically significant. The Fisher's Exact Test was used to analyse the significance of the different relationships where the frequency counts were less than 5. Descriptive and interferential statistics were used to determine the objectives of the research. Additionally, a Descriptive analysis was used to summarize the injury profiles, while summary statistics were used for continuous variables. This was done by Miss Matthews (statistician) at the Durban University of Technology (DUT). The logistic regression model was also used to explain the relationship between one independent binary variable and more nominal variables (Matthews 2018).

3.11 Ethical consideration

All participants were given a letter of information (Appendix A), briefly detailing the research study. Questions and queries pertaining to the research were then answered by the researcher. Participants were required to sign a Consent form (Appendix B), thereby agreeing to participate in the research. Consent forms, which had participants' personal details, were separated from the questionnaire to ensure anonymity.

To ensure Justice, there were no exclusions or preferences of any ethnic groups or gender, but an equal chance of participation was available for all through random selection. Non-maleficence was considered during the research to ensure participants' safety. Benevolence only applied in terms of the beneficial results of the research to weight trainers and gym managers. However, no incentive was given to any participants or participating gyms. Autonomy was ensured by not using any incentive or manipulative speech to recruit participants, but rather allowing them to make their own decisions to participate.

CHAPTER 4: RESULTS

4.1 Introduction

In this chapter, the results of the research are presented in line with the objectives of the research. The research questionnaire (Appendix L) was used to achieve each objective. The results are presented in the form of frequency tables and bar charts.

The research questionnaire was divided into four sections, as follows:

1. A: Demographic profile
2. B: Activity profile
3. C: Point (current) prevalence injury profile
4. D: Period (12 months) prevalence injury profile

4.2 Response rate

A minimum of 322 participants was required to allow generalisation of the results and a 100% response rate was achieved.

4.3 Objective 1: To profile musculoskeletal injuries sustained by weight trainers in the eThekwini municipality

Sections C and D of the questionnaire were used to determine this objective, where Section C addressed the point prevalence of injuries and Section D addressed the period prevalence of injuries.

4.3.1 Point prevalence

Question: Do you ***currently*** have any injury/injuries sustained due to weight training?

Table 4.1 Participants with current injuries

Current injury		Frequency	Percent
Valid	Yes	101	31.4
	No	220	68.3
	Total	321	99.7
Missing	System	1	.3
Total		**322**	**100.0**

Table 4.1 shows the number of people who had injuries due to weight training at the time the research was conducted. Out of the 322 people that completed the questionnaire, only 101 reported injuries at that point in time. That means that only 31.4% of the total population had current injuries.

4.3.1.1 Anatomical location

Question: If you answered YES, in which part of your body did you sustain this injury/injuries?

The anatomical locations of the injuries reported as current injuries during the time the data was collected were indicted under the following headings: Injury 1, Injury 2 and Injury 3. The participants were asked to identify injuries from the most severe (Injury 1) to the least severe (Injury 3).

Table 4.2 Anatomical location of injuries

Injury 1				Injury 2				Injury 3			
Anatomical location		Frequency	%	Anatomical location		Frequency	%	Anatomical location		Frequency	%
					0	74	73.3		0	94	93.1
Valid	F/a	2	2.0	Valid	F/a	0	0.0	Valid	F/a	0	0.0
	Ft/an	1	1.0		Ft/an	0	0.0		Ft/an	0	0.0
	Buttock	2	2.0		Buttock	1	1.0		Buttock	0	0.0
	Knee	13	12.9		Knee	8	7.9		Knee	0	0.0
	L/b	26	25.7		L/b	5	5.0		L/b	3	3.0
	Calf	2	2.0		Calf	1	1.0		Calf	0	0.0
	Hip	0	0.0		Hip	1	1.0		Hip	1	1.0
	Intsc	1	1.0		Intsc	0	0.0		Intsc	0	0.0
	Neck	7	6.9		Neck	0	0.0		Neck	0	0.0
	Shoulder	32	31.7		Shoulder	3	3.0		Shoulder	1	1.0
	Thigh	0	0.0		Thigh	2	2.0		Thigh	0	0.0
	Wrist	2	2.0		Wrist	2	2.0		Wrist	1	1.0
	U/b	1	1.0		U/b	0	0.0		U/b	0	0.0
	Hand	0	0.0		Hand	1	1.0		Hand	0	0.0
	Elbow	6	5.9		Elbow	3	3.0		Elbow	1	1.0
	M/b	2	2.0		M/b	0	0.0		M/b	0	0.0
	Chest	4	4.0		Chest	0	0.0		Chest	0	0.0
	Total	101	100.0		Total	101	100.0		Total	101	100.0

F/a = Forearm; Ft/an =Foot/Ankle; L/b = Lower back; Intsc = Interscapular; U/b = Upper back; M/b = Mid/back

% = Percentage

Table 4.2 shows the anatomical locations of the injuries reported in this research under current injuries. The areas with the highest injury frequency under "Injury 1'' were the shoulder (31.7%), followed by the lower back (25.7%) and the knee (12.9%). Out of the 101 participants who had "Injury 1", 27 of them reported having "Injury 2"; whereas knee injuries had the highest frequency of 29.6%, followed by the lower back (18.5%) under "Injury 2". There were only seven participants out of the

101 who reported having a 3rd injury, "Injury 3", and out of the seven the lower back (42.8%) was the most injured anatomical location.

4.3.1.2 Injury severity

The severity of injuries was measured using a pain rating scale, where the individual would circle a number from the least severe (1/10) to the most severe (10/10) pain intensity due to the injury. The ability to carry out daily activities and to continue with their training program were also used to measure the severity of the injuries that were reported.

The following questions were used to assess the severity of the reported injuries:
Question: Using the scale below, please rate the severity of your injury in terms of pain.
Question: Did the injury interfere with your ability to carry out daily activities?
Question: Did the injury interfere with your training ability/program?

Table 4.3 Pain rating scale of injuries under "Injury 1"

	Injury 1 (current pain)				Injury 1 (worst pain felt)		
Pain rating		Frequency	Percent	Pain rating		Frequency	Percent
Valid	1	12	11.9	Valid	1	0	0.0
	2	20	19.8		2	3	3.0
	3	15	14.9		3	10	9.9
	4	19	18.8		4	7	6.9
	5	12	11.9		5	16	15.8
	6	16	15.8		6	14	13.9
	7	4	4.0		7	14	13.9
	8	3	3.0		8	20	19.8
	9	0	0.0		9	4	4.0
	10	0	0.0		10	13	12.9
	Total	**101**	**100.0**		**Total**	**101**	**100.0**

Table 4.3 above shows the pain rating that the participants were feeling at the time the data was collected due to "Injury1". Pain rating with the highest frequency was 2/10 (19.8%), followed by 4/10 (18.8%), whilst 8 /10 (2.9%) was the lowest current pain rating. In terms of the worst pain the participants had experienced due to the current injury, 8/10 (19.2%) had the highest frequency of pain rating, followed by 5/10 (15.8%). The pain rating with the lowest frequency in terms of the worst pain felt was 2/10 (2.9%).

Table 4.4 Pain rating scale under "Injury 2"

Pain rating		Injury 2 (current pain) Frequency	Percent	Pain rating		Injury 2 (worst pain felt) Frequency	Percent
Valid	0	75	74.3	Valid	0	75	74.3
	1	4	4.0		1	0	0.0
	2	2	2.0		2	0	0.0
	3	6	5.9		3	2	2.0
	4	2	2.0		4	3	3.0
	5	2	2.0		5	3	3.0
	6	3	3.0		6	2	2.0
	7	3	3.0		7	3	3.0
	8	4	4.0		8	4	4.0
	9	0	0.0		9	2	2.0
	10	0	0.0		10	7	6.9
	Total	**101**	**100.0**		**Total**	**101**	**100.0**

Amongst the 101 that had reported having "Injury 1", only 26 of them had "Injury 2". The pain rating with the highest frequency in terms of current pain among these was 3/10 (23.0%), followed by 1/10 and 8/10 which had a frequency of 3.9%. In terms of the worst pain felt due to Injury 2, the table above shows that a rating of 10/10 (26.9%) had the highest frequency, followed by a rating of 8/10 (3.9%) (**Table 4.4**).

Table 4.5 Pain rating scale under "Injury 3"

Pain rating		Injury 3 (current pain) Frequency	Percent	Pain rating		Injury 3 (worst pain) Frequency	
Valid	0	94	93.1	Valid	0	94	93.1
	1	0	0.0		1	0	0.0
	2	2	2.0		2	0	0.0
	3	2	2.0		3	1	1.0
	4	1	1.0		4	1	1.0
	5	2	2.0		5	1	1.0
	6	0	0.0		6	1	1.0
	7	0	0.0		7	1	1.0
	8	0	0.0		8	0	0.0
	9	0	0.0		9	1	1.0
	10	0	0.0		10	1	1.0
	Total	**101**	**100.0**		**Total**	**101**	**100.0**

Table 4.5 shows that 2/10, 3/10 and 5/10 had the highest frequency of 28.5%, while 4/10 had the lowest frequency of 14.2% in terms of current pain due to "Injury 3". The worst pain rating by the participants due to "Injury 3" had the same frequency of 14.2%.

Table 4.6 Effects of injuries under "Injury 1'' on daily activities and training program.

Daily activities		Injury 1 Frequency	Percent		Training	Injury 1 Frequency	Percent
Valid	0	1	1.0	Valid	No	29	28.7
	No	53	52.5		Slightly	36	35.6
	Slightly	29	28.7		Severely	36	35.6
	Severely	18	17.8		**Total**	**101**	**100.0**
	Total	**101**	**100.0**				

Table 4.6 shows that injuries under "Injury 1" did not affect most (52.5%) of the participants' daily activities; while for 28.7% of them, their training program was affected. About 28.7% reported that the injury slightly affected their daily activities, while 35.6% reported that their training was slightly

affected. Only 17.8% reported their daily activities being severely affected by their injury and 35.6% had their training severely affected by the injury.

Table 4.7 Effects of injuries under "Injury 2" on daily activities and training program

Daily activities		Injury 2 Frequency	Percent	Training		Injury 2 Frequency	Percent
Valid	0	76	75.2	Valid	0	75	74.3
	No	11	10.9		No	6	5.9
	Slightly	7	6.9		Slightly	8	7.9
	Severely	7	6.9		Severely	12	11.9
	Total	**101**	**100.0**		**Total**	**101**	**100.0**

Table 4.7 shows how daily activities and training programs were affected by "Injury 2". A notable 42.3% indicated that their daily activities were not affected and 23.0% indicted that their training was not affected. There were 26.9% of participants who reported that "Injury 2" had either affected their daily activities slightly or severely. The majority (46.1%) of participants who had "Injury 2" reported that their training program was affected severely and 30.7% reported that their training was only slightly affected.

Table 4.8 Effects of injuries under "Injury 3" on daily activities and training program

Daily activities		Injury 3 Frequency	Percent	Training		Injury 3 Frequency	Percent
Valid	0	94	93.1	Valid	0	94	93.1
	No	1	1.0		No	1	1.0
	Slightly	3	3.0		Slightly	2	2.0
	Severely	3	3.0		Severely	4	4.0
	Total	**101**	**100.0**		**Total**	**101**	**100.0**

Table 4.8 shows that only 14.2% of the participants who had "Injury 3" were not affected by the injury in terms of daily activities and training. However, 42.8% had their daily activities either slightly or severely affected by the injuries. The training program was slightly affected in 28.5% of the participants and severely affected in 57.1% of the participants.

4.3.1.3 Type of injury

The table below (**Table 4.9**) shows that muscle sprains (40.5%) had the highest frequency under "Injury 1", followed by joint sprains (30.6%) and tendonitis (11.9%). Amongst the 26 that reported "Injury 2", joint sprain injuries (38.4) had the highest frequency, followed by muscle strains and tendonitis with a frequency of 15.3%. Amongst the seven participants that had an "Injury 3", muscle strains (42.8%) were the injuries with the highest frequency.

Table 4.9 Types of injuries sustained

Injury 1				Injury 2				Injury 3			
		Freq	%			Freq	%			Freq	%
Valid				Valid	0	75	74.3	Valid	0	94	93.1
	Sprain	31	30.7		Sprain	10	9.9		Sprain	1	1.0
	Bursitis	1	1.0		Bursitis	0	0.0		Bursitis	0	0.0
	Contusion	0	0.0		Contusion	1	1.0		Contusion	0	0.0
	Dislocation	0	0.0		Dislocation	2	2.0		Dislocation	0	0.0
	Lig/Tear	1	1.0		Lig/Tear	0	0.0		Lig/Tear	1	1.0
	Lig/Sprain	6	5.9		Lig/Sprain	2	2.0		Lig/Sprain	0	0.0
	Fracture	0	0.0		Fracture	0	0.0		Fracture	0	0.0
	Msc/Spasms	5	5.0		Msc/Spasms	2	2.0		Msc/Spasms	1	1.0
	Msc/Strain	41	40.6		Msc/Strain	4	4.0		Msc/Strain	3	3.0
	Msc/Tear	2	2.0		Msc/Tear	0	0.0		Msc/Tear	0	0.0
	Tendonitis	12	11.9		Tendonitis	4	4.0		Tendonitis	1	0.0
	Tnd/Tear	0	0.0		Tnd/Tear	0	0.0		Tnd/Tear	0	0.0
	Pnch/Nerve	1	1.0		Pnch/Nerve	0	0.0		Pnch/Nerve	0	0.0
	Disc/Bulge	1	1.0		Disc/Bulge	0	0.0		Disc/Bulge	0	0.0
	Mnsc/Injury	0	0.0		Mnsc/Injury	0	0.0		Mnsc/Injury	0	0.0
	Total	**101**	**100.0**		**Total**	**101**	**100.0**		**Total**	**101**	**100.0**

Lig = Ligament; Msc = Muscle; Tnd =Tendon; Pnch =Pinched; Mnsc = Meniscal

Freq = Frequency; % = Percent

4.3.4 Type of treatment received

The table below (**Table 4.10**) shows the different types of treatment that the participants received after sustaining the reported injuries. More than half (62.4%) of the participants who reported having an injury under "Injury 1" did not seek any treatment. The types of treatment that had the highest frequency amongst those who got treatment were Medical (GP) (16.8%), followed by physiotherapy and the lowest was homeopathy (7.9%). The table below shows that 50% of those who sustained injuries under "Injury 2" did not receive any form of treatment. Treatment with the highest frequency was Medical (GP) (26.9%), while over-the-counter medication (1.0%) had the lowest frequency. The majority (42.8%) of the participants who had injuries under "Injury 3" did not receive any treatment for their injury. Chiropractors were amongst the least consulted professionals, with only 5.0% of consultations under "Injury 1" and 2.0% under "Injury 2".

