THE RELATIONSHIP BETWEEN FIBULARIS MUSCLE STRENGTH AND LATERAL ANKLE SPRAIN AMONG HIGH SCHOOL NETBALL PLAYERS IN GAUTENG NORTHEN REGION

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirement for degree of Master of Science in Physiotherapy

By

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DECLARATION

I declare that this is my own work. It is being submitted for the degree of Master of Science in Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.

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ABSTRACT

Previous and current research findings contradict each other about whether a relationship exists between Fibularis Muscle Strength and Lateral Ankle Sprain. As it stands, there is no finality about the relationship between Fibularis Muscle Strength and Lateral Ankle Sprain. Hence, this study was aimed at establishing whether a relationship exists between Fibularis Muscle Strength and Lateral Ankle Sprain amongst high school net ball players in Gauteng Northern Region. If a relationship does exist and is well understood, further research may be recommended to come up with a rehabilitation protocol that may be used to prevent Lateral Ankle Sprain. In conducting this study, a longitudinal analytical approach was adopted where subjects were observed over a four months period of high school netball season in Gauteng Northern Region. This was the best design for this study because it enabled the researcher to examine the relationship between independent variables (Height, weight, age, balance and Fibularis Muscle Strength) and the dependent variable (Lateral Ankle Sprain). 100 randomly selected high school female netball players, ranging in age from 13 to 19 years (mean ± SD = 16.5 ±1.27), who represented schools in tournaments and games participated in this study. The researcher recorded baseline measurements of Fibularis Muscle Strength, balance, demographic characteristics (age, height and weight) for each of the 100 randomly selected subjects 2 weeks before the beginning of 2009 netball season. Subjects who sustained Lateral Ankle Sprain, during the netball season, filled in injury assessment forms which were collected by the researcher on every Monday until the end of the netball season. Data was then analysed using logistic regression analyses with testing done at 0.05 level of significance. The findings from this study revealed that 5% of the subjects reported Lateral Ankle Sprain. Balance and age were significantly associated with lateral ankle sprain ($p<0.05$) while Fibularis Muscle Strength, weight and height were not ($p>0.05$). Therefore, there was no relationship between Fibularis Muscle Strength and Lateral Ankle Sprain. Furthermore, Age and balance were identified as predictors of lateral ankle sprain.

DEDICATION

To my beloved wife and mother for their endless unrelenting love and support

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Netball is the most popular and largest non-contact sport usually played by females. It is the second largest sport in South Africa and it is very common in South African high schools (Sports Information and Science Agency, 1995). Those playing for high schools may end up playing for the South African National Netball Team which usually participates in netball world championship games and commonwealth games.

The game of Netball involves jumping and sudden change in direction hence it is associated with acute traumatic injuries, one of which is lateral ankle sprain (Pollard et al., 2002: Hertel, 2002 and Fong et al., 2007).

Garrick and Requa, (1988) defined Lateral Ankle Sprain as inversion trauma to the ankle, which results in damage to the lateral ligamentous complex of the ankle. According to Safran et al.,(1999) as high as 40 % of those who sustain lateral ankle sprain continue to report residual disability of giving way and pain at the ankle despite treatment attempts. As a result, according to Fong et al (2000) and Kaminiski et al (2003), prevention and treatment programs for ankle injuries can be time consuming and costly. Therefore, in line with the reasoning by Munn et al.(2003), the researcher is of the opinion that it is of utmost importance to identify impairments that are associated with lateral ankle sprain so as to minimise occurrence of lateral ankle sprain injuries.

In addition to identifying proprioceptive deficits and mechanical insufficiency as the main impairments associated with lateral ankle sprain, Brunt (1992) also suggested that muscle weakness specifically of the ankle evertors must be considered. The argument was that considering that the injury mechanism of lateral ankle sprain involves the weight bearing foot giving way into plantaflexion and inversion which should be countered by the ankle evetrors, weakness of the evertors therefore, would reduce the ability of these muscles to resist inversion and thereby prevent lateral ankle sprain injury. However, the literature is divided about whether fibularis muscles strength has any role in prevention of lateral ankle sprain. Earlier research (Almquist, 1974; Bosien et al.,1955; Evans et al.1984; Freeman, 1965; Kannus and Renstrom, 1991) found deficits in fibularis muscle strength in those with history of lateral ankle sprain while current research (Kaminski et al. 1999, Munn et al., 2003) contradicts these findings showing no isometric, concentric and eccentric fibularis muscle strength deficits in those with history of lateral ankle sprain. Despite this controversy that overlies the relationship between fibularis muscle strength and lateral ankle sprain, clinicians in current practice as indicated by Wilkerson et al. (1997), consider strengthening fibularis muscles to be a fundamental component of lateral ankle sprain rehabilitation

protocol. Therefore, in the researcher's opinion, unless clear evidence of fibularis muscle strength deficits exists, clinicians may find that common practice of strengthening fibularis muscles post lateral ankle sprain is unnecessary and that other measures should rather be taken. Therefore, this study was set out to address the issue of whether fibularis muscle strength is associated with lateral ankle sprain.

1.2 Problem Statement

Current research (Munn et al., 2003 and Wilkerson et al., 1997) and earlier research (Almquist, 1974: Bosien et al.,1955: Freeman, 1965: Evans et al.1984: Kannus and Renstrom, 1991) contradict each other on whether there is a relationship between fibularis muscle strength and lateral ankle sprain. However, despite this conflict, current practice considers strengthening of the fibularis muscles to be a key component of lateral ankle sprain rehabilitation protocol. Why current practice advocates for the strengthening of the fibularis muscles when rehabilitating lateral ankle sprain injuries is not clear. Therefore, is there any relationship between fibularis muscle strength and lateral ankle sprain, that warrants strengthening of the fibularis muscles? Unless clear evidence of weakness of the fibularis muscles exists in netball players, eversion strength training may be unnecessary. The current study therefore, aims at establishing whether a relationship exists between fibularis muscle strength and lateral ankle sprain.

1.3 Aim of the Study

The aim of this study was to establish the relationship between fibularis muscle strength and lateral ankle sprain among high school netball players in Gauteng Northern Region.

1.4 Objectives of the Study

The objectives of this study were to establish:

1. The relationship between fibularis muscles strength and lateral ankle sprain among high school netball players in Gauteng northern region.
2. Point prevalence of lateral ankle sprain among high school netball players in Gauteng Northern Region during 2009 netball season.
3. The relationship between balance and lateral ankle sprain.
4. The relationship between demographic information (age, height and weight) and lateral ankle sprain.
5. Predictors of lateral ankle sprain.

1.5 Significance of the Study

The findings of the study will benefit the researcher by enhancing his knowledge regarding fibularis muscle strength as a predictor of lateral ankle sprain, body of Knowledge on understanding ankle sprain injuries will be enhanced, netball coaches will understand better on how to advice players about prevention of lateral ankle sprain injuries hence prevention of associated morbidity, loss of

training time and performance opportunities particularly for the athlete, and the Ministry of Sports and Recreation will be informed about ankle sprain injuries which helps with decision making particularly when looking at how schools can be advised on prevention of ankle sprain injuries amongst net ball players.

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CHAPTER TWO

LITERATURE REVIEW

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2.1 Introduction

This chapter explores the incidence of lateral ankle sprain, structure and function of the ankle/foot complex, mechanism of lateral ankle sprain injury, dynamic and static defence mechanisms of the ankle/foot complex against lateral ankle sprain, views on association of fibularis muscle strength with lateral ankle sprain, factors associated with lateral ankle sprain and finally, management of lateral ankle sprain.

2.2 Theoretical Issues on Fibularis Muscle Strength and Lateral Ankle Sprain

Search engines: Medline, Cinahl, Pedros, Pubmed and Cochrane databases were searched for relevant articles

Key words: Fibularis Muscle Strength, Relationship, Lateral Ankle Sprain.

2.2.1 Incidence of Lateral Ankle Sprain

Four lateral ankle sprains have been reported for every 1000 hours of exposure per netball player (Hopper et al.,1995) which is higher than for soccer which is 2 sprains per 1000hours of exposure per player (Ekstrand and Tropp, 1990) and volleyball (2.6 sprains per 1000 hours of exposure per player) (Bahr et al., 1994). These injuries are also common in everyday life and in other sporting activities particularly those that involve jumping (Fong et al., 2009). Approximately 5000 and 27000 new cases are reported daily in The UK and USA respectively (Kumai et al., 2002). South African figures could not be located.

The following paragraphs discuss the structure and function of the ankle foot complex, mechanism of lateral ankle sprain together with dynamic and static defence mechanisms of the ankle against lateral ankle sprain to provide background for discussion on views about the relationship between fibularis muscle strength and lateral ankle sprain.