Table 4.10 Type of Treatment received

Injury 1				Injury 2				Injury 3			
		Freq	**%**			**Freq**	**%**			**Freq**	**%**
Valid				Valid	0	75	74.3	Valid	0	94	93.1
	Biokinetic	0	0.0		Biokinetics	0	0.0		Biokinetics	0	0.0
	Chiropractor	5	5.0		Chiropractor	2	2.0		Chiropractor	1	1.0
	First Aid	3	3.0		First Aid	0	0.0		First Aid	1	1.0
	GP	17	16.8		GP	7	6.9		GP	0	0.0
	Orthopaedic	0	0.0		Orthopaedic	0	0.0		Orthopaedic	0	0.0
	Physio	8	7.9		Physio	3	3.0		Physio	1	1.0
	Trd/Zulu	0	0.0		Trd/Zulu	0	0.0		Trd/Zulu	0	0.0
	None	63	62.4		None	13	12.9		None	3	3.0
	OTC	4	4.0		OTC	1	1.0		OTC	1	1.0
	Homeo	1	1.0		Homeo	0	0.0		Homeo	0	0.0
	Total	**101**	**100.0**		**Total**	**101**	**100.0**		**Total**	**101**	**100.0**

GP = General Practitioner; Trd/Zulu = Traditional Zulu; Homeo = Homeopathic; OTC = Over the Counter Treatment;

Freq = Frequency; % = Percent

4.3.1.5 Exercises that might have caused injury

The following table (**Table 4.11**) shows the exercises the participants were doing during the time of injury. These exercises were grouped into free weights or weight training machines. The majority of people who had injuries under "Injury 1" had sustained the injury while using free weights (88.1%). The barbell shoulder press (18.8%) had the highest injury frequency, followed by the deadlift and the barbell back squat with a frequency of 17.8% each. The weight training machine exercises with the highest injury frequency were the lateralise pulldown and the leg press with 4.0% each.

Table 4.11 Exercises that caused injuries under "injury 1"

Free Weight				Weight Training Machines			
Exercise		Frequency	%		Exercise	Frequency	%
Valid	0	12	11.9	Valid	0	89	88.1
	Barbell bench squat	18	17.8		Lateralise pulldown	4	4.0
	Barbell bench press	12	11.9		Leg press	4	4.0
	Barbell curls	2	2.0		Pec Dec	1	1.0
	Barbell extensions	2	2.0		Standing calf raises	1	1.0
	Barbell front squats	3	3.0		Triceps push downs	2	2.0
	Barbell lunges	3	3.0		**Total**	**101**	**100**
	Barbell shoulder press	19	18.8				
	Deadlift	18	17.8				
	Dumbbell biceps curl	2	2.0				
	Dumbbell flies	3	3.0				
	Inclined dumbbell press	3	3.0				
	Reveres dumbbell curl	1	1.0				
	Dumbbell jump squat	1	1.0				
	Dumbbell front raises	1	1.0				
	Military press	1	1.0				
	Total	**101**	**100.0**				

Table 4.12 below shows that the barbell back squat (26.9%) had the highest frequency of injuries sustained while using free weights, whereas the leg press had the highest injury frequency (15.3%) of injuries sustained when using weight training machines

Table 4.12 Exercises that caused injuries under Injury 2

Free Weights				Weight Training Machines			
	Exercises	**Frequency**	**%**		**Exercises**	**Frequency**	**%**
Valid	0	80	79.2	Valid	0	95	94.1
	Barbell back squat	7	6.9		Hack squat	1	1.0
	Barbell bench squat	1	1.0		Leg press	4	4.0
	Barbell curls	1	1.0		Lying leg press	1	1.0
	Barbell extensions	1	1.0		**Total**	**101**	**100.0**
	Barbell front squat	2	2.0				
	Barbell row	1	1.0				
	Barbell shoulder press	2	2.0				
	Deadlift	1	1.0				
	Dumbbell row	1	1.0				
	Reverse barbell curl	1	1.0				
	Triceps kickback	1	1.0				
	Barbell calf raises	1	1.0				
	Dumbbell pullover	1	1.0				
	Total	**101**	**100.0**				

In **Table 4.13, it can be seen** that amongst those who had sustained injuries under "Injury 3", only 14.2% were injured while on the weight training machines. Under free weights, the dumbbell lateral raise was the free weight exercise with the highest injury frequency of 28.6%.

Table 4.13 Exercises that caused injuries under "Injury 3"

Free Weights				Weight Training Machine			
		Frequency	**Percent**			**Frequency**	**Percent**
Valid	0	95	94.1	Valid	0	100	99.0
	Barbell back squat	1	1.0		Leg press	1	1.0
	Barbell row	1	1.0		**Total**	**101**	**100.0**
	Deadlift	1	1.0				
	Dumbbell flies	1	1.0				
	Dumbbell lateral raise	2	2.0				
	Total	**101**	**100.0**				

4.3.2 Period prevalence

The table below shows that the number of people who reported having had an injury within the past 12 months were only 85 out of 322. This means that the majority of the participants (73.6%) did not have a recent injury and only 26.3% of the research population had sustained an injury in the preceding 12 months (**Table 4.14**).

Table 4.14 Injuries sustained in the past 12 months

Injuries in the past 12 months		Frequency	Percent
Valid	yes	85	26.4
	No	236	73.3
	Total	321	99.7
Missing	System	1	.3
Total		**322**	**100.0**

4.3.2.1 Anatomical location

Table 4.15 (next page) shows the different anatomical locations in relation to the frequency of injuries sustained in each area. The most commonly injured anatomical location under "Injury 1" was the shoulder, which had an injury frequency of 32.0%, followed by the lower back with a 25.0% injury frequency. The foot/ankle, thigh and chest were the anatomical locations with the lowest injury rate of 1.2%.

Of the 85 participants who reported having an injury under "Injury 1", 72 (84.7%) of them did not have any other injuries. However, 13 (15.3%) reported the presence of another injury under "Injury 2". Of the 15.3% who had a second injury, the knee had the highest injury frequency of 38.0%, followed by the elbow (23.0%).

There were fewer people who reported having a third injury and the table below shows that only 5.9% of the 85 injured people had a third injury. The lower back (40%) had the highest injury frequency amongst the injuries reported under "Injury 3'.

Table 4.15 Anatomical location of injuries

Injury 1				Injury 2				Injury 3			
Anatomical Location		Frequency	%	Anatomical location		Frequency	%	Anatomical location		Frequency	%
					0	72	84.7		0	80	94.1
Valid	F/a	3	3.5	Valid	F/a	0	0.0	Valid	F/a	0	0.0
	Ft/an	1	1.2		Ft/an	0	0.0		Ft/an	0	0.0
	Buttock	0	0.0		Buttock	0	0.0		Buttock	0	0.0
	Knee	6	7.1		Knee	5	5.9		Knee	0	0.0
	L/b	22	25.9		L/b	1	1.2		L/b	2	2.5
	Calf	3	3.5		Calf	0	0.0		Calf	0	0.0
	Hip	0	0,0		Hip	0	0,0		Hip	0	0.0
	Intsc	0	0.0		Intsc	0	0.0		Intsc	0	0.0
	Neck	5	5.9		Neck	1	1.2		Neck	0	0.0
	Shoulder	28	32.5		Shoulder	2	2.5		Shoulder	1	1.2
	Thigh	1	1.2		Thigh	0	0.0		Thigh	1	1.2
	Wrist	6	7.1		Wrist	0	0.0		Wrist	0	0.0
	U/b	2	2.4		U/b	1	1.2		U/b	0	0.0
	Hand	3	3.5		Hand	0	0,0		Hand	0	0.0
	Elbow	2	2.4		Elbow	3	3.5		Elbow	1	1.2
	M/b	0	0.0		M/b	0	0.0		M/b	0	0.0
	Chest	1	1.2		Chest	0	0.0		Chest	0	0.0
	Groin	2	2.4		Groin	0	0.0		Groin	0	0.0
	Total	**85**	**100**		**Total**	**85**	**100**		**Total**	**85**	**100**

F/a = Forearm; Ft/an =Foot/Ankle; L/b = Lower back; Intsc = Interscapular; U/b = Upper back; M/b = Mid/back

% = Percentage

4.3.2.2 Severity of injury

The severity of injuries was measured using a pain rating scale of 1-10. The individual would circle a number, rating the pain from the least severe (1/10) to the most severe (10/10) intensity felt due to the injury. The ability to carry out daily activities and to continue with their training program was also used to measure the severity of the injuries.

Question: Using the scale below, please rate the severity of the injury experienced in terms of the following:

1. The amount of pain you would experience due to the injury.
2. The worst the pain would get.

Table 4.16 shows “Injury 1” ratings on the pain rating scale in terms of pain felt during the time of injury. The pain ratings 4/10 and 5/10 had the highest frequencies of 21.1%, followed by a rating of 6/10 (16.4%). The 3rd highest rating was 2/10 with a frequency of 12.9%. The lowest pain rating was 10/10 with a frequency of 2.3%.
The table below also shows pain ratings in terms of the worst pain experienced due to injuries under “Injury 1”. The pain ratings with the highest frequencies were 6/10 and 10/10 with a frequency of 16.5%. These ratings were followed by 5/10, 7/10 and 8/10 which had a frequency of 12.9%. The pain rating with the lowest frequency was 2/10, with a frequency of 1.2%.

Table 4.16 Pain ratings under “Injury 1” injuries

	Injury 1 *(Pain experienced)*				Injury 1 (worst pain experienced)		
	Pain rating	**Frequency**	**Percent**		**Pain rating**	**Frequency**	**Percent**
Valid	1	3	3.5	Valid	1	0	0.0
	2	11	12.9		2	1	1.2
	3	6	7.1		3	7	8.2
	4	18	21.2		4	7	8.2
	5	18	21.2		5	11	12.9
	6	14	16.5		6	14	16.5
	7	7	8.2		7	11	12.9
	8	3	3.5		8	11	12.9
	9	3	3.5		9	9	10.6
	10	2	2.4		10	14	16.5
	Total	**85**	**100.0**		**Total**	**85**	**100.0**

Amongst the 13 participants who reported having injuries under "Injury 2", 2/10 had the highest pain frequency rating of 23.0%. The second highest pain ratings were 1/10 and 4/10 with a frequency rating of 15.3% (**Table 4.17**).

Table 4.17 also shows the ratings of the worst pain experienced due to injuries under "Injury 2" and their frequencies. The pain rating with the highest frequency was 7/10 with a frequency of 23.0%, followed by 2/10 and 8/10 with a frequency of 15.3%.

Table 4.17 Pain ratings under "Injury 2" injuries

	Injury 2 (pain experienced)				Injury 2 (worst pain experienced)		
Pain rating		Frequency	Percent	Pain rating		Frequency	Percent
Valid	0	72	84.7	Valid	0	80	94.7
	1	2	2.4		1	0	0.0
	2	3	3.5		2	2	2.4
	3	1	1.2		3	1	1.2
	4	2	2.4		4	1	1.2
	5	1	1.2		5	2	2.4
	6	1	1.2		6	0	0.0
	7	1	1.2		7	3	3.5
	8	1	1.2		8	2	2.4
	9	0	1.2		9	1	1.2
	10	1	0.0		10	1	1.2
	Total	**85**	**100.0**		**Total**	**85**	**100**

Table 4.18 shows that amongst the five participants who reported having "Injury 3", the pain rating with the highest frequency was 2/10 with a frequency of 60.0%.
For "Injury 3", in terms of the worst pain felt, 4/10 was the pain rating with the highest frequency of 40.0% (**Table 4.18)**.

Table 4.18 Pain ratings under "Injury 3" injuries

	Injury 3 (pain experienced)				Injury 3 (worst pain experienced)		
	Pain rating	**Frequency**	**Percent**		**Pain rating**	**Frequency**	**Percent**
Valid	0	80	94.1	Valid	0	80	94.1
	1	0	0.0		1	0	0.0
	2	3	3.5		2	0	0.0
	3	1	1.2		3	0	0.0
	4	0	0.0		4	2	2.4
	5	0	0.0		5	0	0.0
	6	1	1.2		6	1	1.2
	7	0	0.0		7	1	1.2
	8	0	0.0		8	1	1.2
	9	0	0.0		9	0	0.0
	10	0	0.0		10	0	0.0
	Total	**85**	**100.0**		**Total**	**85**	**100.0**

Table 4.19 below shows that of the 85 people who reported having an injury under "Injury 1", in 47.1% of the participants the injury did not affect their daily activities. Amongst those affected, only 14.1% reported that the injury did not affect their training program; 34.1% of the participants reported that "Injury 1" slightly interfered with their daily activities; and 40.0% reported that their training was slightly affected. Only 18.8% of the participants reported that the injury severely affected their daily activities and 45.0% reported that the injury severely affected their training program.

Table 4.19 Effects of "Injury 1" injuries on daily activities and training

	Injury 1 (activity)			Injury 1 (training)		
	Intensity	Frequency	Percent	Intensity	Frequency	Percent
Valid	No	40	47.1	Valid No	12	14.1
	Slightly	29	34.1	Slightly	34	40.0
	Severely	16	18.8	Severely	39	45.9
	Total	**85**	**100.0**	**Total**	**85**	**100.0**

Amongst the 13 participants who had injuries under "Injury 2", 30.7% reported that the injury did not affect their daily activities. There were 23.0% who reported that their training program was not affected; 53.8% who had their daily activities affected by "Injury 2"; and 38.4% reported that their training program was slightly affected by "Injury 2". About 15.3% of the participants reported that their daily activities were severely affected by injuries under "Injury 2", while 38.4% reported that these injuries severely affected their training program (**Table 4.20**).

Table 4.20 Effects of "Injury 2" on daily activities and training

	Injury 2 (Activity)			Injury 2 (training)		
	Intensity	Frequency	Percent	Intensity	Frequency	Percent
Valid	0	72	84.7	Valid 0	72	84.7
	No	4	4.7	No	3	3.5
	Slightly	7	8.2	Slightly	5	5.9
	Severely	2	2.4	Severely	5	5.9
	Total	**85**	**100.0**	**Total**	**85**	**100.0**

Of the 5 participants who reported injuries under "Injury 3", 40.0% of them reported that their daily activities were not affected; whereas 60.0% had both their daily activities and training programs slightly affected by the injury. With regard to their training program, 40.0% of the participants had their training program severely affected by “Injury 3” (**Table 4.21**).