2.2.2 Structure and function of the ankle/foot complex

The ankle/foot complex comprise of 28 bones that form 25 joints (Snell, 2008). These joints include the talocrural (ankle) joint, talocalcaeneal (subtalar) joint, talonavicular joint, calcaenocuboid joint, five tarsometatarsal joints, five metartasophalengeal joints and nine interphalengeal joints. Talonavicular and calcaenocuboid joints are collectively called transverse tarsal joint or the midtarsal joint while talocalcaneal and talonavicular joints are called the talocalcaneonavicular joint (Norkin and Levangie, 1992).

The function of the ankle/foot complex is to provide the body with optimal stability and mobility under varying weight bearing postures (Norkin and Levangie, 1992: Snell, 2008). According to Norkin and Levangie, (1992), talocrural joint transfers ground reaction forces from the foot to the leg; subtalar joint dampens the rotational forces imposed by the body while allowing contact of the forefoot with the ground and transverse tarsal joint is the link between the hind foot and the forefoot. It adds to the supination and pronation of the subtalar joint and also allows the forefoot to remain flat on the ground when the hind foot is in inversion or eversion. The ankle/foot complex also acts as a lever that propels the body forward during locomotion.

2.2.3 Mechanism of lateral ankle sprain

According to Munn et al. (2003), if the body's centre of mass is displaced laterally and ankle invertors fail to control lateral displacement of the shank over the weight bearing foot such that limit of closed chain eversion is reached, excess lateral postural sway outside the base of support may result in the medial border of the foot rising from the ground, forcing the foot into rapid inversion. As the foot goes into rapid inversion, the talocalcaenonavicular and the transverse tarsal joint are ultimately locked in supination (Norkin and Levangie, 1992) with subsequent damage to the lateral ligamentous complex of the ankle.

2.2.4 Lateral Dynamic Defence Mechanism of the Ankle Joint against Lateral Ankle Sprain

According to Snell, (2008), the ankle/foot complex derives its lateral dynamic stability from the fibularis longus and brevis muscles, initially called peroneal muscles. Fibularis longus attaches on the fibular bone and the base of the first metatarsal bone whereas fibularis brevis attaches on the fibular and medial cuneiform bone. Fibularis muscles evert the foot at the talocalcaneonavicular/subtalar and transverse tarsal joints.

Early research (Almquist, 1974: Bosien et al.,1955 and Freeman, 1965) argued that since the injury mechanism of lateral ankle sprain involves the weight bearing foot giving way into inversion and plantaflexion, contraction of the fibularis muscles (ankle evertors) may resist inversion and return the foot to a neutral position and hence prevent lateral ankle sprain. However, current research (Ashton-Miller et al., 1996; Isakov et al 1986 and Konradsen et al., 1997) hold a contradicting view to that of early research (Almquist, 1974: Bosien et al., 1955 and Freeman 1965) that fibularis defence mechanism is too slow to protect the ankle in case of sudden inversion injury. Ashton-Miller et al.1996 investigated what best protects the inverted weight bearing ankle against further inversion and found that the total estimated inversion time during lateral ankle sprain episode was 40 milliseconds while Isakov et al. 1986 investigated the response of the peroneal muscles to sudden inversion of the ankle and found that the evertor motor response occured between 82 and 84 milliseconds. These researchers therefore, concurred that lateral ankle sprain episode occurs within a very short period of time before the ankle evertors can contract to oppose the rapid inversion.

Similarly, Konradsen et al. (1997) investigated the role of muscular defence mechanism in protection of the ankle joint against sudden forced inversion and found that peroneal electromyographic activity occured 54 milliseconds after detection of ankle inversion. Hamstring and quadriceps electromyographic activity occured 68 milliseconds after ankle inversion. Active ankle eversion was seen 176 milliseconds after sudden inversion while active changes in hip and knee joints angles were even seen later. Konradsen et al. (1997) then concluded that reflex reaction to sudden inversion is initiated at the peripheral level by the inversion motion followed by a reaction pattern mediated by the spinal or cortical centres and such peripheral and central reactions seem too slow to protect the ankle against lateral ankle sprain. Therefore, the findings by Ashton-Miller et al. (1996), Konradsen et al. (1997) and Isakov et al. (1986) concurred that fibularis defence mechanism is too slow to protect the ankle in case of sudden inversion injury.

2.2.5 Lateral Static Defence Mechanisms of the Ankle

There is a general consensus amongst various researchers (Bozkurt and Doral., 2006 and Snell, 2008) that ankle/foot complex derives its lateral static stability from the anterior talar fibular ligament (ATFL), the calcano fibular ligament (CFL) and posterior talar fibular ligament (PTFL) (figure 2.1). In addition to providing lateral stability, these ligaments guide ankle motion and provide proprioceptive input to the ankle/foot complex (Safran et al, 1999).

Figure 2.1: The lateral ligaments of the ankle/foot complex
Source: http://img101.imageshack.us/i/footlig1yf6.jpg/

ATFL is intracapsular and approximately 2-5 mm thick and 20-25 mm long and in addition to providing talocrural joint stability, it stabilizes the talofibular joint (Burks and Morgan, 1994). It is taut in plantaflexion and it is the weakest component of the lateral ligamentous complex (Safran et al, 1999). Its strength is half that of CFL and it is the first ligament to be injured in lateral ankle sprain (Fong et al, 2009). CFL is extracapsular and approximately 6mm wide. This ligament is covered by the fibularis muscle tendons (Safran et al, 1999). CFL is the major limiting ligament to

inversion of the talocalcaneal joint (Snell, 2008).PTFL is the strongest of the lateral ligamentous complex (Burks and Morgan, 1994). This ligament is rarely injured because it is taut in extreme dorsiflexion of the talocrural joint, a position that is rarely assumed (Safran et al, 1999).

2.2.6 The Relationship between Fibularis Muscle Strength and Lateral Ankle Sprain

Kaminiski et al. (1999) hold contradicting views to those of Almquist (1974), Evans et al. (1984), and Kannus and Renstrom (1991) about the presence of fibularis muscle strength deficits in those with history of lateral ankle sprain. Kaminiski et al. (1999) compared concentric, eccentric and isometric evertor strength in 21 subjects with unilateral ankle sprain to 21 matched healthy controls and concluded that those who suffered unilateral ankle sprain had no eversion strength deficits while Almquist (1974) and Evans et al. (1984), and Kannus and Renstrom (1991) found that those with history of lateral ankle sprain had fibularis muscle strength deficits. Almaquist (1974) and Evans et al. (1984) associated such deficits in fibularis muscle strength with inability to resist inversion and thereby prevent lateral ankle sprain. However, the sample sizes of the studies carried out by Evans et al. (1984) and Almquist (1974) were small and furthermore, strength deficits were determined through manual strength testing which is a subjective and crude form of muscle strength evaluation as alluded by Lamb ,(1985).

The conclusion drawn by Kaminiski et al. 1999 that those who suffered unilateral ankle sprain had no eversion strength deficits is more acceptable than that of Evans et al. (1984) and Almquist (1974) because Kaminiski et al. (1999) had adequate statistical power (80 %) and used isokinetic dynamometer to assess peak torque for the motion of ankle eversion which is a much more accurate, reliable and objective form of muscle strength evaluation (Orri and Darden 2008) than manual strength evaluation which was used by Evans et al. (1984) and Almquist (1974).

Interestingly, Wilkerson et al. (1997) and Munn et al. (2003) concurred that subjects with lateral ankle sprain did not show deficits in the evetor strength but rather showed strength deficits in the invertors of the ankle/foot complex. Wilkerson et al. (1997) and Munn et al. (2003) therefore concluded that weakness of the invertors rather than evertors may contribute to lateral ankle sprain as the eccentric action of the invertors assist in controlling lateral postural sway by limiting closed chain eversion. As reasoned by Munn et al., (2003), If the body is displaced laterally and eccentric action of the invetors fail to control lateral movement of the shank such that full closed chain eversion is reached, further lateral displacement of the body beyond lateral border of the fixed foot may result in medial border of the foot rising from the ground in turn forcing the foot into rapid inversion thus resulting in damage to the lateral ligamentous structures of the ankle. Similarly, McKnight and Armstrong (1997) reported no deficits in eversion strength but rather inversion strength deficits in subjects with history of lateral ankle sprain.