Table 4.21 Effect of “Injury 3” on daily activities and training

	Injury 3 (activity)				Injury 3 (training)		
	Intensity	**Frequency**	**Percent**		**Intensity**	**Frequency**	**Percent**
Valid	0	80	94.1	Valid	0	80	94.1
	No	2	2.4		Slightly	3	3.5
	Slightly	3	3.5		Severely	2	2.4
	Total	**85**	**100.0**		**Total**	**85**	**100.0**

4.3.2.3 Types of injuries

Table 4.22 shows the types of injuries reported under "Injury1". The types of injuries with the highest frequencies were muscle strains (37.6%) and joint sprains (30.6%). Bursitis, ligament tears, fractures and pinched nerves had the lowest frequency of 1.2%. In the table below, muscle strains (23.0%) and tendonitis (23.0%) appear to be injuries with the highest frequency amongst the 13 participant who reported having injuries under "Injury 2". Joint sprains (15.3%) had the second highest frequency. Amongst the 5 who reported an "Injury 3", muscle strains (40.0%) had the highest injury frequency.

Table 4.22 Types of injuries sustained

Injury 1				Injury 2				Injury 3			
		Freq	%			Freq	%			Freq	%
Valid				Valid	0	72	84.7	Valid	0	80	94.1
	Joint Sprain	26	30.6		Joint Sprain	2	2.4		Joint Sprain	0	0.0
	Bursitis	1	1.0		Bursitis	1	1.2		Bursitis	0	0.0
	Contusion	0	0.0		Contusion	1	1.0		Contusion	0	0.0
	Dislocation	0	0.0		Dislocation	0	0.0		Dislocation	0	0.0
	Lig/Tear	1	1.0		Lig/Tear	1	1.2		Lig/Tear	0	0.0
	Lig/Sprain	4	4.7		Lig/Sprain	1	1.2		Lig/Sprain	0	0.0
	Fracture	1	1.2		Fracture	0	0.0		Fracture	0	0.0
	Msc/Spasms	5	5.9		Msc/Spasms	1	1.2		Msc/Spasms	1	1.2
	Msc/Strain	32	37.6		Msc/Strain	3	3.5		Msc/Strain	2	2.4
	Msc/Tear	7	8.2		Msc/Tear	0	0.0		Msc/Tear	1	1.2
	Tendonitis	7	8.2		Tendonitis	3	3.5		Tendonitis	1	1.2
	Tnd/Tear	0	0.0		Tnd/Tear	0	0.0		Tnd/Tear	0	0.0
	Pnch/Nerve	1	1.0		Pnch/Nerve	0	0.0		Pnch/Nerve	0	0.0
	Disc/Bulge	0	0.0		Disc/Bulge	0	0.0		Disc/Bulge	0	0.0
	Mnsc/Injury	0	0.0		Mnsc/Injury	0	0.0		Mnsc/Injury	0	0.0
	Total	**85**	**100.0**		**Total**	**85**	**100.0**		**Total**	**85**	**100.0**

Lig = Ligament; Msc = Muscle; Tnd =Tendon; Pnch =Pinched; Mnsc = Meniscal

Freq = Frequency; % = Percent

4.3.2.4 Type of treatment received

The table below (**Table 4.23**) shows that the majority (67.0%) of participants who had an injury under "Injury 1" did not seek any medical attention. Those who did seek medical attention indicated that the physiotherapist had the highest frequency of 9.4% amongst the practitioners. On the other hand, the form of treatment with the lowest frequency were over-the-counter drugs (1.2%). Amongst the 13 people who reported having an injury under "Injury 2", the majority (53.8%) of them did not seek any form of treatment. Similarly, the majority (60%) of the participants with injuries under "Injury 3" did not seek medical attention.

Table 4.23 Type of treatment received

Injury 1				Injury 2				Injury 3			
		Freq	**%**			**Freq**	**%**			**Freq**	**%**
Valid				Valid	0	72	84.7	Valid	0	80	94.1
	Biokinetics	3	3.5		Biokinetics	1	1.2		Biokinetics	0	0.0
	Chiropractor	6	7.1		Chiropractor	1	1.2		Chiropractor	1	1.0
	First Aid	4	4.7		First Aid	1	1.2		First Aid	0	0.0
	GP	6	7.1		GP	1	1.2		GP	0	0.0
	Orthopaedic	0	0.0		Orthopaedic	1	1.2		Orthopaedic	0	0.0
	Physio	8	9.4		Physio	1	1.2		Physio	1	1.0
	Trd/Zulu	0	0		Trd/Zulu	0	0.0		Trd/Zulu	0	0.0
	None	57	67.1		None	7	8.2		None	3	3.0
	OTC	1	1.2		OTC	0	0.0		OTC	0	0.0
	Homeo	0	0.0		Homeo	0	0.0		Homeo	0	0.0
	Total	**85**	**100.0**		**Total**	**85**	**100.0**		**Total**	**85**	**100.0**

GP = General Practitioner; Trd/Zulu = Traditional Zulu; Homeo = Homeopathic; OTC = Over the Counter Treatment;

Freq = Frequency; % = Percent

4.3.2.5 Exercises that might have caused injury

The table below (**Table 4.24**) shows the different exercises participants were doing when they got injured due to "Injury 1". Exercises were either done using free weights or on the weight training machine. The majority of "Injury 1" injuries occurred while people were using free weights (89.4%); while only 12.9% of the reported injuries were sustained using weight training machines. The majority of participants were injured while performing the deadlift (20.0%) and the barbell bench press (18.8%).

Table 4.24 Causes of "Injury 1" related injuries

	Injury 1				**Injury 1**		
	Free weights	**Freq**	**%**	**WTM**		**Freq**	**%**
Valid	0	9	10.6	Valid	0	77	90.6
	Barbell back squat	6	7.1		Lat pulldown	23	2.4
	Barbell bench press	16	18.8		Leg press	3	3.5
	Barbell extensions	1	1.2		Standing calf raises	3	3.5
	Barbell front squats	1	1.2		Total	85	100.0
	Barbell lunges	3	3.5				
	Barbell row	2	2.4				
	Barbell shoulder press	13	15.3				
	Deadlift	17	20.0				
	Dumbbell biceps curl	6	7.1				
	Dumbbell flies	2	2.4				
	Dumbbell lateral raise	2	2.4				
	Inclined dumbbell press	2	2.4				
	Shrug	1	1.2				
	Wrist extensions	1	1.2				
	Dumbbell squats	1	1.2				
	Assisted pull up	1	1.2				
	Dumbbell pullovers	1	1.2				
	Total	**85**	**100.0**				

The table below (**Table 4.25**) shows the back squat as the exercise with the highest injury frequency of 30.7% amongst the 13 participants who hand injuries under "Injury 2".

Table 4.25 Causes of "injury 2" related injuries

	Injury 2				Injury 2		
	Free weights	**Freq**	**%**		**Weight training machine**	**Freq**	**%**
Valid	0	72	84.7	Valid	0	84	98.8
	Barbell back squat	4	4.7		Leg press	1	1.2
	Barbell Curl	1	1.2		Total	85	100.0
	Barbell extensions	1	1.2				
	Barbell front squats	1	1.2				
	Barbell shoulder press	1	1.2				
	Dumbbell biceps curl	1	1.2				
	Dumbbell flies	1	1.2				
	Dumbbell row	1	1.2				
	Inclined dumbbell press	1	1.2				
	Dumbbell squats	1	1.2				
	Total	**85**	**100.0**				

Table 4.26 shows that amongst the participants who reported having injuries under "Injury 3", the deadlift had the highest injury frequency of 40.0%.

Table 4.26 Causes of "Injury 3"-related injuries

	Injury 3				Injury 3		
	Free weight	**Frequency**	**Percent**		**Weight training machine**	**Frequency**	**Percent**
Valid	0	83	97.6	Valid	0	82	96.5
	Deadlift	2	2.4		Leg press	1	1.2
	Total	85	100.0		Pec dec	1	1.2
					Cable pulley	1	1.2
					Total	85	100.0

4.4 Objective 2: To determine musculoskeletal injury risk factors in relation to demographics, anthropometrics and activity

4.4.1 Demographics

This category encompasses gender, ethnicity and age.

4.4.1.1 Gender

Figure 4.1 below shows that there were more male than female participants in this research. There was a total of 91 males out of 291 who reported injury, which means that 31.0% of them sustained weight training-related injuries; whereas 10 out of 30 females reported injury, meaning that 33.0% of females sustained weight training-related injuries. There is no statistically significant difference in the percentage of males to females who sustained any form of weight training-related injuries (p-value= 0.817).

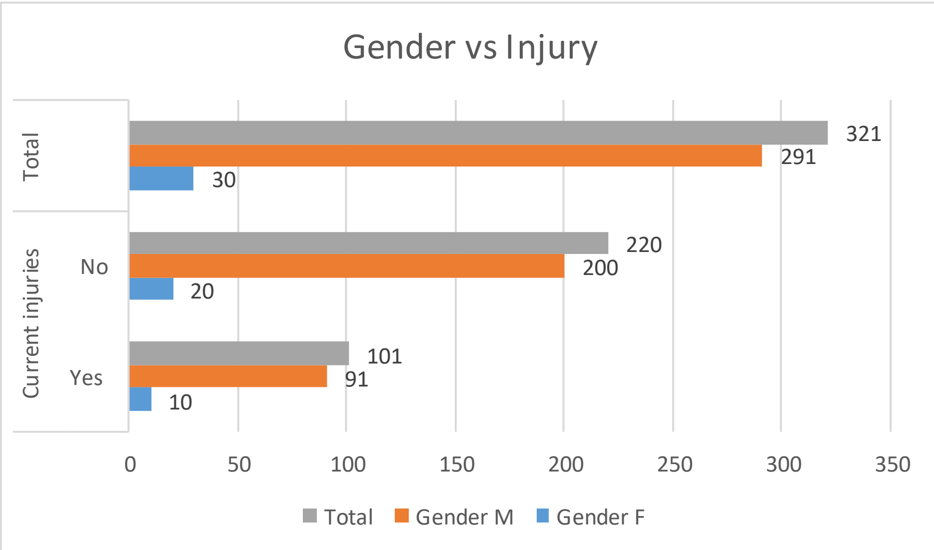


Figure 4.1 Bar graph showing gender differences in relation to injury

4.4.1.2 Ethnicity

There is no statistically significant difference between the rate of injury across ethnic groups (p-value=0.850 > 0.05). The bar chart below shows that less than half of the research population (31%) had weight training-related injuries. The majority of participants were Black (90%), whilst Asians and Other ethnic groups had the least (2%) number of participants (**Figure 4.2**).

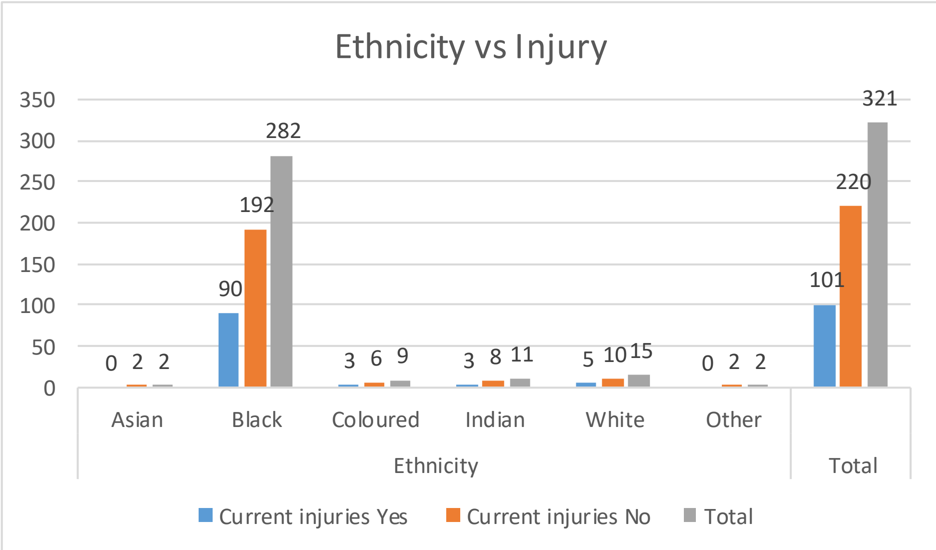


Figure 4.2 Bar graph showing injuries in relation to ethnicity

4.4.1.3 Age

Ages were placed in different categories and a cross-tabulation with injuries was performed. The age category 32 – 38 years (48.9%) sustained injuries that were of statistical significance. This age group had statistically higher injuries compared to other age categories (p-value= 0.07). This significance was at a 10% level **(Table 4.27**).

Table 4.27 Age category cross tabulation

Age category and injury Cross tabulation

			Current injury		Total
			Yes	No	
Categories	18 - 24	Count	43	101	144
		% within Agecat	29.9%	70.1%	100.0%
	25 - 31	Count	32	80	112
		% within Agecat	28.6%	71.4%	100.0%
	32 -38	Count	22	23	45
		% within Agecat	48.9%	51.1%	100.0%
	39 - 45	Count	2	11	13
		% within Agecat	15.4%	84.6%	100.0%
	46 and above	Count	2	5	7
		% within Agecat	28.6%	71.4%	100.0%
Total		**Count**	**101**	**220**	**321**
		% within Agecat	**31.5%**	**68.5%**	**100.0%**

4.4.2 Anthropometrics

This category includes weight and height, which were analysed simultaneously.

4.4.2.1 Weight and height

Levene's Test for Equality of Variances was conducted on the following risk factors: weight and height. There was no significant difference between the mean weight and height for the participants who had reported having sustained an injury (Yes) and those who reported no history of injury (No). All p-values were greater than 0.05, which means that they displayed no statistical significance **(Table 4.28)**.

Table 4.28 Group statistics

Group Statistics			
	Current injuries	**N**	**Mean**
Weight	Yes	101	78.03
	No	220	77.19
Height	Yes	101	1.7074
	No	219	1.7224

4.4.3 Activity

This category includes stretching and warm up, sporting activities and past injuries.

4.4.3.1 Stretching and warm up

The bar chart below, **Figure 4.3,** shows the results of a cross-tabulation between stretching and warm-up against current injuries. The results show that there is no statistically significant difference in the rate of injury amongst those who stretched and warmed up before their workout and those who did not. A total of 16/54 of those who did not stretch and warm up (30.0%) sustained an injury/injuries, while 85/267 of participants who stretched and warmed up before their workout sustained an injury/injuries (32.0%).