2.2.7 Factors that are associated with Lateral Ankle Sprain

Several factors have been associated with increased risk for lateral ankle sprain. In a study that investigated the influence of foot positioning on ankle sprains, Wright et al. (2000) found that, increased plantar flexion angle at touchdown was associated with increased lateral ankle sprains. Wright et al. 2000 explained that increased touchdown plantar flexion may be the mechanism which causes ankles with history of lateral ankle sprains to have increased risk of recurrent sprains. Wright et al.(2000) argued that the more the foot was plantar flexed at touchdown, the greater the incidence of excessive supination which may damage the ATF ligament because this ligament is loaded when the foot is plantar flexed and supinated. Similarly, Ekstrand and Tropp (1990) reported an increased risk for lateral ankle-ligament injury in athletes who had suffered a prior lateral ankle sprain. Their argument was that injury to the ankle ligaments also results in damage to the sensory/ mechanoreceptors in these ligaments which may impair the feedback needed to retain well-functioning central motor programs. The injury might directly alter the motor programs so that abnormal, injury-related motor performance occurs when an ankle is perturbed. In contrast, a study done by Baumhauer et al, 1995 on school athletes revealed no increased risk for lateral ankle sprain after suffering a prior ankle sprain.

One explanation for these findings may be that the condition of the joint after injury not only depends on the associated damage to the ligaments and muscles, but also on what type of rehabilitation was given and whether or not the subject complied with the rehabilitation program or not.

Furthermore, Joint laxity, which refers to lack of joint stability (Snell, 2008), has been considered to be a risk factor for lateral ankle sprain. Chomiak et al., (2000) reported 12 % incidence of lateral ankle sprains among soccer players with excessive joint laxity, measured with anterior drawer and talar tilt tests. These researchers concluded that since ankle/foot complex derives its lateral static stability from the lateral ligamentous complex, laxity of these ligaments may result in lateral instability of the ankle/foot complex such that players may easily go into excessive supination.

According to Watson (1999) and Milgrom et al. (1991), height and weight are risk factors for sustaining lateral ankle sprain. Watson, (1999) found that male soccer players who sustained lateral ankle sprain were much taller than those who did not. Similar results were reported by Migrom et al. (1991) who found that during training, military recruits who were taller and heavy were at risk of lateral ankle sprain. In contrast, Beynnon et al. (2001) who were in agreement with Sitler et al. (1994), found that weight and height were not independent factors for sustaining lateral ankle sprain.

Ostenburg and Roos, 2000 reported that age was associated with lateral ankle sprain. Ostenburg and Roos, 2000 reported higher Injury rates amongst older netball players than younger players. Similar results were reported by Stevenson et al., 2000 and Knapik et al, 2001.

Decrease in balance has been associated with lateral ankle sprain by Mcguine et al, (2000). According to the findings by Mcguine et al, (2000), subjects with increased postural sway scores, demonstrated by failure to maintain single leg stance for 15 seconds, had 7 fold increase in ankle sprains compared with those with normal sway. Contrary to the above findings by Mcguine et al, (2000), Beynnon et al. 2001 studied collegiate soccer, lacrosse and field hockey players who had not suffered prior ankle sprain and found no relationship between postural sway score and risk of ankle sprain.

2.2.8 Diagnosis of Lateral Ankle Sprain

There is general consensus amongst various researchers (Safran et al.1999 and Fong 2009) that accurate diagnosis of lateral ankle sprain is key to successful management of this injury. Safran et al.1999 emphasised that Magnetic resonance imaging (MRI) is of great diagnostic value for lateral ankle sprains and that it reveals thickening of the capsule associated with lateral ankle sprain. One other investigation method used to diagnose lateral ankle sprain is the anterior drawer test (Brukner and Khan, 2005). However, this method has limited reliability, particularly if it is negative because of muscle guarding.

Furthermore, Raatkanen et al., 1992 argues that unless there is a fracture or dislocation, X-rays are not of great diagnostic value because ligamentous tears are not visible on X-rays. The Ottawa ankle rules stipulates that tenderness in the posterior half of the lower 6 cm of the fibular/ tibia and inability to weight bear immediately following inversion injury are indicators to obtain radiographs to rule out fractures of the ankle (Stiell et al., 1994).

2.2.9 Management

2.2.9.1 Treatment

Different researchers (Safran et al., 1999, Pollard et al., 2002 and Wolfe et al., 2001) are in agreement that the initial management of lateral ankle sprain focuses on limiting pain, further injury, hemorrhage and subsequent edema through the use of rest, ice, compression and elevation (RICE) in addition to electrotherapy and non steroidal anti-inflammatory drugs.

Despite that no clear evidence of evertor strength deficits exists in those with history of lateral ankle sprain, current practice advocates for strengthening evertor muscles as a key component of lateral ankle sprain rehabilitation protocol (Docherty et al.,1998 : Alisson and Eammon, 2009:

Bruckner and Khan, 2005). However, what these authors failed to address with evidence was whether increased evertor strength translates into protection against lateral ankle sprain.

The third phase focuses more on restoring proprioception and independence in functional activities (e.g. jumping, hopping twisting, and figure of eight running) which are progressed to sport specific activities (Pollard et al., 2002). Return to sport is allowed if functional exercises can be done without pain during or after the activity (Pollard et al., 2002).

2.2.9.2 Prevention of Lateral Ankle Sprain

Ankle taping, special shoes, bracing and proprioceptive exercises are used to prevent lateral ankle sprain (Shapiro et al., 1994). Cordova and Ingersol (2003) demonstrated that initial application of a lace up ankle brace and prolonged use of semi-rigid brace facilitates the amplitude of the peroneus longus stretch reflex. Pederson et al, (1997) and Shapiro et al. (1994) demonstrated 50% decrease in the stabilization effect of ankle tape in as little as 10 minutes of exercise. Secondary to this deterioration of support and the cost of tape, re-usable ankle braces were made (Shapiro et al., 1994). According to Sitler et al., (1994), ankle braces are effective if not more effective than tape in preventing lateral ankle sprain. Sitler et al., (1994) reported that ankle injuries are more than tripled in the non braced volley ball players as compared to the braced subjects. One possible rationale is that the use of ankle tape or brace increases the kinesthetic awareness of ankle positioning and limits hindfoot motion especially inversion (Shapiro et al., 1994).

2.3 Conclusion

Various researchers have drawn contradicting conclusions about the relationship between fibularis muscle strength and lateral ankle sprain. Clearly, the literature is divided about the presence of fibularis muscle strength deficits in those with history of lateral ankle sprain. However, dispite this conflict, current practice as alluded by many researchers, for instance Wilkerson et al. (2007), considers strengthening of the fibularis muscles to be a key component of lateral ankle sprain rehabilitation protocol. Why current practice advocates for the strengthening of the fibularis muscles when rehabilitating lateral ankle sprain injuries is not clear. Therefore, is there any relationship between fibularis muscle strength and lateral ankle sprain, that warrants strengthening of the fibularis muscles ? Unless clear evidence of weakness of the fibularis muscles exists in netball players, eversion strength training may be unnecessary. The current study therefore, aims at establishing whether a relationship exists between fibularis muscle strength and lateral ankle sprain. The study is presented in the following chapters.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this chapter was to elucidate the study design and the methodology used in this study.

3.2 Study Design

The quantitative approach design was adopted for the current study that was conducted over a period of 4 months (March to June 2009) of high school netball season. The rationale behind adoption of the quantitative design was because it enabled the researcher to examine relationship between independent variables (Height, weight, age balance and muscle strength) and the dependent variable (lateral ankle sprain).

3.3 Study Population

There are 36 high schools In Gauteng Northern Region. Twenty two (22) out these 36 high schools had netball teams and therefore a total of 330 netball players. Twenty (20) out of 36 high schools had netball teams which played at level A and/or B, and were involved in at least one netball practice and/ or match in a week (active teams).Therefore, there were a total of 300 active netball players in Gauteng Northern Region.

NB: Level A/or B refers to teams at high level of performance i.e. members of teams who represented schools in competitions or tournaments.

3.4 Sample Selection

3.4.1 Sampling Frame

The sampling frame was 20 out of 36 high schools with active netball teams from Gauteng Northern Region.

3.4.2 Sampling Method

The study population, which was 36 high schools from Gauteng Northern region, was stratified into two groups of 22 schools with netball teams and 14 schools without netball teams. The group that comprised of 22 schools with netball teams was selected for further sampling while the group with 14 schools without netball teams was left out of the study. Out of 22 schools that had netball teams, teams from 2 schools were not active. The group with 20 schools with active teams was retained for further sampling because in the researchers opinion, active netball teams had much

more increased likelihood of sustaining lateral ankle sprain because they were involved in regular netball practices, represented schools in matches and tournaments which predisposed them to lateral ankle sprain injuries. Out of 20 schools with active teams, 10 schools were randomly selected. From each of the 10 randomly selected schools, 10 subjects were randomly selected to generate 100 randomly selected subjects. This was mainly because by convention, 10 subjects must be included per risk factor with a preferred sample size of 100 subjects. This powered the study at 90 percent. The following diagram summarises the sampling procedure (Figure 3.1).