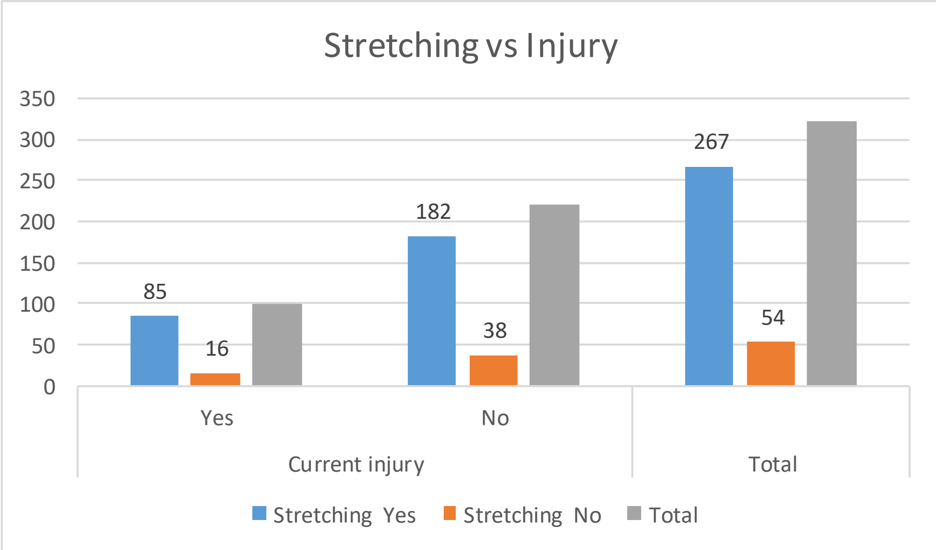


Figure 4.3 Bar graph showing stretching and warm-up in relation to injury

4.4.3.2 Sporting activities

The chi square test for other sports/activities versus injury showed no statistical significance as the p-value= 0.288 was greater than 0.05. The bar graph in **Figure 4.4** shows the results of a cross- tabulation between sports/activities and injury. This means that participating in sports other than weight training did not statistically predispose one to injury.

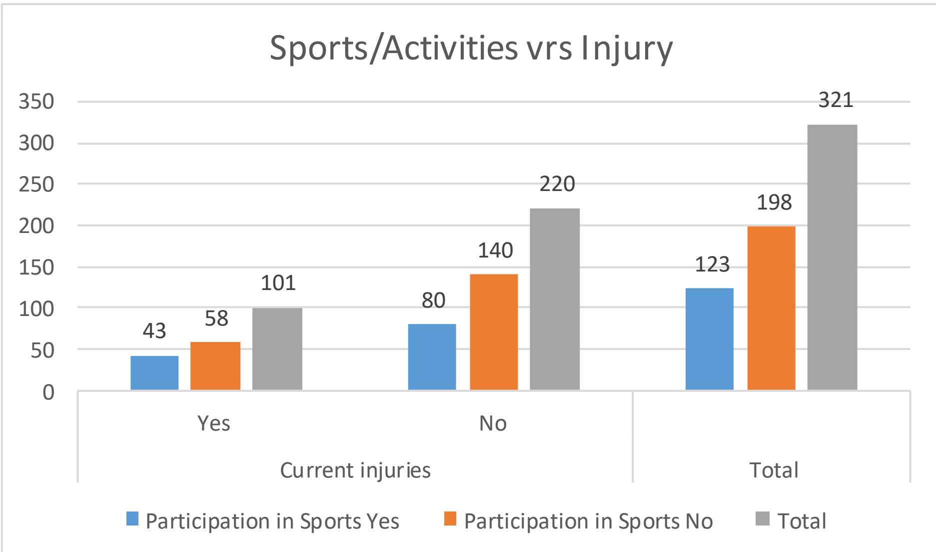


Figure 4.4 Bar graph showing participation in other sports in relation to injury

4.4.3.3 Past injuries

Figure 4.5 below presents the results of a cross-tabulation between current injuries and injuries in the past 12 months. The results of this cross-tabulation show a statistically significant correlation between current injuries and past injuries, p-value= 0.017, which is less than p-value= 0.05. This implies that past injuries might predispose one to sustaining future injuries.

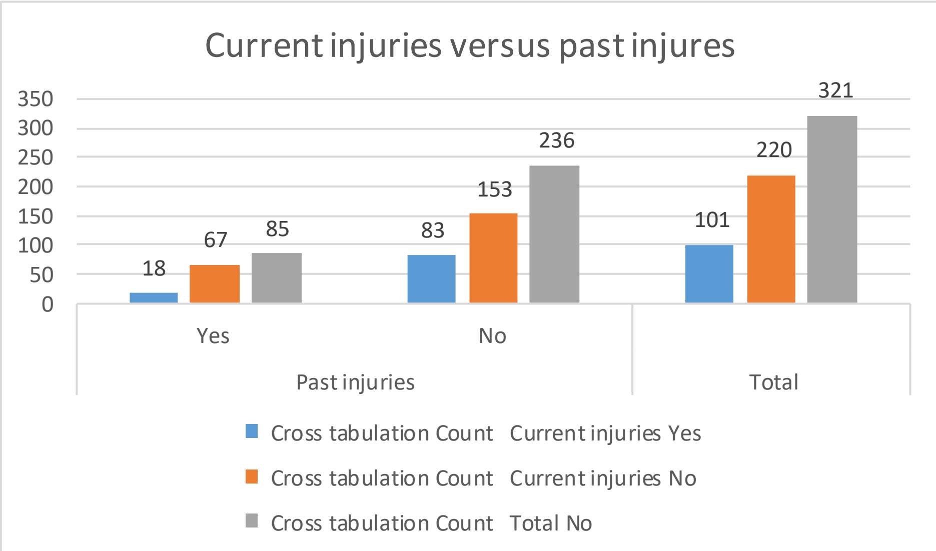


Figure 4.5 Current injuries in relation to past injuries

4.4.8 Logistic Regression Model

A Logistic Regression Model was fitted to the data with the binary variable of whether the person had an injury or not as a result of the dependent variable. The independent variables entered were age (in years), gender, weight (in kg), height (in m), whether the person stretched before and after training; and the number of hours spent weight training per week. Only the number of hours spent training per week was statistically significant (p-value= 0. 017). The odds ratio (OR) for the variable training hours was 1.382. This means that every additional hour of training per week increased the odds of injury by 38.0%. The table below gives the SPSS output for the logistic regression model **(Table 4.29**).

Table 4.29 Logistic Regression Model

Variables in the Equation

		B	S.E.	Wald	df	Sig.	OR = Exp(B)
Step 1[a]	Age	.022	.018	1.526	1	.217	1.023
	Gender(1)	.113	.443	.065	1	.799	1.120
	Weight	.008	.010	.750	1	.386	1.008
	Height	-1.713	1.194	2.056	1	.152	.180
	Stretch and warmup	.043	.334	.017	1	.897	1.044
	Stretch and cool down	.076	.250	.092	1	.762	1.078
	Training hours	.324	.136	5.665	1	.017	1.382
	Constant	-.930	2.049	.206	1	.650	.395

a. Variable(s) entered on step 1: Age, Gender, Weight, Height, stretch and warmup, stretch and cool down, training hours

CHAPTER 5: DISCUSSION

5.1 Introduction

In this chapter, the response rates of the research will be discussed. Moreover, the results of the research will be discussed in relation to the aims and objectives of the research. The literature currently available on this topic as per Chapter 2 will also be explored and compared to the findings of the research as per Chapter 4.

5.2 Response rate

During data collection, the researcher strived for a 100% response rate of the given sample size. The research participants were assisted in completing the questionnaire, which helped to ensure that they were filled out correctly. A total of 322 participants were required to complete the questionnaire in order to allow for generalisation of the results. The majority of participants were males (90.4%), while the females contributed only 9.3% of the total population size. This was also common in previous studies as weight training is still mostly a male-dominated activity (Quatman *et al.* 2009).

5.3 Objective 1: To profile musculoskeletal injuries sustained by weight trainers in the eThekwini municipality

5.3.1 Point and period prevalence

Current and past injuries will be discussed simultaneously in this section, while analysing existing literature under the various sub-titles.

5. 3.1.1 Injury rate

The results of the research show that only 31.4% of the 322 participants had an injury during the time of data collection and only 26.3% reported having had an injury in the past 12 months. These figures show a low injury rate and correspond with other findings from previous studies done on professional weight-trainers. Willick *et al.* (2016) reported a low injury rate of 23.3% of weight lifters. Additionally, Keogh, Hume and Pearson (2006) reported a rate of 1-4 injuries per 1000 hours of training amongst powerlifters. Raske and Norlin (2002) also noted a low injury rate of 2.6 per 1000 hours of training amongst weight training athletes.

This shows that although weight training may be perceived as scary or unsafe due to the lifting of heavy weights, it does not predispose participants to a higher risk of injury than other sporting activities (Raske and Norlin 2002; Stone *et al.* 2006; Keogh and Windwood 2016). In actual fact, the injury rates for weight training sports appear to be considerably lower than those reported for many team sports (Alabbad and Muaidi 2016; Keogh and Windwood 2016). Aasa *et al.* (2016) advocate that injury incidences in weight training sports are similar to those of non-contact sports, but lower when compared to contact sports. In a research study by Winwood *et al.* (2014) however, there were 82%

strongmen that sustained injury either during training or competition, which displayed a high injury rate. This significantly high injury incidence may be due to the fact that strongmen are also required to lift other heavy objects such as logs and stones as part of the strongman implement. Reportedly, 66% of the injuries that occurred were sustained during the performance of strongman implement activates, rather than the traditional weight training activities/exercises such as bench pressing or squatting (Winwood *et al.* 2014).

In addition, Strömbäck *et al.* (2018) reported a high injury rate amongst powerlifters, noting 70% current injuries and 87% in the past 12 months. The findings of this research concur with those presented by Kerr, Collins and Comstock (2010), who found that the injury incidence in the weight training population had significantly increased over the 17-year period of this research. In the conclusion, the possible cause of an increased incidence of weight training-related injuries was related to the rise in the number of people participating in weight training activities (sports). This research however displayed a low weight training injury incidence rate, which may also be due to under-reporting of injuries, as this research depended on self-reported injuries.

5.3.1.2 Anatomical location

There are disagreements when it comes to the most commonly injured anatomical location in weight training sports (Lavallee and Balam 2010). Powerlifters tend to commonly injure their shoulders, while weightlifters tend to injure their elbows and knees more. When viewed simultaneously, lower back pain due to strain is high in both weightlifters and powerlifters (Lavallee and Balam 2010).

The majority (36%) of weight training-related injuries occur at the shoulder complex (Kolber *et al.* 2010; Keogh and Windwood 2016). Likewise, this research found that the most commonly injured anatomical location in current injuries (31.7%) and past injuries (32%) was the shoulder region. Several literature review studies also identify the shoulder as the most frequently injured anatomical location in weight training (Kolber *et al.* 2014; Alabbad and Muaidi 2016; Willick *et al.* 2016). This is believed to be due to the fact that the shoulder is a non-weight bearing joint that is made to assume the role of a weight bearing joint during the course of repetitive lifting in awkward positions (Kolber *et al.* 2010).

The second most frequently injured anatomical location under “Injury 1” was the lower back with a 25.7% current and 25.9% past injury rate. The lower back was also recognized as the anatomical location with the highest injury frequency in other studies (Willick *et al.* 2016; Mohtasham and Salehi 2019). Weight training men, according to Riihimäki (1991), have been shown to have less degenerative changes in the lumber spine compared to men who do physical work. The reason for this is that the gradual loading of soft-tissue has a training effect. However, weight training participants can develop back pain if they exceed the endurance of their soft tissue through the sudden overloading of muscles or fatigue due to repeated loading. These statements above were reported by Winwood *et al.* (2014) who found that most of the lower back strains and tears that occurred in weight training were sustained under heavy loads.

Weightlifting belts are used by some people to prevent lower back injuries. However, no conclusive evidence has been found to support this function. Nevertheless, the belts have been shown to increase intra muscular stiffness of the erector spinea muscles and provide tactile feedback. These may possibly provide the "injury prevention" benefits that are associated with the use of the weight training belt (Durall and Manske 2005). Weightlifting belts were even found to increase the injury rate in a study by Siewe *et al.* (2011). Contrary to these findings, a literature review by Renfro and Ebben (2006) concluded that weightlifting belts help to reduce spinal compression; increase motion unit recruitment of the spine prime movers; and increase spinal stability. These factors are believed to reduce the risk of injury in the lower back. The possible effects of using weight training belts were not evaluated in this research due to the controversial nature of extant literature on the subject.

The anatomical location with the third highest injury rate was the knee region, with 12.9% under current and 12.7% under past injuries. This site was also associated with high injury rates in several other studies. The squat is suspected to be the exercise that predisposes one to knee injuries (Raske and Norlin 2002; Winwood *et al.* 2014). This has been hypothesised because the squatting position and addition of heavy load (weights) places the knees in a flexed angle exceeding 90 degrees. This position places significant load on the thinnest parts of the cartilage and ligaments in the area, thus predisposing them to injury (Raske and Norlin 2002). Participants in this study mostly complained of ligamentous injuries of the knee more than other knee injuries. However, with the majority of the participants reportedly not seeking medical attention, the true nature of the injuries they sustained is unknown.

The findings of this study corroborate the international results of various research (Raske and Norlin 2002; Lavallee and Balam 2010; Keogh and Windwood 2016 ; Strömbäck *et al.* 2018; Mohtasham and Salehi 2019) which found that the shoulder, lower back and knee were the most frequently injured areas amongst weight trainers and body-builders.

5.3.1.3 Severity

The severity of the injuries sustained by participants in this research were rated using a pain rating scale of 1/10 to 10/10. The effect of injuries on the participants' daily activities and on their training programs were also used to assess severity. Overall, the majority of participants had mild injuries scoring between 1/10 to 4/10 on the pain scale and moderate types of injuries, scoring between 5/10 and 7/10 on the pain scale and there were a few reported cases of severe injuries, scoring between 8/10 and 10/10 on the pain rating scale. In terms of Injury 1, current injures (2/10) had the highest frequency of 19.8% and with regard to past injuries (injury 1), pain rating scores with the highest frequency were 4/10 and 5/10, with a frequency of 21.1%. Regarding "Injury 2," 3/10 had the highest frequency of 23.0% under current injuries and 2/10 had the highest injury frequency relating to past injuries, with a frequency of 23.0%. These findings concur with those of Keogh and Windwood (2016) that the majority of injuries were mild (33%) to moderate (47%) in nature.

Amongst the participants who sustained injuries under "Injury 1", the majority (52.5%) indicated that the injury did not affect their daily activities. Similarly, amongst participants who sustained injuries under "Injury 2", the majority (42.3%) reported that the injury did not affect their daily activities. With regard to training, the training programs of some participants were reportedly affected either slightly (35.6%) or severely (35.6%). This was determined by the participants at the time of data collection where they were asked to indicate: *no, slightly or severely*. *NO* indicated that the injury did not affect them and *slightly* meant that the injury affected them slightly and *severely* meant that the injury affected them severely. In cases where participants were slightly affected, they reported that modifications were made when performing certain exercises, while other exercises were completely avoided altogether. There was a significant number of cases that severely affected the training program of participants, about 35% current injuries under Injury 1 and 57% current injuries under Injury 2. In relation to past injuries, there were about 45% cases that reportedly affected the training program severely under Injury 1 and 38% under Injury 2. In research by Winwood *et al.* (2014), the majority (47%) of injuries sustained were of a moderate nature; 33% were reportedly mild; and only 20% were severe.