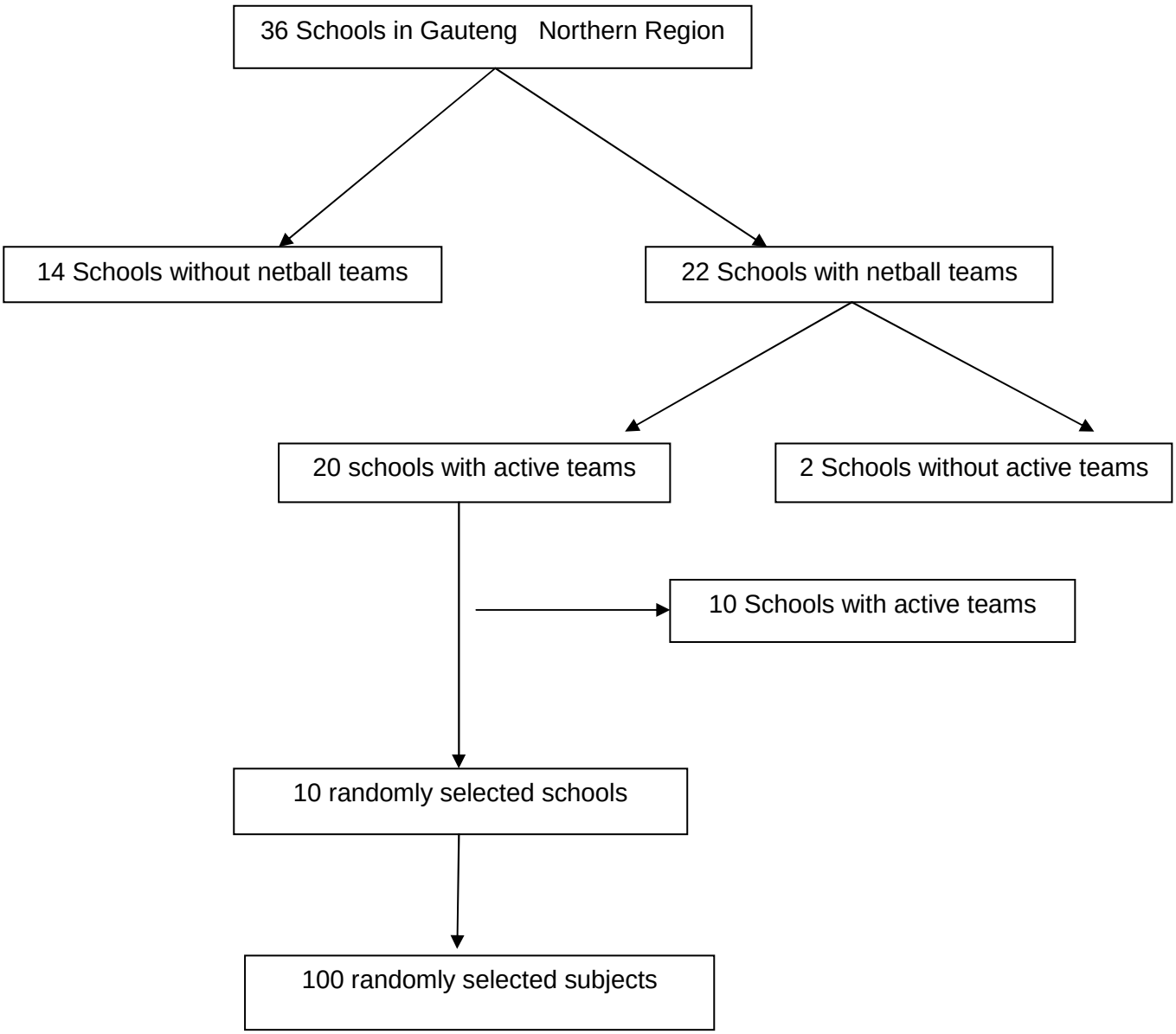


Figure 3.1: Sampling procedure

STATA software was used to generate random numbers that were used to pick ten schools. From each school, ten subjects were chosen making a total of 100 subjects using randomly generated numbers from STATA (figure 3.1).

3.4.2.1 Inclusion Criteria

100 high school female netball players ranging in age from 13 to 19 years (mean ± SD = 16.5 ±1.27) participated in this study. Subjects were included in the study if they:

- had no pain at the ankle or foot (Lentell et al. 1990);
- Played at level A and /or B; and
- Participated in at least one netball practice and/ or match in a week.

NB; Female netball players who played at level A and/or B or who participated in at least one netball practice and /or match per week were included in the study because they were at high risk of sustaining lateral ankle sprain injury. Being at high level of performance and frequently participating in matches and practices predisposed netball players to lateral ankle sprain injuries.

3.4.2.2 Exclusion Criteria

Excluded from the study were female netball players from High schools in Gauteng Northern region who:

- had subtalar inversion disability;
- had pain in the ankle or foot; and
- used ankle supports.

The exclusion criteria is based on the researcher's opinion, which is supported by Ekstrand and Tropp, (1990) who argued that those with previous ankle sprains were at higher risk for subsequent lateral ankle sprain injuries. Furthermore, Wright et al. (2000) explained that ankles with history of lateral ankle sprains had increased risk of recurrent lateral ankle sprains because of increased touchdown planta flexion angle. Wright et al.(2000) argued that the more the foot was plantar flexed at touchdown, the greater the incidence of excessive supination which may damage the ATF ligament because this ligament is loaded when the foot is plantar flexed and supinated.

3.5 Ethical Considerations

As noted by Freed - Tailor (2003), a research should be conducted in an ethical manner to avoid infringing on the rights of the parties involved. Therefore, to ensure that ethical considerations were upheld while conducting this study, subjects were informed of test procedures and written consent was obtained before data collection. The following steps were taken.

- Ethical clearance certificate (Appendix H) was obtained from Human Research Ethics Committee at the University of the Witwatersrand.
- Permission to conduct this study in High Schools in Gauteng Northern region was obtained from Gauteng Province-Department of Education (Appendix A2).

- Further permission to conduct this study was obtained from principals of all high schools with active netball teams and at level A and /or B in Gauteng Northern Region (Appendix B).
- Consent was obtained from all netball players from High schools in Gauteng Northern Region that were involved in netball practices, games and tournaments (active teams) and that were at level A and/or B (Appendix D).
- Subjects or guardians/parents for subjects below 16 years of age gave consent on behalf of the subjects.
- Subjects were:
    - Given information sheet (Appendix C)
    - Warned about the possibility of discomfort from pressure generated by hand held dynamometer.
    - Informed that the study or the procedure was without negative repercussions to their ability to take part in netball practices, games or tournaments.
    - Given the freedom not to participate and withdraw from the study at any stage.

3.6 Instrumentation

To evaluate ankle evertor or invertor muscle strength, current research (Munn et al 2003: Wilkerson et al. 1997; Kaminiski et al.1999: Yildiz et al.2003) used and advocate for isokinetic dynamometer which is a much more accurate, reliable and objective form of muscle strength evaluation (Orri and Darden 2008). Isokinetic dynamometer can evaluate isometric, concentric and eccentric muscle strengths (Houglum 2010, Kaminiski et al. 1999) and it offers resistance at a constant speed, so the amount of resistance varies through the range of motion (Houglum 2010). This is sometimes referred to as accommodating resistance (Houglum 2010). Munn et al.(2003) emphasised that it is critical to evaluate eccentric evertor strength in functional ankle instability because of the biomechanical role the evertors have in preventing ankle sprain and the need to measure strength specific to contraction type. Apart from Isokinetic dynamometer, other methods/instruments used to evaluate muscle strength include Cable tensiometers such as Hand held dynamometers which can evaluate only isometric strength, Free weights/weight machines which can evaluate 1 Repetition Maximum (1RM) and Manual Muscle Testing which mostly relies on gravity to evaluate muscle strength (Houglum 2010).

Although it would have been more ideal and acceptable to use isokinetic dynamometer to measure eccentric fibularis muscle strength in this study, because there is a need to measure strength specific to contraction type as the evertors are required to contract eccentrically to counteract the initial invertor moment and stop the ankle being forced into inversion (Miller et al. 1996) , the nature of this study, i.e. 100 subjects all at 10 different schools scattered around Gauteng Northern Region , made it very difficult to carry isokinetic dynamometer to these schools nor bring 100

subjects to the station where isokinetic dynamometer could be located. Furthermore, Isokinetic dynamometer is a very expensive, heavy and highly sensitive machine that is usually mounted on the floor. Therefore, instead of using isokinetic dynamometer to evaluate fibularis muscle strength, the researcher found it more appropriate to use a portable digital Hand Held Dynamometer(HHD) (discussed below) which is a reliable and valid tool for measuring muscle force or torque in adults (Bohannon, 1999). Digital HHD only measures isometric strength. Therefore, the researcher could only measure isometric strength. In their study that looked at isometric strength measurements as predictors of physical performance in college men, Guy et al. 1996 concluded that isometric strength measurements were significantly related to power performances.

3.6.1 Hand Held Dynamometer (MicroFET II HHD)

A hand-held dynamometer is a battery-operated electronic device consisting of strain gauges that records force in Newton or pounds. MicroFET II HHD was chosen because it measured both perpendicular and non perpendicular forces applied to the plate head, which was important when assessing forces generated at the ankle joint (Reese, 2005). The sensitivity (0.1 lbs) and range (0.8–150 lbs) of the HHD is within the force ranges produced by children (Berry et al, 2004) and adults (Bohannon, 1999).

HHD Micro FET II is a reliable and valid tool for measuring muscle force or torque in adults (Bohannon, 1999) and children (Berry et al, 2004). The researcher had experience in using MicroFET II HHD from previous working environment.

3.7 Outcome Measures

Lateral ankle sprain was the outcome measure. This was identified by pain on the lateral aspect of the ankle joint after the netball player landed from a jump with the ankle and/or sub talar joint in planta flexion and inversion respectively.

3.8 Variables

Fibularis muscle isometric strength, body weight, height, age and balance were the independent variables

Lateral ankle sprain was the dependent variable.

3.9 Procedure

- The researcher made appointments to go to the schools.
- Information sheets (Appendix C) were distributed by the researcher to all high school netball players in Gauteng Northern Region who were involved in netball practices, games and tournaments and that were at level A and or /B.
- Subjects filled in consent forms.

- Subjects below the age of consent (16 years of age) who were at level A and /or B and were involved in netball practices, games and tournaments (active teams), who were willing to participate in the study were given the consent form (Appendix E) to give to their parents or guardians to consent on their behalf. Players returned the forms to the netball coaches and the researcher collected the consent forms from the coaches.
- Three weeks before the beginning of the netball season, the researcher took baseline measurements for fibularis isometric strength for each leg, body weight, age, height and balances for the 100 subjects and recorded them in a table (Appendix G). The researcher noted the type of surfaces on which games and practices were held.
- Subjects were taught how to fill in injury assessment form (Appendix F)
- Injury assessment forms were left with the coaches
- At the end of each practice, match or game, only those subjects who sustained lateral ankle sprain filled in the injury assessment form and immediately returned them to the coaches.
- The researcher collected the injury assessment forms from the coaches on Monday of every week until the end of the netball season (From beginning of March 2009 until the end of June 2009).
- Data was transferred from the injury assessment forms into Microsoft excel.
- From Microsoft excel, data was exported to STATA 10 software then analysed.

3.10 Procedure for Measurement of Fibularis Muscles Isometric strength

The researcher used digital HHD II to test isometric strength of the fibularis muscles as described by Reese, (2005).

3.10.1 Subject Position

The subject was in supine lying with the knee joint extended. The ankle that was tested was in neutral position and the subtalar joint was everted.

3.10.2 Stabilization by the Researcher

The researcher stabilised over the medial aspect of the distal leg.

3.10.3 Dynamometer Placement /Resistance

The area of the skin over the lateral aspect of the ankle that was tested, just distal to the base of the fifth metatarsal, was cleaned with methylated spirit.

Dynamometer was placed over the lateral aspect of the foot just distal to the base of the fifth metatarsal (Figure 3.2).

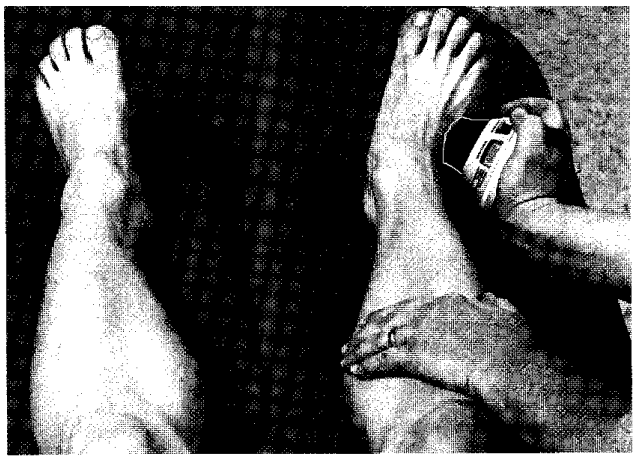


Figure 3.2: Fibularis longus and brevis muscles isometric strength measurement (scanned from, Muscle and sensory testing (2nd Ed) (Reese, 2005)

- Verbal cue (go) was given when the subject must start the isometric fibularis muscle contraction.
- The subject was instructed to push as hard as she could into subtalar eversion against the dynamometer and sustained the contraction for 5 seconds.
- Resistance was applied perpendicular to the lateral aspect of the foot in the direction of subtalar inversion and was held for 5 seconds.
- Three readings were taken with 30 seconds rest between each reading to avoid muscle fatigue (Keating and Matyas, 1996)
- The mean of the 3 readings was calculated and recorded for each leg.

3.11 Procedure for Measurement of Balance

The Stork Balance Stand Test was used to measure balance as per recommendations by Tritschler, 2000.

Procedure:

- The subject removed the shoes and placed the hands on the hips, then positioned the non-supporting foot against the inside knee of the supporting leg.
- The subject was given one minute to practice the balance.
- The subject raised the heel of the supporting leg to balance on the ball of the foot.
- The researcher started the stopwatch as the heel was raised from the floor.
- The stopwatch was stopped if any of the follow occurred:
- The hand(s) came off the hips
- The supporting foot swivelled or moved (hopped) in any direction
- The non-supporting foot lost contact with the knee.
- The heel of the supporting foot touched the floor.

Scoring:

The total time in seconds was recorded. The score that was used was the average of the three attempts.

3.12 Procedure for Measuring Body Weight

The researcher weighed the subjects using the guideline as per the recommendations by the manufacturer of the bathroom scale.

- The bathroom scale was put on a flat surface.
- The scale was reset to zero.
- A known 1 kg mass was weighed by the researcher to insure the accuracy of the scale
- The subject tapped the scale with the ball of the foot and released it.
- After the scale had displayed 0.0 reading.
- Bare footed, the subject gently stepped on the scale and waited until the reading had stabilised.
- Three readings were taken and the mean was recorded by the researcher as the score.

3.13 Procedure for Measuring Height of the Subjects

- A talor's metric tape measure was secured to the wall and perpendicular to the ground.
- Barefooted, the subject stood against the tape and her height was measured by the researcher.
- The reading was taken at a point perpendicular to and touching the vertex of the head.

3.14 Pilot Study

A convenient sample of 10 subjects was choosen from one school where the researcher measured height, weight balance and fibularis muscle strength 3 times for each subject. The outcome was analysed through analysis of varience (ANOVA) and there was no statistical difference between the first, second and third reading.

Secondly, there was a need to conduct a pilot study to ascertain the construct validity of the injury assessment which was adopted from Fuller et al, (2006) and modified to suit netball. Subjects did not have difficulties filling in the form. Therefore, there was no need to change the content of the injury assessment form that was used in the main study. Subjects who participated in the pilot study were not included in the main study. It is important to note that testing for Construct validity testifies as to how well the results obtained from the use of the measure fit the theories around which the test is designed, which is as observed by Chinapaw et al, (2009).

Finally, the pilot study findings indicated that non of the subjects sustained lateral ankle sprain. In the researchers opinion the implication was that when carrying out the main study the result will be skewed towards not having a sprain.

3.15 Intra-rater Reliability

First and foremost, the researcher ensured that he personally took the measurements as he has a lot of experience in using Hand Held Dynamometer the outcome of which would be consistency in taking measurements. The researcher has 8 years experience in using the digital Hand Held dynamometer in a sports clinic which managed sports injuries sustained by players from soccer, netball and rugby sport codes. In addition to personally taking the measurements, the researcher went on to take means of 3 readings when evaluating strength, weight, balance and height of the subjects. In the researcher opinion, this enhanced the intra-rater reliability. Furthermore, a pilot study conducted by the researcher also went on to indicate that there was no statistical difference between the first second and third readings of measurements relating to muscle strength, weight and balance

3.16 Statistical Analysis

The gathered information was coded and captured through the use of Microsoft Excel. Data manipulation was executed by the use of Statistical Software for Social Sciences (SPSS) and in the process the relationship between independent variables and dependent variable was established through multiple regression analysis method. To test whether the skewed findings from the study had any impact on the relationship between independent variables and dependent variable, Wilcoxon's ranksum t-test was utilised. Data was interpreted through the use of percentages, means, standard deviations and p-value that was measured at 95% level of confidence. On the other hand data presentation took place in form of tables and pie charts.