In a literature review, Keogh, Hume and Pearson (2006) similarly found that the majority of the injuries (78-99%) sustained during weight training were of mild to moderate severity. The nature of injuries that occurred due to the act of weight training, such as lifting loads, is associated with low injury severity. According to Lavallee and Balam (2010), where severe injuries such as muscle or tendon ruptures and fractures occurred, there was carelessness involved, such as the dropping of weights (46.0%). Kerr, Collins and Comstock (2010) concur with this, reporting 65.5% of the most severe injuries being related to the dropping of weights; 10.4% due to being crushed between weights due to overloading; and 9.8% of injuries resulting from people hitting themselves with weights during their workout.

5.3.1.4 Types of injuries

Muscle strains (40.5%) under current and past (37.8%) had the highest frequency of injuries, followed by joint sprains with a frequency of 30.6%, for current and past injuries under "Injury 1". Amongst the 27 who reported an "Injury 2", the majority were joint sprains (38.4%) under current injuries and muscle strains (23.0%) under past injuries. With regard to "Injury 3", muscle strains had the highest frequency on both current (40.0%) and past injuries (42.8%) in this research. These results were similar to the findings of Lavallee and Balam (2010). Golshani *et al.* (2017) also found that sprains and strains are the most common types of injuries, accounting for about 46% of resistance training-related injuries. The muscles, ligaments and tendons in the area take the most strain due to the nature of their function and they are therefore easily damaged (Kumar 2001). The muscles have a contractile function to assist in moving the load while, the tendons transmit the force and the ligaments help to stabilize the joint. Therefore, repeated heavy loading results in injury to these areas (Kumar 2001).

Tendinopathies were recorded by Lavallee and Balam (2010) as the most commonly occurring chronic type of injuries, accounting for 12-25% of all strength training injuries. In this research tendinopathies were the third (11.9%) most commonly reported type of injuries under "Injury 2", past injuries. The more severe types of injuries such as tendon ruptures or muscle ruptures, stress fractures etc. were less frequent in this research. The reason for this is possibly because this investigation was conducted on the general population where there are lower competitive standards, if any. In addition, tendon and muscle ruptures respectively are more common amongst weight trainers who use muscle-enhancing products such as steroids, human growth hormones, creatine, etc., (Lavallee and Balam 2010).

5.3.1.6 Treatment

The majority of participants in this research who reported having either 1 or more injuries did not seek any medical attention. This applied to both current (62.4%) and past (67.0%) injuries, where more than 50.0% of the injured participants did not seek any medical attention. In contrast to these findings, Strömbäck *et al.* (2018) discovered that the majority of participants (58%) had visited a health practitioner in relation to their weight training injury. This may be due to the fact that the participants in his study were athletes involved in competitive weight training, while this study was conducted on the general public.

Of those who did seek medical attention, most consulted their medical doctor/GP (16. 8%).The second most consulted practitioner was a physiotherapist (7.9%). Contrary to this, Strömbäck *et al.* (2018) found that the majority of participants consulted physical therapists (23.0%) and the second most consulted practitioner was a medical doctor/GP (21.0%). Furthermore, in this research, fewer people resorted to other medical practitioners such as chiropractors: 5.0% with regard to current injuries under Injury 1 and 2.0% under Injury 2. For treatment of injuries relating to past injuries, only 7.1% resorted to chiropractic treatment under Injury 1 and 1.2% under Injury 2. Fewer people also consulted with biokineticists. In actual fact, there were no people who consulted biokineticists under current injuries and under past injuries, whilst only 3.5% consulted them with regard to Injury 1 and 1.2% consulted with regard to Injury 2. There were also fewer participants who used over-the-counter drugs to treat their injuries, as there was only 4.0% under Injury 1 and none under Injury 2 with regard to treatment used for current injuries. In relation to past injuries, there were 1.2% under Injury 1 and none under Injury 2. The results of this research are in keeping with the results obtained by Strömbäck *et al.* (2018) regarding the fact that a low rate of participants received treatment from either a chiropractor or massage therapist. In this study, the reason for fewer people consulting chiropractors is possibly because, the chiropractic profession and its scope of practice is still not well understood in most predominantly black communities. The results of this study also show that the majority of the research participants were black, thus most of them either do not know about chiropractors or do not understand their scope of practice.

5.4 Objective 2: To determine musculoskeletal injury risk factors in relation to demographics, anthropometrics and activity

5.4.1 Demographics

This category was discussed in relation to gender, ethnicity and age.

5.4.1.1 Gender

There were only 9.3% female participants in this research, which parallels to the findings that weight training is still predominantly performed by more males than females (Quatman *et al.* 2009; Kerr, Collins and Comstock 2010). In terms of injury rates, there was no statistically significant findings to support one gender being more predisposed to injuries than the other. This was also evident in a study by Willick *et al.* (2016). Gray and Finch (2014) conversely found that males were more commonly injured than females, accounting for 78.0% of injury cases overall. They further explicate that males possibly sustain more injuries due to the types of activities/exercises they choose to do, using heavier loads and training at higher intensities than females.

Strömbäck *et al.* (2018), on the other hand, found that the differences in male and female injuries were the anatomical location of the injuries. Females were found to have frequently injured the neck and thoracic region more than their male counterparts. They further noted a significant association between "current" hip injury and gender. The study found a significant association with hip injuries in males but not females. In relation to anatomical location, Keogh, Hume and Pearson (2006) discovered that females had no chest and thigh injuries compared to males. There was an age and gender link found by Kerr, Collins and Comstock (2010), highlighting that males aged 45 to 55 years old had a larger number of injuries than females of the same age group. The association between anatomical location and age on gender-related injuries was not investigated in this research.

5.4.1.2 Age

In a Logistic Regression model, age was not statistically significant in this research. However, when one looks at age in categories (**Table 4.28**), there does appear to be a relationship between risk of injury and the age group investigated. The results show that the age group 32-38 years sustained 48.0% of injuries and had statistically higher injuries than the other age groups. Similarly, in other studies, there are some age groups hypothesised to be more prone to injury than others. In relation to age groups, Willick *et al.* (2016) found that participants within the 24-34 year old age group had the highest injury incidence rate. Gray and Finch (2014) also found the age group between 25-34 years to have the second highest weight training-related injury incidence, following the 15-24 year old age group. This age group was hypothesised to have the highest injury incidence because of skeletal immaturity, poor technique and lack of supervision (Gray and Finch 2014; Strömbäck *et al.* 2018). However, the differences noted in this research were identified as statistically insignificant. In this study, participants were only individuals above the age of 18 years.

5.4.2 Anthropometry

As stated earlier on, anthropometry in this study was tackled as it relates to weight and height only. There was no statistically significant difference between anthropometry and the risk of injury in this research. These results were parallel to results in a study by Keogh, Hume and Pearson (2006). Keogh and Windwood (2016), however, stated that weight class has a minor effect on weight training injury epidemiology. Not many studies investigated anthropometry as a possible risk factor for injury.

5.4.3 Activity

This category includes activities such as hours spent exercising, technique, stretching, warm-up and types of exercises performed.

5.4.3.1 Activity

Strömbäck *et al.* (2018) highlighted the following as factors that increase the risk of injury: fast progression, poor technique, excessively high intensity of training or high frequency of training. Other factors, such as technical errors, fatigue, overloading and dropping of weights ,were identified by Golshani *et al.* (2017) as injury risk factors. In this research, a high number of hours spent training was associated with higher chances of sustaining injury, meaning that the number of hours spent training had a statistically significant influence on injury.

For every additional hour spent training per week, there was a 38.0% increase in the odds of sustaining an injury. This could be explained through the Fatigue Theory of Injury because fatigue alters motor control. Tiredness (fatigue) due to high training frequency and excessive overload were found by Winwood *et al.* (2014) to contribute to about 81.0% of injuries. In research by Strömbäck *et al.* (2018), participants stated that their injuries were due to high training volumes or high intensity (23.0%), poor technique (6.0%), poor mobility (6.0%) and 24.0% stated other causes.

People sustained more weight training-related injuries in research by Kerr, Collins and Comstock (2010), irrespective of using machines or free weights, due to avoidable mishaps. In this research however, there were fewer reports of avoidable mishaps, with more injuries being sustained while executing the exercise, possibly due to over-exertion, poor technique, fast progression or high frequency of training.

In this study, participants within the 32-38-year age group were the ones found to have the highest injury incidence rate. These findings were of statistical significance. Participants below the age of 18 years did not participate in this research, so it cannot be assumed that the 15-24 year old group could have not had the highest injury incidence, as discovered by Gray and Finch (2014). Furthermore, the findings in this study do not completely correlate with those of previous studies, which warrants future investigation.

5.4.3.2 Stretching and warm up

Many people stretch before or after they engage in any form of exercise for the purpose of decreasing their risk of injury, reducing muscle soreness after exercise or improving performance (Herbert and Gabriel 2002). Traditionally, static stretching was a prominent feature of warm-up. However, several studies have now determined that pre-exercise static stretching does not necessarily help with injury risk prevention (McMillian *et al.* 2006). Over the past few years, support for dynamic warm-up instead of static warm-up has grown due to the perceived performance reduction effect of static stretching (McMillian *et al.* 2006). The type of stretching and warm-up done before exercising was not evaluated in this research.

The general purpose of pre-exercise warm-up and stretching, irrespective of whether it is static or dynamic, is to: increase blood flow to the extremities; increase muscle and tendon suppleness to stimuli; increase body temperature; and enhance free coordination which will ultimately yield benefits such as injury risk reduction (Herbert and Gabriel 2002; McMillian *et al.* 2006). The results of this research showed no significant difference in the rate of injury amongst those who stretched and warmed up before their workout and those who did not. These results concur with the conclusion made by Bullock *et al.* (2010) that neither stretching before or after exercise reduces the risk of injury. This is a consistent finding in literature because although Herbert and Gabriel (2002) discovered that stretching and warm-up reduced the risk of injury by (5.0%), this value was considered too low to be of benefit to athletes.

5.4.3.2 Types of exercises

The existing body of literature exhibits free weights as the leading cause of weight training-related injuries when compared to weight training machines (Kerr, Collins and Comstock, 2010; Lavallee and Balam, 2010). The results of this research correspond with the existing literature confirming that over 80% of both current and past injuries occurred while the participants were using free weights rather than weight training machines. Golshani *et al.* (2017) recorded that an astonishing 90% of weight training-related injuries occur with the use of free weights when exercising.

In a literature review by Mohtasham and Salehi (2019), the chest press exercise (95.7%) was the leading cause of injuries, followed by the squat (72.3%) and the shoulder press (71.9%). Additionally, Strömbäck *et al.* (2018) found that most injuries started while performing the squat (42.0%), followed by the deadlift (31.0%) and then the bench press (27.0%). In this research, the exercises that were associated with the highest injury rate were the deadlift with 20.0% past injuries under “Injury 1”, followed by the shoulder press with 18.8% current injuries under “Injury 1”. The squat had 26.9% current injuries under “Injury 2” and the bench press had 18.8% past injuries reported under “Injury 2”.

Machines that resulted in the highest injury frequencies reported in this study were the lat pulldown (40.0%) and the leg press (40.0%) under current injuries. With regard to past injuries, the lat pulldown (27.0%) was the exercise that had the highest injury frequency. Machines are believed to predispose to injury, although they are considered safer than free weights. It is important to note that they are therefore not completely safe, especially since most of them are proportioned for the average-sized person. This design therefore potentially places shorter/smaller and taller/bigger people at increased risk of injury (Kerr, Collins and Comstock 2010). When considering the fact that the use of free weights results in over 90.0% of weight training-related injuries, Kerr, Collins and Comstock (2010) worry that this knowledge creates a false sense of security amongst people using weight training machines. The projected rates of injury due to weight training machines could therefore possibly reduce significantly if people used the equipment with caution.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The weight training population in the gyms within the eThekwini municipality displayed similar patterns to those found in studies of professional weight trainers across the world. The ratio of people who sustained injuries to those who did not was low, with 31.4% who had current injuries and only 26.3% reported having sustained an injury in the past 12 months. Contrary to the misconception that weight training would result in an excessive number of injuries due to the nature of the sport, weight training in this study displayed a low injury incidence rate. Of the injuries reported, 88.1% current and 89.4% past were sustained while using free weights, thus concurring with previous studies. Free weights require more stability and good joint biomechanics. The movements involved during free weight training expose the joint to more forces, making it more vulnerable to injury than using weight training machines.

The male to female ratio in terms of participation was low in this research, with females only comprising 9.3% out of a total 322 participants. This was also common in similar studies and simply means that although more females are starting to engage in weight training, it is still a male-dominated sport. The top three most common injury sites were the shoulder, the lower back and the knee joints. The findings of this research were parallel to the existing literature in this regard. Reported injuries in this research were mostly muscle strains and joint or ligament sprains, with hardly any fractures or muscle ruptures reported. This might be due to the fact that the general population hardly lift excessively heavy loads when compared to professionals in weightlifting competitions. In addition, there is possibly a lower incidence of the use of muscle enhancing substances, which are noted to increase the risk of injury amongst professional lifters.

The injuries that were reported in this research were mostly of mild or moderate severity in nature, with a few reports of severe injuries. Most of the severe injuries in the literature were noted to be due to avoidable mishaps such as dropping of weights, being crushed by overloaded weights or the use of steroids. There were no reports of such mishaps as the cause of injury in this research. Due to most of the injuries being of low severity, more than 50.0% of the participants did not consult any healthcare provider. Amongst the participants that consulted healthcare providers, the majority of them consulted their general practitioner or physiotherapist.

The injury risk factors that were found to be statistically significant in this research were the number of hours spent training and the age group 32-38 years old. The more hours spent training was found to increase the chances of one sustaining an injury. Therefore, a balance needs to be found and established so that people do not over-train. Overtraining has also been proven in other studies to predispose one to injury due to fatigue. When fatigue starts, correct exercise form gets disrupted and so do joint biomechanics, leading to injury. Different studies have shown different age groups to be at higher risk of injury than others, with some of the reasons hypothesized having yet to be examined.

The findings of this research have provided insight into the types of injuries, anatomical location, severity and possible risk factors of weight training-related injuries specific to the eThekwini municipality population. This information can be of use to personal trainers and alternative health-care professionals, such as chiropractors and physiotherapists who deal with the majority of patients that present with such complaints. Healthcare professionals can also give better advice against the injury predisposing factors and offer much needed guidance to prevent injuries.

6.2 Strengths of the research

1. This research is amongst the few studies that look at weight training in the general population rather than amongst trained competitors who have more insight and experience in the sport.
2. There was a 100% response rate, which allowed for generalisation of the results obtained in the research.

6.3 Limitations of the research

1. The researcher depended on the participants' ability to recall injuries, but some of them might have not been able to recall injuries that occurred over the past 12 months.
2. The majority of participants did not seek professional medical attention, meaning that some of the diagnoses may not be accurate.
3. Only participants from gyms where the researcher was given permission to conduct the research were included in the research, rather than all gyms within the targeted area.
4. The research was only limited to the population of Durban central, rather than the entire eThekwini municipality.

6.3 Recommendations

1. The possible inclusion of children and adolescents who participate in weight training to assess their injury incidence should be considered.
2. Doing a current injury profile with a qualified professional who can assess and diagnose injuries correctly would ensure less likelihood of self-misdiagnosis.
3. Closely examining anthropometry and including all its features to assess for risk of injury. These factors have not been thoroughly examined as potential injury risk factors in previous studies.
4. Having a research assistant to help guide participants when completing the questionnaire in order to maximize outcome and reduce data collecting days.
5. Close assessment on the number of hours spent training to determine the minimum and maximum hours of training before the risk of injury is reached.
6. Due to the low number of females participating in weight training at the gyms, assessment should be done on the different genders separately.
7. Other factors such as diet and alcohol consumption can also be investigated as some literature highlights them as possible injury predisposing factors.

8. The amount of weight (load) that the participants were using at the time of injury could also be closely evaluated, as some studies show that most injuries occurred when participants were lifting very heavy loads.

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Appendix A

Letter of information

Title of the Research Study: A musculoskeletal injury profile of weight trainers within the eThekwini municipality.

Principal Investigator/researcher: Miss Wabo Dhlamini, B-Tech Chiropractic

Supervisor: Dr. P. Maharaj M-Tech Chiropractic

Co-Supervisor: Dr. A. Pastellides M-Tech Chiropractic

Brief introduction and purpose of the study: Thank you for your interest in participating in my study. Weight training has grown in popularity over the years having a wide range of people from the young to the old, both males and females participating in it, due to its various health benefits. However just like any other form of physical activity people are prone to error and injury while performing some of the weight training exercises. This study aims to identify and profile the most commonly occurring weight training injuries within the eThekwini municipality. This information will help sports medicine professionals, personal trainers and individuals participating in weight training develop strategies targeting the most prevalent injuries to reduce their rate of occurrence.

Outline of the Procedures:

Risks or Discomforts to the Participant: There are no risks or perceived possible discomforts to you participating in this study, due to the non- invasive nature of the study.

Benefits: This study will benefit you through providing weight training information pertaining to the local population, which will also be useful to local primary health care providers and fitness managers.

Reason/s why the Participant may be withdrawn from the Study: You may be withdrawn from the study if you are unable to answer the minimum number of questions required or if you wish to withdraw from the study, no penalty will be incurred in such instances.

Remuneration: You will not receive any form of remuneration for participating in this study. Participation in this study is done so entirely on a voluntary basis.

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

Confidentiality: All information obtained in this study will be used only for the purposes of research. The questionnaire will not contain your identity information and all information obtained will be regarded as confidential throughout the duration of the study.

Research-related Injury: Due to the nature of the study, there are no projected research-related injuries.

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

For any queries or problems please contact: Researcher: Wabo Dhlamini at (0719686158), my Supervisor: Dr. P. Maharaj M-Tech Chiropractic at (0312627490), my Co-supervisor: Dr. A. Pastellides M-Tech at Chiropractic (0312011442) or Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Prof K Duffy on 031-3732576/7

General:
You are not obligated to participate in this study, only if you are willing to and you are above the age of 18 years.

Appendix B

Consent form

Title of research: A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality.

Name of researcher: Wabo Dhlamini

Name of supervisor: Dr P. Maharaj

Name of co-supervisor: Dr A. Pastellides

Name of institution: Durban University of Technology

Consent

I____hereby confirm that I have been informed by the researcher, Wabo Dhlamini, about the nature, conduct, benefits and risks of this study.

I have also received, read and understood the letter of information regarding this study.

I am aware that the results of the study such as personal details regarding my age and injuries will be anonymously issued into a study report.

In view of the requirements of research, I agree that the information collected during this study can be processed in a computerized system by the researcher.

I am aware that I can withdraw my consent and participation in the study at any stage before the study is published without hinder.

I have had sufficient time to ask questions and I am prepared to participate in this study.

Date:_____________________________. **Signature**:_____________________________________.

I Wabo Dlamini acknowledge that the participant has been fully informed on the study, its benefits, dangers and risk factors. **Date**:______________________ **Signature**:____________________________

Witness (full name):____

Date________________ signature ___________________________________

Appendix C

QUESTIONNAIRE FOR WEIGHT TRAINERS WITHIN THE ETHEKWINI MUNICIPALITY

(pre-focus group questionnaire)

SECTION A *(Personal profile)*

Please answer the following questions and place a **CROSS** on the relevant box where necessary.

1) Age (years)____________________. 2) Gender_________________________.

3) Weight (Kgs)__________________. 4) Height (meters)__________________.

5) Ethnicity (for statistical purposes only)

Asian	Black	Coloured
Indian	White	Other (please specify)______________________________.

6a) Please give your main reason for participating/doing weight training:

	For good health (prevent sickness and maintain good health)
	Help restore function/movement (rehabilitation)
	To look good (weight loss/build muscle)

6b) If for medical reasons, please select below (may select more than one):

	Arthritis
	Cardiovascular disease (heart disease)
	Diabetes Mellitus
	Hypertension
	Respiratory disease (difficulty breathing)
	Other (please specify)

SECTION B *(Activity profile)*

7) For how long have you been weight training?	3 months	6 months	1 year	2-5 years	More than 5 years

8) Do you always stretch and warmup for 10-15 minutes before your workout/ exercise?	Yes	No

9) How many times a week do you do weight training?	1-2	3-4	4-5	5-6	everyday

10) How many hours do you spend weight training per week?	1-2	3-5	6-8	9-11	12+

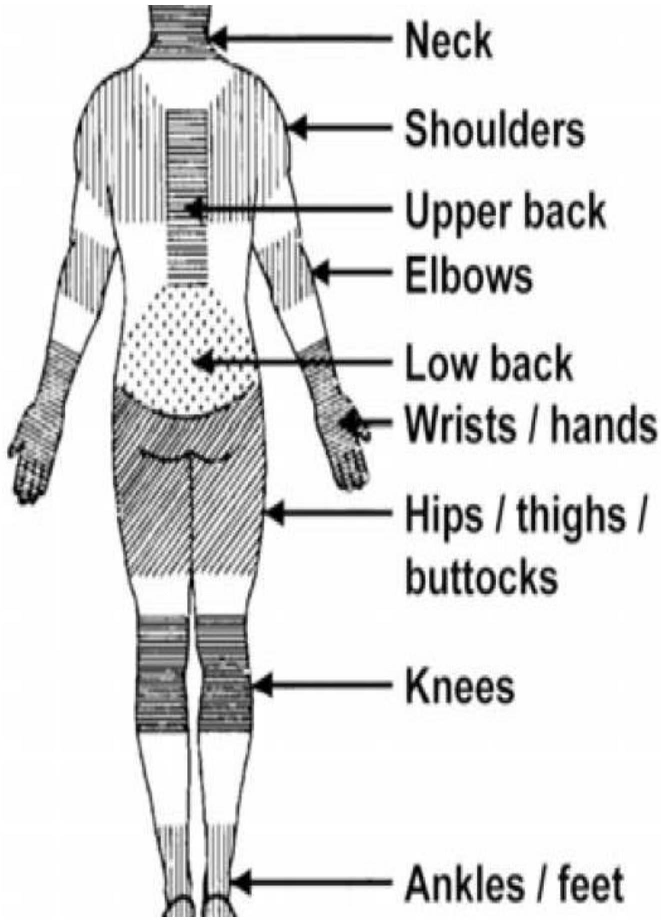
11) Do you participate in any other sports or activities if so please select other activities you participate in regularly and the hours spent on the activity?

Activity	Tick	Hours	Activity	Tick	hours
Baseball			Netball		
Basketball			Rugby		
Cricket			Running		
Frisbee			Soccer		
Hockey			Swimming		
Martial arts			Tennis		
Other (please specify)					

SECTION C *(Injury profile)*

12) On the table below plese select your response to the relevent questions by placing a **CROSS** in the relevent box.

Body part		During the last week how often was the pain/discomfort experienced?					When the pain was experienced how painful was it?			Did the pain interfere with your ability to work or carry out daily activities?		
		Never	1-2 A week	3-4 A week	Once every day	Several times a day	Slightly	Mode-rate	Severe	No	Slightly	Severely
Neck												
Shoulder	Right											
	Left											
	Both											
Elbow	Right											
	Left											
	Both											
Wrist	Right											
	Left											
	Both											
Hand	Right											
	Left											
	Both											
Upper back												
Lower back												
Hip	Right											
	Left											
	Both											
Thigh	Right											
	Left											
	Both											
leg	Right											
	Left											
	Both											
Ankle	Right											
	Left											
	Both											
Foot	Right											
	Left											
	Both											



13) Of the painful areas marked in the diagram, which top 3 are the most painful (severe/uncomfortable?). Please place a **cross** in the relevant box.

Injury one	
Forearm	Neck
Foot	Shoulder
Hip/Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg	Wrist

Injury two	
Forearm	Neck
Foot	Shoulder
Hip/Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg	Wrist

Injury three	
Forearm	Neck
Foot	Shoulder
Hip/Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg	Wrist

14) For the 3 injuries selected in the table above, did you get any treatment? Please select below from

the treatment for each injury. Note: Traditional medicine covers; Inyanga, Sangoma and Traditional healers.

Injury one	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
Other (please specify)	

Injury two	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
Other (please specify)	

Injury three	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
Other (please specify)	

15) What was the cause/diagnosis of the pain? Please select one for each injury

Injury one	
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Fracture	Tendonitis
Ligament sprain	Tendon tear
Other (please specify)	

Injury two	
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Fracture	Tendonitis
Ligament sprain	Tendon tear
Other (please specify	

Injury three	
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Fracture	Tendonitis
Ligament sprain	Tendon tear
Other (please specify)	

16) Which of the following exercises do you think might have caused your injuries?

Free weights (dumbbells/barbells/kettlebells)	
Barbell back squats	Dumbbell biceps curl
Barbell bench press	Dumbbell flies
Barbell curls	Dumbbell lateral raise
Barbell extensions	Dumbbell lunges
Barbell front squats	Dumbbell row
Barbell lunges	Inclined dumbbell press
Barbell pelvic thrust	Reverse barbell curl
Barbell row	Shrug
Barbell shoulder press	Triceps kickback
Deadlift	Wrist extensions
Other (please specify)	

Weight training machines	
Biceps cable curl	Rowing machine
Biceps curl machine	Seated cable row
Cable crossover	Seated calf raises
Cable kick-back	Seated leg curls
Chest press	Standing calf raises
Hack squats	Smith machine squats
Lat pulldown	Triceps push down
Leg press	
Lying leg curls	
Pec dec machine	
Other (please specify)	

Appendix D

Letter of information *(pilot study)*

Title of the Research Study: A musculoskeletal injury profile of weight trainers within the eThekwini municipality.

Principal Investigator/researcher: Miss Wabo Dhlamini, B-Tech Chiropractic

Supervisor: Dr. P. Maharaj M-Tech Chiropractic

Co-Supervisor: Dr. A. Pastellides M-Tech Chiropractic

Brief introduction and purpose of the study: Thank you for your interest in participating in my study. Weight training has grown in popularity over the years having a wide range of people from the young to the old, both males and females participating in it, due to its various health benefits. However just like any other form of physical activity people are prone to error and injury while performing some of the weight training exercises. This study aims to identify and profile the most commonly occurring weight training injuries within the eThekwini municipality. This information will help sports medicine professionals, personal trainers and individuals participating in weight training develop strategies targeting the most prevalent injuries to reduce their rate of occurrence.

Outline of the Procedures:

Risks or Discomforts to the Participant: There are no risks or perceived possible discomforts to you participating in this study, due to the non- invasive nature of the study.

Benefits: This study will benefit you through providing weight training information pertaining to the local population, which will also be useful to local primary health care providers and fitness managers.

Reason/s why the Participant May Be Withdrawn from the Study: You may be withdrawn from study if you are unable to answer the minimum number of questions required or if you wish to withdraw from the study, no penalty will be incurred in such instances.

Remuneration: You will not receive any form of remuneration for participating in this study. Participation in this study is done so entirely on a voluntary basis.

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

Confidentiality: All information obtained in this study will be used only for the purposes of research. The questionnaire will not contain your identity information and all information obtained will be regarded as confidential throughout the duration of the study.

Research-related Injury: Due to the nature of the study there are no projected research related injuries

Date:_____________________________. **Signature**:____________________________________.

I Wabo Dlamini acknowledge that the participant has been fully informed on the study, its benefits, dangers and risk factors. **Date**:__________________ **Signature**:__________________________

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

For any queries or problems please contact: Researcher: Wabo Dhlamini at (0719686158), my Supervisor: Dr. P. Maharaj M-Tech Chiropractic at (0312627490), my Co-supervisor: Dr. A. Pastellides M-Tech Chiropractic (0312011442) or Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Prof K Duffy Dr 031-3732576/7.

Witness (full name):____

Date________________ **signature** ___________________________________

General:

You are not obligated to participate in this study, only if you are willing to participate and are above the age of 18 years.

Appendix E

Consent form *(Pilot study)*

Title of research: A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality.

Name of researcher: Wabo Dhlamini

Name of supervisor: Dr P. Maharaj

Name of co-supervisor: Dr A. Pastellides

Name of institution: Durban University of Technology

Consent

I____ hereby confirm that I have been informed by the researcher, Wabo Dhlamini, about the nature, conduct, benefits and risks of this study.

I have also received, read and understood the letter of information regarding this study.

I have received enough information and had sufficient time to ask questions regarding this study.

I am aware that I can withdraw my consent and participation in the study at any stage the study without having to give reason.

I voluntarily agree to participate in this study.

Date:____________________________ **Signature**:_________________________________.

I Wabo Dlamini acknowledge that the participant has been fully informed on the study, its benefits, dangers and risk factors. **Date**:______________________________
Signature:_______________________

Witness (full name):____

Date____________________ Signature_____________________________

Appendix F

Letter of information *(Focus group)*

Title of the Research Study: A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality.

Title of the Research Study: A musculoskeletal injury profile of weight trainers within the eThekwini municipality.

Principal Investigator/researcher: Miss Wabo Dhlamini, B-Tech Chiropractic

Supervisor: Dr. P. Maharaj M-Tech Chiropractic

C0-supervisor: Dr. A. Pastellides M-Tech Chiropractic

Brief introduction and purpose of this group: I Wabo Dhlamini (researcher) have developed a research questionnaire (Appendix C) for the investigation of injury profile of weight trainers within the eThekwini municipality. This questionnaire (Appendix C) has not been used before and therefore needs to be evaluated and corrected to ensure it produces the necessary information that needs to be attained for the study. The purpose of this group therefore is to discuss and evaluate the questions in the questionnaire (Appendix C) to make sure that all it can deliver the necessary information.