Focusing on Wilcoxon's rank sum t- test, subjects who sustained lateral ankle sprain were compared with those who did not with respect to fibularis muscle strength, balance, age, height and weight using the Welch t-test which adjusted for unequal variances. Since the sprain group was very small (N=5), Wilcoxon's ranksum test was also interpreted. If Wilcoxon's ranksum t-test was significant ($p < 0.05$) whilst the Welch t-test was not, the former was accepted. Where both the Wilcoxon's ranksum and the Welch t-tests were significant, the Welch t-test was accepted.Where the Welch t-test was significant whereas the Wilcoxon's ranksum t-test was not, the Welch t-test was accepted. All this along with descriptive statistics i.e. mean, standard deviation and 95 % confidence interval was considered exploratory, particularly with respect to sprain group.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents description and analysis of the data of this study. The study sample consisted of 100 female netball players. All 100 subjects played on flat grounds.

4.2 Presentation of Findings

The first part of the analysis was descriptive. The last section was analytical and examined factors closely associated with lateral ankle sprain in a multivariate logistic regression analysis.

KEY:
sd = standard deviation
CI = Confidence interval
* = P -value was statistically significant ($p < 0.05$).

4.3. Demographic Data

The data collected was of age, height and weight. The results are illustrated in the following tables.

4.3.1 Age

Table 4.1 Age distribution of subjects

Age (years)	Frequency distribution (N=100)
13	3
14	3
15	7
16	33
17	33
18	14
19	7

The results showed that subjects who participated in the study ranged in age between 13 -19 years. Majority of the subjects (66 subjects) were 16 and 17 years old.

As shown in Figure 4.1, the age of the sampled population ranged between 13 and 19 years. The majority however (66%) were between 16 and 17 years. All subjects were females.

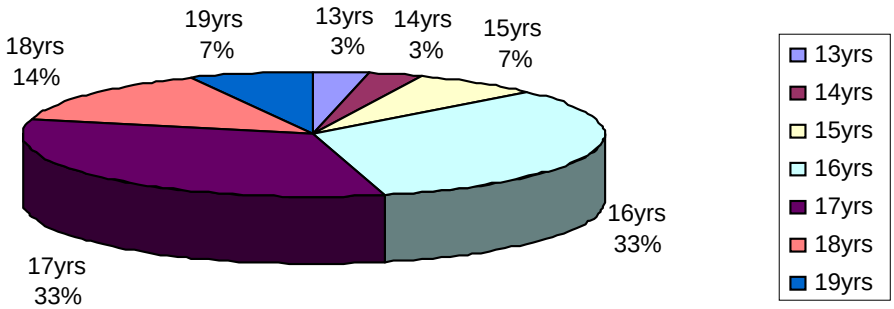


Figure 4.1: Age

4.3.2 Weight

Table 4.2 Weight distribution of subjects

Weight (kg)	Frequency distribution (N=100)
41-50	30
51-60	34
61-70	20
71-80	12
81-90	3
91-100	1

The results showed that 34 out of 100 subjects in this study were in the 51-60 kg weight category and these were majority. Furthermore, only 1 subject was in the 91-100 kg category.

Figure 4.2 shows that majority of the subjects (34%) weighed between 51-60 kg while only 1% was in the 91-100 kg category.

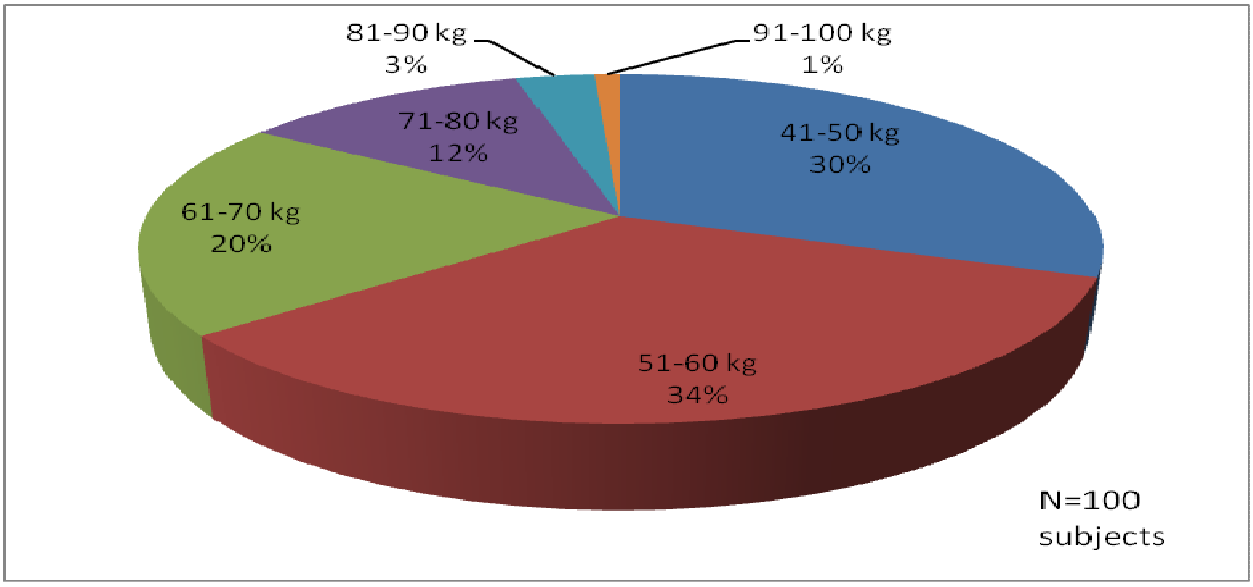


Figure 4.2: Weight

4.3.3 Height

Table 4.3 Height distribution of subjects

Height (cm)	Frequency distribution (N=100)
140-150	**10**
151-160	**44**
161-170	**36**
171-180	**9**
181-190	**1**

The results show that 44 out of 100 subjects in the study were in the 151-160 cm height category and only 1 subject was in the 181-190 cm height category**.**

Figure 4.3 shows that majority of the subjects (44%) were in the 151-160 cm Height category while only 0ne subject (1%) was in the 171-180 cm Height category**.**

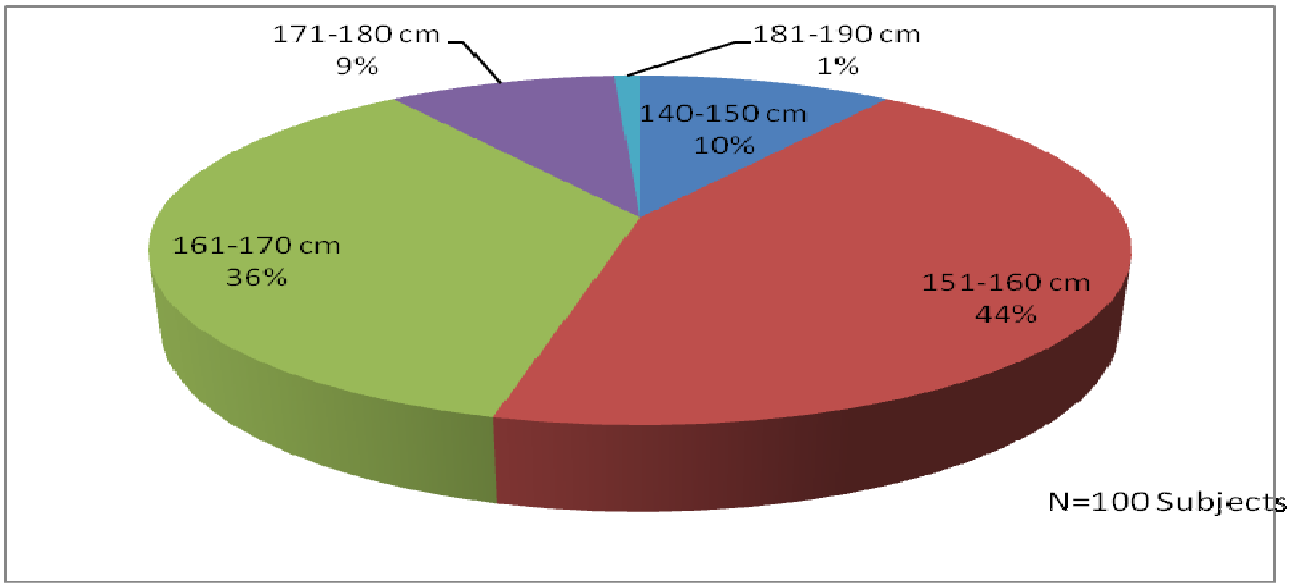


Figure 4.3 Height

4.4 Functional Attributes

The strengh and the balance of the participants was tested prior to the start of the netball season.The results thereof are illustrated in table 4.4 and 4.5**.**

Table 4.4 Strength distribution of subjects

Strength (Newton)	Frequency distribution (N=100)	
	Left side	Right side
5-25	5	3
26-35	12	30
36-45	34	38
46-55	31	22
56-65	16	7
66-75	2	0

The lowest strength in all subjects was 17.1 N and the highest was 67.8 N. For easy presentation of data for 100 subjects, categories were created with an interval of 10 and were used to illustrate the results.