Outline of the Procedures: The questionnaire (Appendix C) and pens will be handed out to you. I the researcher will moderate discussions about questionnaire (Appendix C) and record the focus group discussions, you will be allowed to make notes or write suggestions on your copy of the questionnaire. The copies will then be collected by the researcher after the focus group discussion.

Risks or Discomforts to the Participant: There are no risks or perceived possible discomforts to you participating in this study, due to the non- invasive nature of the study

Benefits: This study will benefit you through providing weight training information pertaining the local population which will be useful for local primary health care providers and fitness managers.

Reason/s why the Participant May Be Withdrawn from the Study: You may be withdrawn from the study if they are unable to make it on the day the focus group due to any unforeseen circumstances or if you wish to withdraw from the study.

Remuneration: You will not receive any form of remuneration for participating in this study. Participation in this study is done so entirely on a voluntary basis.

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

Confidentiality: All information obtained in this study will be used only for the purposes of research and it will threfore be regarded as confidential.

Research-related Injury: Due to the nature of the study there are no projected research related injuries

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

For any queries or problems please contact: Researcher: Wabo Dhlamini at (0719686158), my Supervisor: Dr. P. Maharaj M-Tech Chiropractic at (0312627490), my Co-supervisor: Dr. A. Pastellides M-Tech at Chiropractic (0312011442) or Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Prof C E Napier on 031 373 2577 or carinn@dut.ac.za

General
You are not obligated to participate in this study, only people who are willing to and are above the age of 18 may participate in the study.

Appendix G

<u>**Consent form**</u> *(Focus group)*

Date:

Title of research: A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality.

Name of researcher: Wabo Dhlamini

Name of supervisor: Dr P. Maharaj

Name of co-supervisor: Dr A. Pastellides

Name of institution: Durban University of Technology

Consent

I____hereby confirm that I have been informed by the researcher, Wabo Dhlamini, about the nature, conduct, benefits and risks of this study.

I have also received, read and understood the letter of information regarding this study.

I am aware that the results of the study such as personal details regarding my age and injuries will be anonymously issued into a study report.

In view of the requirements of research, I agree that the information collected during this study can be processed in a computerized system by the researcher.

I am aware that I can withdraw my consent and participation in the study at any stage before the study is published without hinder.

I have had sufficient time to ask questions and I am prepared to participate in this study.

Date:______________________________. **Signature**:______________________________________.

I Wabo Dlamini acknowledge that the participant has been fully informed on the study, its benefits, dangers and risk factors

Name of researcher: Wabo Dhlamini

Date:__________________________________. **Signature**:______________________________________.

Appendix H

HAVE YOU BEEN WEIGHT TRAINING FOR THREE MONTHS OR MORE?

HELP US IDENTIFY COMMON INJURIES AMONGST WEIGHT TRAINERS BY PARTICIPATING IN THIS STUDY.

CONTACT:

WABO DHLAMINI @ 031 373 2205

Appendix I

<u>**Confidentiality Statement and Code of Conduct**</u>

(focus group members)

IMPORTANT NOTICE: This form is to be read, understood and signed by every member participating in the focus group, before the discussions begin.

1. All the information contained in the research documents and any information discussed during the focus group meeting must be kept private and confidential.

2. None of the information discussed is to be communicated to any other individual or organization outside focus group.

3. The information from this focus group will be made public in terms of a dissertation/thesis and/or journal publication, in which no identification of any participants involved in this focus group will be made possible

4. The assistant moderator will record the proceedings of the group discussions; this recording will only be available to the researcher to ensure confidentiality. Recording will be disposed of once all necessary information has been extracted after being kept for 5 years by the Durban University of technology in a secure location.

5.The questionnaires used during the discussions will be coded and kept anonymous in the research process, to maintain confidentiality.

6. All the information that will be obtained from the focus group discussions will be kept in a secure location at the Durban University of Technology for 5 years following which information will be appropriately disposed of.

Name of participant:____.

Date:_____________________________._**Signature**:______________________________________.

I Wabo Dlamini acknowledge that the participant has been fully informed on the focus group code of conduct and requirements.

Name of researcher: Wabo Dhlamini

Date:_____________________________.   **Signature**:______________________________________.

Appendix J

Letter of permission to gym owners or managers

Dear Sir/Madam

This letter serves as a request to use your gym to collect information regarding this study.

Research Title:

A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality.

Name of researcher: Wabo Dhlamini

Name of supervisor: Dr P. Maharaj

Name of co-supervisor: Dr A. Pastellides

Name of institution: Durban University of Technology

Brief introduction and purpose of the study

Weight training has grown in popularity over the years having a wide range of people from the young to the old, both males and females participating in it, due to its various health benefits. However just like any other form of physical activity people are prone to error and injury while performing some of the weight training exercises. This study aims to identify and profile the most commonly occurring weight training injuries within the eThekwini municipality. This information will help sports medicine professionals, personal trainers and individuals participating in weight training to develop strategies targeting the most prevalent injuries to reduce their rate of occurrence.

Study procedure

A 4 paged questionnaire divided into 3 sections will be handed out to willing participants to complete. The first section of the questionnaire will include participants demographics, the second section will focus of activity levels and the last section will address history of injury. Only people who have read, understood the letter of information and signed the consent form will participate.

Those who may participate in the study

Participants must be above the age of 18 to sign their own consent forms.

People only doing free weights and using resistance machines.

Participants must be registered with a gym in the Durban central area.

Only people who will sign the consent form of the study.

Risks, costs, discomfort and benefits to participants

There will be no risks to any participants, no costs incurred costs or any form of discomfort to any participants. This study will benefit participants through the development of strategies to increase and ensure safety during weight training, this will be done based on the findings of the study.

Confidentiality

All information obtained in this study will be used only for the purposes of research. Anonymity of all participants will be ensured, questionnaire will not contain participants' identity information and all information obtained will be regarded as confidential.

For any queries or problems please contact:

Researcher: Wabo Dhlamini (0719686158)

Supervisor: Dr. P. Maharaj M-Tech Chiropractic (0312627490)

Co-supervisor: Dr. A. Pastellides M-Tech Chiropractic (0312011442)

Appendix K

QUESTIONNAIRE FOR WEIGHT TRAINERS WITHIN THE ETHEKWINI MUNICIPALITY

(post-focus group questionnaire)

SECTION A

Part 1 *(Personal profile)*

Please answer the following questions and **place a CROSS** on the relevant box where necessary.

1) Age (years)________________________   2) Gender______________________________

3) Weight (Kgs)________________________   4) Height (meters)________________________

5) Occupation?________________________________

6) Ethnicity (for statistical purposes only)

Asian	Black	Coloured
Indian	White	Other (please specify)______________________________

Part 2 *(Medical history)*

7) Are you currently on any medication or supplements? | YES | NO |

	Acute medication	**Chronic medication**	**Over the counter medication**	**Performance enhancing supplements**
1. Brand & name				
2. Brand & name				
3. Brand & name				
4. Brand & name				

SECTION B *(Activity profile)*

1) Do you stretch and warmup before your workout/ exercise? | Yes | NO |

2.1) If yes to the question above, for how many minutes? ____________________________________

3) Do you stretch and cool down after your workout/ exercise? | Yes | NO |

3.1) If yes to the question above, for how many minutes?______________________________________

4) For how long have you been weight training?	3 -6 months	6-9 months	9-12 months	1-2 years	2-3 years	3-4 years	More than 4 years

5) How many days a week do you do weight training?	1-2	2-3	3-4	4-5	5-6	6-7

6) How many hours do you spend weight training per week?	1-2	2-3	3-4	4-5	5-6	More than 6

7) Do you participate in any other sports or activities?

7.1) If you answered **NO** to the above question please proceed to **section C.** If your answer was **YES,** please select other sports/ activities you participate in regularly and indicate the number of hours spent on the activity per week?

Activity	**Cross**	**Hours**	**Activity**	**Cross**	**hours**
Baseball			Netball		
Basketball			Rugby		
Cricket			Running		
Frisbee			Soccer		
Hockey			Swimming		
Martial arts			Tennis		
Other (please specify)					

NOTE: In this study an injury has been defined as a condition of pain or impairment of body function that affects training (Strömbäck *et al.* 2018).

7.2) Have you sustained any current or recent (within 12 months) injuries as a result of any of the sports/ activities listed above?

YES	NO

7.3) If you answered **NO**, to the above question please proceed to **section C.** If your answer is **YES,** please select on the table below, the 3 most sever areas of recent injuries sustained in the sports or activities stated above.

Injury one	
Forearm	Neck
Foot	Shoulder
Hip/Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg	Wrist

Injury two	
Forearm	Neck
Foot	Shoulder
Hip/Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg	Wrist

Injury three	
Forearm	Neck
Foot	Shoulder
Hip/Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg	Wrist

SECTION C [*Part 1* *(current injury)*]

1) Do you ***currently*** have any injury/injuries sustained due to weight training?

Yes	No

2) If your answered **NO** to the above question, please proceed to ***part 2*** of **section C.** If you answered **YES**, in which part of your body did you sustain this injury/injuries? please **place a CROSS** in the relevant box.

Injury one	
Forearm	Neck
Foot/ Ankle	Shoulder
Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg (Calf)	Hand
Hip	Elbow
Interscapular	Mid back

Injury two	
Forearm	Neck
Foot/ Ankle	Shoulder
Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg (Calf)	Hand
Hip	Elbow
Interscapular	Mid back

Injury three	
Forearm	Neck
Foot/Ankle	Shoulder
Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg (Calf)	Hand
Hip	Elbow
Interscapular	Mid back

3) Using the scale bellow please rate the severity of your injury in terms of pain.

Intensity **(Circle the relevant number).**	
a. The amount of pain you are currently experiencing due to the injury?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*
b. The worst the pain gets?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*

Injury 1

Intensity **(Circle the relevant number).**	
a. The amount of pain you are currently experiencing due to the injury?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*
b. The worst the pain gets?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*

Injury 2

Intensity **(Circle the relevant number).**	
a. The amount of pain you are currently experiencing due to the injury?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*
b. The worst the pain gets?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*

Injury 3

4) What type of injury did you sustain? (Diagnosis) **Place a CROSS** on the relevant box. Where injury is not listed in the table please use the spaces provided and specify the type of injury you sustained.

Injury one	
Joint sprain	Fracture
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Ligament tear	Tendonitis
Ligament sprain	Tendon tear
Not sure	

Other_______________________

Injury two	
Joint sprain	Fracture
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Ligament tear	Tendonitis
Ligament sprain	Tendon tear
Not sure	

Other _______________________

Injury three	
Joint sprain	Fracture
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Ligament tear	Tendonitis
Ligament sprain	Tendon tear
Not sure	

Other _______________________

5) Please select the treatment you received for each injury on the table below (**place a CROSS** in the relevant box). Traditional medicine covers; Inyanga, Sangoma and Abathandazi. Where medical assistance received is not listed in the table please use the spaces provided and specify the type of treatment received.

Injury one	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
None	

Other_______________________

Injury two	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
None	

Other_______________________

Injury three	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
None	

Other ___________________________

6) Did the injury interfere with your ability to carry out daily activities? (**Place a CROSS** in the relevant box).

Injury 1			**Injury 2**			**Injury 3**		
No	Slightly	Severely	No	Slightly	Severely	No	Slightly	Severely

7) Did your injury interfere with your training ability/program?

Injury 1			**Injury 2**			**Injury 3**		
No	Slightly	Severely	No	Slightly	Severely	No	Slightly	Severely

Appendix L

QUESTIONNAIRE FOR WEIGHT TRAINERS WITHIN THE ETHEKWINI MUNICIPALITY

SECTION A

Part 1 *(Personal profile)*

Please answer the following questions and **place a CROSS** on the relevant box where necessary.

1) Age (years)________________________ 2) Gender______________________________

3) Weight (Kgs)________________________ 4) Height (meters)________________________

5) Occupation?_________________________________

6) Ethnicity (for statistical purposes only)

Asian	Black	Coloured
Indian	White	Other (please specify)______________________________

Part 2 *(Medical history)*

7) Are you currently on any medication or supplements?

YES	NO

	Acute medication	**Chronic medication**	**Over the counter medication**	**Performance enhancing supplements**
1. Brand & name				
2. Brand & name				
3. Brand & name				
4. Brand & name				

SECTION B *(Activity profile)*

1) Do you stretch and warmup before your workout/ exercise?

Yes	NO

2.1) If yes to the question above, for how many minutes? ____________________________________

3) Do you stretch and cool down after your workout/ exercise?

Yes	NO

3.1) If yes to the question above, for how many minutes?______________________________________

4) For how long have you been weight training?	3 -6 months	6-9 months	9-12 months	1-2 years	2-3 years	3-4 years	More than 4 years

5) How many days a week do you do weight training?	1-2	2-3	3-4	4-5	5-6	6-7

6) How many hours do you spend weight training per week?	1-2	2-3	3-4	4-5	5-6	More than 6

7) Do you participate in any other sports or activities?

7.1) If you answered **NO** to the above question please proceed to **section C.** If your answer was **YES,** please select other sports/ activities you participate in regularly and indicate the number of hours spent on the activity per week?

Activity	Cross	Hours	Activity	Cross	hours
Baseball			Netball		
Basketball			Rugby		
Cricket			Running		
Frisbee			Soccer		
Hockey			Swimming		
Martial arts			Tennis		
Other (please specify)					

NOTE: In this study an injury has been defined as a condition of pain or impairment of body function that affects training (Strömbäck *et al.* 2018).

7.2) Have you sustained any current or recent (within 12 months) injuries as a result of any of the sports/ activities listed above?

YES	NO

7.3) If you answered **NO**, to the above question please proceed to ***part 1*** of **section C (Page 3).** If your answer is **YES,** please select on the table below, the 3 most sever areas of recent injuries sustained in the sports or activities stated above.

Injury one	
Forearm	Neck
Foot	Shoulder
Hip/Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg	Wrist

Injury two	
Forearm	Neck
Foot	Shoulder
Hip/Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg	Wrist

Injury three	
Forearm	Neck
Foot	Shoulder
Hip/Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg	Wrist

SECTION C [*Part 1* *(current injury)*]

1) Do you ***currently*** have any injury/injuries sustained due to weight training? | Yes | No |

2) If your answered **NO** to the above question, please proceed to ***part 2*** of **section C (Page 5).** If you answered **YES**, in which part of your body did you sustain this injury/injuries? please **place a CROSS** in the relevant box.

Injury one	
Forearm	Neck
Foot/ Ankle	Shoulder
Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg (Calf)	Hand
Hip	Elbow
Interscapular	Mid back

Injury two	
Forearm	Neck
Foot/ Ankle	Shoulder
Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg (Calf)	Hand
Hip	Elbow
Interscapular	Mid back

Injury three	
Forearm	Neck
Foot/Ankle	Shoulder
Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg (Calf)	Hand
Hip	Elbow
Interscapular	Mid back

3) Using the scale bellow please rate the severity of your injury in terms of pain.