The results show that majority of the subjects (38 out of 100 subjects) had right fibularis muscle strength that was within 36-45 N strength category. Likewise, majority of the subjects (N=34) had left fibularis muscle strength that was within 36-45 N strength category.

Table 4.5 Balance distribution of subjects

Balance (Seconds)	Frequency distribution (N=100)	
	Left side	Right side
1-5	70	63
6-10	22	23
11-15	2	6
16-20	3	3
21-25	2	2
26-30	0	1
31-35	0	0
36-40	1	0
41-45	0	2

Table 4.5 above shows that majority of the subjects (70 subjects) had left leg balance that was within 1-5 seconds balance category.The results also show that most of the subjects had poor balance. However, none of the subjects had a balance score that fell within 31-35 seconds balance category**.**

4.5 Prevalence of lateral ankle sprain.

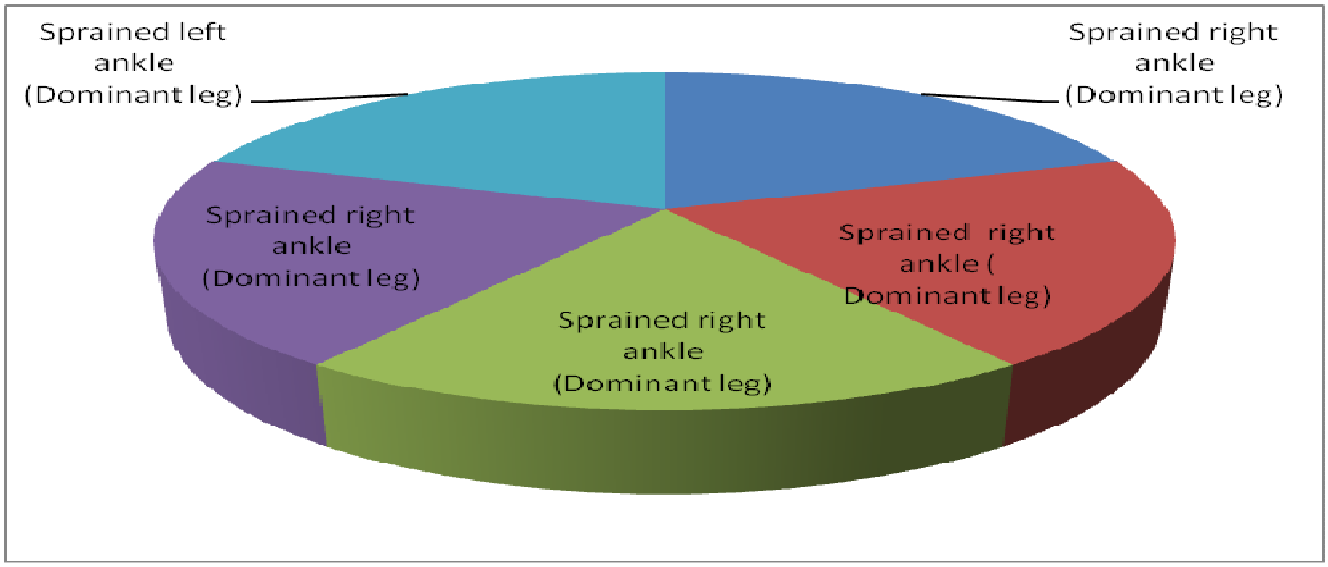
Table 4.6 : Sprain versus no-sprain

	SPRAIN	NO SPRAIN	TOTAL (N)
subjects	**5**	**95**	**100**
Prevalence	**5 %**		

The results in table 4.6 shows that out of a total of 100 subjects who participated in this study, 95 subjects did not sustain lateral ankle sprain whilst 5 subjects did. This gave a prevalence of 5 %

4.6 Leg Dominance of sprained subjects

From figure 4.4 below all subjects (N=5) who sprained their ankles, sprained their dominant legs. Except for one subject who sustained left ankle all four sprained their right ankles.



N=5

Figure 4.4 Leg dominance

4.7 Age and Sprain

Figure 4.5 shows that 60 percent (i.e three out of five) of those who sprained their ankles were in the 19 year old category.

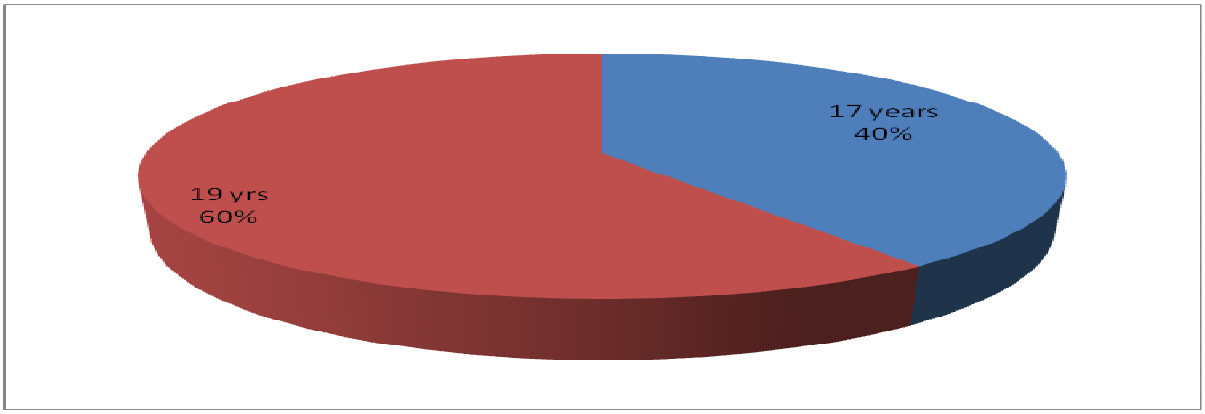


Figure 4.5 Age and Sprain

4.8 Association between demographic information and lateral ankle sprain.

The association between demographic information and lateral ankle sprain was analysed and the results are illustrated in table 4.7 below.

Table 4.7 The relationship between age, height, weight and lateral ankle sprain.

Variable		No Sprain (N=95)	Sprain (N=5)	Difference In Mean	P-Value
Age (years)	mean	16.5	18.2	1.68	
	± SD	1.24	1.10		0.022*
	95 % CI	(16.3-16.8)	(16.8-19.6)	(-3.00- -0.37)	
Height (cm)	mean	160.2	165.0	4.77	
	± SD	7.08	11.11		0.137
	95 % CI	(158.6-161.9)	(151.2-178.8)	(-18.34-8.81)	
Weight(kg)	mean	56.9	60.12	3.25	
	± SD	11.97	7.72		0.412
	95% CI	(54.4-59.3)	(50.5-69.7)	(-12.37-5.87)	

The results show subjects in the sprain group were older (mean age 18.2±1.1) than subjects in the no-sprain group (mean age 16.5±1.24).The mean age difference between the two groups (1.68 years) was statistically significant (p=0.022). However, the difference in mean height between the sprain and no sprain group was not statistically significant (p=0.137).Similarly, the difference in mean weight between the sprain and no-sprain group was not statistically significant (p=0.412).

4.9 Associations between functional attributes and lateral ankle sprain.

The association between fibularis muscle strength, balance and lateral ankle sprain was looked at and is presented in table 4.8

4.9.1 Relationship between Isometric Fibularis Muscle Strength and Lateral Ankle Sprain

At the beginning of 2009 netball season, baseline measurement of isometric fibularis muscle strength was recorded with a hand held dynamometer for each of the 100 subjects. The association between muscle strength and lateral ankle sprain was looked at in table 4.8 below.