Intensity **(Circle the relevant number).**	
a. The amount of pain you are currently experiencing due to the injury?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*
b. The worst the pain gets?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*

Injury 1

Intensity **(Circle the relevant number).**	
a. The amount of pain you are currently experiencing due to the injury?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*
b. The worst the pain gets?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*

Injury 2

Intensity **(Circle the relevant number).**	
a. The amount of pain you are currently experiencing due to the injury?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*
b. The worst the pain gets?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*

Injury 3

4) What type of injury did you sustain? (Diagnosis) **Place a CROSS** on the relevant box. Where injury is not listed in the table please use the spaces provided and specify the type of injury you sustained.

Injury one	
Joint sprain	Fracture
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Ligament tear	Tendonitis
Ligament sprain	Tendon tear
Not sure	

Other________________________

Injury two	
Joint sprain	Fracture
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Ligament tear	Tendonitis
Ligament sprain	Tendon tear
Not sure	

Other ________________________

Injury three	
Joint sprain	Fracture
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Ligament tear	Tendonitis
Ligament sprain	Tendon tear
Not sure	

Other ________________________

5) Please select the treatment you received for each injury on the table below (**place a CROSS** in the relevant box). Traditional medicine covers; Inyanga, Sangoma and Abathandazi. Where medical assistance received is not listed in the table please use the spaces provided and specify the type of treatment received.

Injury one	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
None	

Other_______________________

Injury two	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
None	

Other________________________

Injury three	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
None	

Other ____________________________

6) Did the injury interfere with your ability to carry out daily activities? (**Place a CROSS** in the relevant box).

Injury 1			**Injury 2**			**Injury 3**		
No	Slightly	Severely	No	Slightly	Severely	No	Slightly	Severely

7) Did your injury interfere with your training ability/program?

Injury 1			**Injury 2**			**Injury 3**		
No	Slightly	Severely	No	Slightly	Severely	No	Slightly	Severely

8) Which of the following exercises do you think might have caused your injury/injuries? (**place ONE CROSS** per table in the relevant box.)

Free weights (dumbbells/barbells/kettlebells)	
Barbell back squats	Dumbbell biceps curl
Barbell bench press	Dumbbell flies
Barbell curls	Dumbbell lateral raise
Barbell extensions	Dumbbell lunges
Barbell front squats	Dumbbell row
Barbell lunges	Inclined dumbbell press
Barbell pelvic thrust	Reverse barbell curl
Barbell row	Shrug
Barbell shoulder press	Triceps kickback
Deadlift	Wrist extensions
Other (please specify)	

Weight training machines	
Biceps cable curl	Rowing machine
Biceps curl machine	Seated cable row
Cable crossover	Seated calf raises
Cable kick-back	Seated leg curls
Chest press	Standing calf raises
Hack squats	Smith machine squats
Lat pulldown	Triceps push down
Leg press	
Lying leg curls	
Pec dec machine	
Other (please specify)	

Injury 1

Free weights (dumbbells/barbells/kettlebells)	
Barbell back squats	Dumbbell biceps curl
Barbell bench press	Dumbbell flies
Barbell curls	Dumbbell lateral raise
Barbell extensions	Dumbbell lunges
Barbell front squats	Dumbbell row
Barbell lunges	Inclined dumbbell press
Barbell pelvic thrust	Reverse barbell curl
Barbell row	Shrug
Barbell shoulder press	Triceps kickback
Deadlift	Wrist extensions
Other (please specify)	

Weight training machines	
Biceps cable curl	Rowing machine
Biceps curl machine	Seated cable row
Cable crossover	Seated calf raises
Cable kick-back	Seated leg curls
Chest press	Standing calf raises
Hack squats	Smith machine squats
Lat pulldown	Triceps push down
Leg press	
Lying leg curls	
Pec dec machine	
Other (please specify)	

Injury 2

Free weights (dumbbells/barbells/kettlebells)	
Barbell back squats	Dumbbell biceps curl
Barbell bench press	Dumbbell flies
Barbell curls	Dumbbell lateral raise
Barbell extensions	Dumbbell lunges
Barbell front squats	Dumbbell row
Barbell lunges	Inclined dumbbell press
Barbell pelvic thrust	Reverse barbell curl
Barbell row	Shrug
Barbell shoulder press	Triceps kickback
Deadlift	Wrist extensions
Other (please specify)	

Weight training machines	
Biceps cable curl	Rowing machine
Biceps curl machine	Seated cable row
Cable crossover	Seated calf raises
Cable kick-back	Seated leg curls
Chest press	Standing calf raises
Hack squats	Smith machine squats
Lat pulldown	Triceps push down
Leg press	
Lying leg curls	
Pec dec machine	
Other (please specify)	

Injury 3

Part 2 *(Injuries sustained within the past 12 months)*

1) Have you had any weight training related injuries in ***the past 12 months***?

Yes	No

2) If you answered **NO** to the above question, thank you for participating in this study you may return the questionnaire to the researcher. If you answered **YES**, in which part of your body did you sustain this injury/injuries? please **place a CROSS** in the relevant box.

Injury one	
Forearm	Neck
Foot/ Ankle	Shoulder
Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg (Calf)	Hand
Hip	Elbow
Interscapular	Mid back

Injury two	
Forearm	Neck
Foot/ Ankle	Shoulder
Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg (Calf)	Hand
Hip	Elbow
Interscapular	Mid back

Injury three	
Forearm	Neck
Foot/Ankle	Shoulder
Buttocks	Thigh
Knee	Wrist
Lower back	Upper back
Lower leg (Calf)	Hand
Hip	Elbow
Interscapular	Mid back

4) Using the scale bellow please rate the severity of the injury experienced.

Injury 1

Intensity **(Circle the relevant number).**	
a. The amount of pain you would experience due to the injury?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*
b. The worst the pain would get?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*

Injury 2

Intensity **(Circle the relevant number).**	
a. The amount of pain you would experience due to the injury?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*
b. The worst the pain would get?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*

Injury 3

Intensity **(Circle the relevant number).**	
a. The amount of pain you would experience due to the injury?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*
b. The worst the pain would get?	0 1 2 3 4 5 6 7 8 9 10 *(0=least amount of pain and 10=most amount of pain)*

4) What type of injury did you sustain? (Diagnosis) **Place a CROSS** on the relevant box. Where injury is not listed in the table please use the spaces provided and specify the type of injury you sustained.

Injury one	
Joint sprain	Fracture
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Ligament tear	Tendonitis
Ligament sprain	Tendon tear
Not sure	

Other________________________

Injury two	
Joint sprain	Fracture
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Ligament tear	Tendonitis
Ligament sprain	Tendon tear
Not sure	

Other _________________________

Injury three	
Joint sprain	Fracture
Bursitis	Muscle spasms
Contusion	Muscle strain
Dislocation	Muscle tear
Ligament tear	Tendonitis
Ligament sprain	Tendon tear
Not sure	

Other ________________________

5) Please select the treatment you received for each injury on the table below (**place a CROSS** in the relevant box). Traditional medicine covers; Inyanga, Sangoma and Abathandazi. Where medical assistance received is not listed in the table please use the spaces provided and specify the type of treatment received.

Injury one	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
None	

Other_______________________

Injury two	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
None	

Other________________________

Injury three	
Biokinetic	Orthopedic
Chiropractic	Physiotherapy
First aid	Traditional Medicine
Medical (GP)	None
None	

Other ____________________________

6) Did the injury interfere with your ability to carry out daily activities? (**Place a CROSS** in the relevant box).

Injury 1			**Injury 2**			**Injury 3**		
No	Slightly	Severely	No	Slightly	Severely	No	Slightly	Severely

7) Did your injury interfere with your training ability/program?

Injury 1			**Injury 2**			**Injury 3**		
No	Slightly	Severely	No	Slightly	Severely	No	Slightly	Severely

8) Which of the following exercises do you think might have caused your injury/injuries? (**place ONE CROSS** per table in the relevant box.)

Free weights (dumbbells/barbells/kettlebells)	
Barbell back squats	Dumbbell biceps curl
Barbell bench press	Dumbbell flies
Barbell curls	Dumbbell lateral raise
Barbell extensions	Dumbbell lunges
Barbell front squats	Dumbbell row
Barbell lunges	Inclined dumbbell press
Barbell pelvic thrust	Reverse barbell curl
Barbell row	Shrug
Barbell shoulder press	Triceps kickback
Deadlift	Wrist extensions
Other (please specify)	

Weight training machines	
Biceps cable curl	Rowing machine
Biceps curl machine	Seated cable row
Cable crossover	Seated calf raises
Cable kick-back	Seated leg curls
Chest press	Standing calf raises
Hack squats	Smith machine squats
Lat pulldown	Triceps push down
Leg press	
Lying leg curls	
Pec dec machine	
Other (please specify)	

Injury 1

Free weights (dumbbells/barbells/kettlebells)	
Barbell back squats	Dumbbell biceps curl
Barbell bench press	Dumbbell flies
Barbell curls	Dumbbell lateral raise
Barbell extensions	Dumbbell lunges
Barbell front squats	Dumbbell row
Barbell lunges	Inclined dumbbell press
Barbell pelvic thrust	Reverse barbell curl
Barbell row	Shrug
Barbell shoulder press	Triceps kickback
Deadlift	Wrist extensions
Other (please specify)	

Weight training machines	
Biceps cable curl	Rowing machine
Biceps curl machine	Seated cable row
Cable crossover	Seated calf raises
Cable kick-back	Seated leg curls
Chest press	Standing calf raises
Hack squats	Smith machine squats
Lat pulldown	Triceps push down
Leg press	
Lying leg curls	
Pec dec machine	
Other (please specify)	

Injury 2

Free weights (dumbbells/barbells/kettlebells)	
Barbell back squats	Dumbbell biceps curl
Barbell bench press	Dumbbell flies
Barbell curls	Dumbbell lateral raise
Barbell extensions	Dumbbell lunges
Barbell front squats	Dumbbell row
Barbell lunges	Inclined dumbbell press
Barbell pelvic thrust	Reverse barbell curl
Barbell row	Shrug
Barbell shoulder press	Triceps kickback
Deadlift	Wrist extensions
Other (please specify)	

Weight training machines	
Biceps cable curl	Rowing machine
Biceps curl machine	Seated cable row
Cable crossover	Seated calf raises
Cable kick-back	Seated leg curls
Chest press	Standing calf raises
Hack squats	Smith machine squats
Lat pulldown	Triceps push down
Leg press	
Lying leg curls	
Pec dec machine	
Other (please specify)	

Injury 3

Thank you for completing the questionnaire, your contribution is greatly appreciated!!

Appendix M

20 May 2019

The Post Graduate Research Director
Post Graduate Research Office
Durban University of Technology
Durban
4001

Request for Permission to Conduct Research

Dear Professor C Napier

My name is Wabo Dhlamini, I am a Chiropractic student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation is **A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality**.

I am hereby seeking your consent to conduct my research pilot study at the Durban University of Technology student gym.

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

If you require any further information, please do not hesitate to contact me at 0719686158 or email me at wabodhlamini@ymail.com . Thank you for your time and consideration in this matter.

Yours sincerely,

Wabo Dhlamini
Durban University of Technology

DURBAN UNIVERSITY OF TECHNOLOGY

Pilot Study Questionnaire Evaluation Sheet

(Please cross one box only)

1. What is your opinion on the subject raised in this questionnaire?
☐ Very Interesting
☐ Interesting
☐ Average
☐ Boring
☐ Very Boring

2. Was the topic adequately covered in the questionnaire?
☐ Yes
☐ No

3. What is your opinion of the Letter of Information?
☐ Very clear
☐ Sufficiently clear
☐ Adequate
☐ Unclear
☐ Need revising

4. What is your opinion of the instructions on the Letter of Information?
☐ Very clear
☐ Sufficiently clear
☐ Adequate
☐ Unclear
☐ Need revising

5. In your opinion, is the questionnaire too long?
☐ Yes
☐ No

6. What is your opinion of the wording of the questionnaire?
☐ All questions are absolutely clear
☐ Questions are mostly clear
☐ Too many confusing Chiropractic/Medical terms
☐ The questionnaire will be difficult for the lay person to understand
☐ The questionnaire is completely confusing and needs to be revised

If you found any question/s difficult to answer, please write the number/s of the questions in the space provided with your comments on how the question/s can be improved____
____
____
____

Please print in block letters:

Participant: _____________________________________ Signature:__________________________
Witness Name:____________________________________ Signature: _________________________
Researcher’s Name:_______________________________ Signature: _________________________
Supervisor’s Name: ________________________________Signature: _________________________

Request for Permission to Conduct Research

Dear Sir

My name is Wabo Dhlamini. I am a Chiropractic student at the Durban University of Technology. The research I wish to conduct for my Masters dissertation involves **A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality**

I am hereby seeking your consent to data collect at your gym.

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

If you require any further information, please do not hesitate to contact me at 0719686158 or email at wabodhlamini@ymail.com . Thank you for your time and consideration in this matter.

Yours sincerely,

Wabo Dhlamini
Durban University of Technology

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

P O Box 1334, Durban, South Africa, 4001

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

www.dut.ac.za

14 May 2019

Ms W Dhlamini
P O Box 1192
Lukwatini

Dear Ms Dhlamini

A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality

I am pleased to inform you that **PROVISIONAL APPROVAL** has been granted to your proposal subject to:

- Piloting of the data collection tool. *Please note that should there be any changes to the data collection tool, in a letter signed by the researcher and supervisor, list the changes to the documents and submit to IREC with the final data collection tool. Even when there are no changes to the data collection tool, IREC has to be notified.*
- Obtaining and submitting the necessary gatekeeper permission/s to Institutional Research Ethics Committee (IREC).

PLEASE NOTE THAT THIS IS NOT A FINAL APPROVAL LETTER. KINDLY SUBMIT THE ABOVE MENTIONED DOCUMENTS WITHIN THREE MONTHS TO THE IREC OFFICE. DATA COLLECTION CAN ONLY COMMENCE WHEN IREC ISSUES FULL APPROVAL

The Proposal has been allocated the following Ethical Clearance number **IREC 201/18**. Please use this number in all communication with this office.

Approval has been granted for a period of **ONE YEAR**, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Yours Sincerely

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY
2019 -05- 14
INSITUTUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA

DUT
DURBAN UNIVERSITY OF TECHNOLOGY

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

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http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

31 July 2019

Ms W Dhlamini
P O Box 1192
Lukwatini

Dear Ms Dhlamini

A musculoskeletal injury profile of weight trainers at gyms within the eThekwini municipality
Ethical Clearance number IREC 201/18

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,

Professor J K Adam
Chairperson: IREC