Table 4.8 The association between Fibularis Muscle Strength and lateral ankle sprain.

Variable	No Sprain (N=95)	Sprain (N=5)	Difference in Mean	P-Value
Absolute difference in strength				
mean	8.22 N	11.95 N	3.73 N	
± SD	6.76	7.08		0.306
95 % CI	(6.84:-9.59)	(3.15-20.74)	(-12.30-4.83)	

As shown by table 4.8, the difference (3.73 N) between absolute difference in strength values between the no-sprain (8.22 N) and the Sprain group (11.95 N) was not statistically significant (P=0.306).

4.9.2 Relationship between Balance and Lateral Ankle Sprain

Baseline measurements of balance were obtained at the beginning of 2009 netball season, from each of the 100 subjects. Each subject balanced on one leg and 3 readings, measured in seconds, were taken for each leg. An average of these 3 readings was recorded. The analyses of the relationship between Balance and lateral ankle sprain is presented in table 4.9

Table 4.9 The association between balance and lateral ankle sprain

Variable	No Sprain	Sprain	Difference in Mean	P-Value
Balance right mean ± SD 95% CI	 6.6 seconds 7.04 (5.1-8.03)	 7.6 seconds 7.12 (-1.2-16.5)	 1.04 seconds (-9.64-7.56)	 0.764
Balance left mean ± SD 95% CI	 5.7 seconds 5.27 (4.62-6.77)	 3.09 seconds 1.02 (1.8-4.4)	 2.60 seconds (1.16-4.05)	 0.001*
Absolute difference in Balance mean ± SD 95% CI	 2.28 seconds 2.99 (1.67-2.89)	 4.9 seconds 7.35 (-4.23-14.03)	 -2.62 (-11.70-6.46)	 0.475

The results showed that the mean difference in balance for the left leg between the sprain and no sprain group was statistically significant ($p<0.05$).

4.10 Multivariate Logistic Regression of Factors Associated with Lateral Ankle Sprain

Age, strength and balance were regressed against lateral ankle sprain in a multivariate logistic regression analysis. The main reason why only age, strength and balance were regressed against lateral ankle sprain, while weight and height were not was because, from the comparison of the mean values between sprain and no sprain group, age and balance were found to be significantly associated with lateral ankle sprain.

Although muscle strength was not found to be significantly associated with lateral ankle sprain (table 4.8) when comparing mean values for the strength between the sprain and no sprain group, strength was regressed against lateral ankle sprain because it was the main factor being looked at in this study. Table 4.10 shows the results of the regression analysis.

Table 4.10 Factors Associated with Predicting Lateral Ankle Sprain

Variables	Odds ratios	95 % CI	P-value
Absolute Strength difference	1.12	0.94-1.32	0.202
Age	6.46	1.55-26.96	0.010*
Absolute balance difference	1.22	1.01-1.47	0.042*

Table 4.10 shows that a netball player was 6.5 times more likely to sustain lateral ankle sprain if they were older (p= 0.010) and that a netball player was 1.22 times more likely to sustain lateral ankle sprain if the balance was decreased (p= 0.042). Strength was not associated with lateral ankle sprain (p=0.202). Age and balance explained 38 % of the variance. Age and balance therefore, are predictors of lateral ankle sprain.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This study was set to establish the relationship between fibularis muscle strength and lateral ankle sprain amongst high school netball players in Gauteng Northern Region. Point prevalence for lateral ankle sprain during 2009 netball season and predictors of lateral ankle sprain were also determined. Furthermore, this study established the relationship between balance, demographic characteristics (age, weight and height) and lateral ankle sprain. Brief summary of the findings from this study is as follows:

Fibularis muscle strength was not significantly associated with lateral ankle sprain ($p< 0.05$). Out of 100 subjects who participated in the 2009 netball season, 5 subjects sustained lateral ankle sprain which gave a point prevalence of 5 % over 4 months period. Except for one subject who sustained left lateral ankle sprain, four sprained their right ankles. All subjects sprained their dominant side. Further findings from this study were that, balance and age were predictors of lateral ankle sprain ($p<0.05$) while height and weight were not significantly associated with lateral ankle sprain ($p>0.05$). These findings are discussed in the following paragraphs.

5.2 The Relationship between Fibularis Muscle Strength and Lateral Ankle Sprain

The results of this study (Table 4.8) showed that the difference (3.73 N) between absolute difference in strength values between No-Sprain (8.22 N) and Sprain group (11.95 N) was not statistically significant ($P=0.306$). Thus fibularis muscle strength was not significantly ($p=0.306$) associated with lateral ankle sprain.

The findings of this study are similar to those from current research by Kaminiski et al. (1999), Munn et al. (2003), and Wilkerson et al. (1997) who concluded that fibularis muscle strength is not associated with lateral ankle sprain but differed with those from early research by Bosien et al. (1955) and Freeman (1965) who found that fibularis muscle strength is associated with lateral ankle sprain. The results of this study differed from those by Bosien et al. (1955) and Freeman (1965) possibly because unlike this study which used Digital Hand Held Dynamometer which is a reliable and valid tool to evaluate muscle strength (Bohannon, 1999) , Bosien et al. (1955) and Freeman (1965) based their conclusion on strength deficits determined through manual muscle testing which is a crude and subjective form of muscle strength evaluation (Lamb ,1985).

Although this study used digital HHD and measured strength before sprain occurred while Kaminiski et al. (1999) and Wilkerson et al. (1997) used Isokinetic dynamometer and tested strength after sprain has occurred, the result of this study was similar to those of their studies in that evertors strength was not associated with lateral ankle sprain even though testing was done after the players had been injured. In the researcher's opinion, this could lead to the conclusion that literally there is no relationship between fibularis muscle strength and sprain because even though the research methodology for this study differed with that from the previous research, the findings were in agreement.

In the researcher's opinion, which is in accordance with the reasoning by Konradsen et al. (1997), once the ankle is in a potential lateral ankle sprain situation, fibularis muscles cannot contract fast enough to oppose the rapid inversion and both the talocalcaenonavicular and the transverse tarsal joint are ultimately locked in supination (Norkin and Levangie, 1992). The implication could be that, whether the fibularis muscles are strong or weak, once the ankle is in a potential lateral ankle sprain situation, the sprain is bound to occur because the fibularis muscles start contracting to oppose the inversion injury longtime after the injury has occurred and the joint is locked.

Based on the fact that the findings of this study are in accordance with findings from majority of the studies reviewed (Munn et al. 2003, Kaminiski et al. 1999 and Wilkerson et al 1997) even though the methodology differed, the researcher is of an opinion that, the suggestion by Bosien et al 1955 and Freeman 1965 and also as alluded by Wilkerson et al.(1997) as being common in current practice, that fibularis muscle strengthening exercises form an important component of the rehabilitation protocol following lateral ankle sprain injury would not seem warranted.

5.3 Prevalence

The other finding from this study was that out of 100 subjects who participated in the 2009 netball season in Gauteng Northern Region, five subjects sustained lateral ankle sprain which gave a prevalence of 5 % (Table 4.6).

The findings of this study (5 % prevalence of lateral ankle sprain) differed with those of other researchers (Yeung et al., 1994; Woods et al., 2003; Fong et al., 2009; Safran et al., 1999) who reported prevalence of 45-85 %.

In the researchers' opinion which is in line with the argument brought by Pintsaar et al, (1996), one possible reason why prevalence of lateral ankle sprain was low in this study compared to other studies could be that this study comprised of relatively younger subjects compared to other studies. The average age for this study was 16.5 ±1.27 while it ranged between 18 and 34 for other

studies (Yeung et al., 1994; Woods et al., 2003 and Fong et al., 2009). In accordance with the argument by Pintsaar et al, (1996), the researcher is of the opinion that unlike older subjects, younger subjects should still have very good vestibular function, proprioception and muscle strength which controlled substantial moments created by the ground reaction forces. This protected subjects from lateral ankle sprain. With good ankle balance, younger subjects adopted good ankle strategy to maintain the centre of gravity above the base of support during single leg stance as explained by Pintsaar et al, (1996). Therefore, it is not surprising that prevalence for this study (5 %) was lower than in other studies (45-85 %) which had much older subjects than this study.

Secondly, the prevalence for this study was lower than in other studies possibly because this study excluded subjects with history of lateral ankle sprain while other studies included them. In accordance with the conclusion drawn by Ekstrand and Tropp, (1990), subjects with history of lateral ankle sprain are at increase risk for subsequent ankle sprain injuries. Therefore, the researcher was of the view that those studies that included subjects with history of lateral ankle sprain reported high prevalence than this study.

As shown in figure 4.4, the findings of this study are that except for one subject who sustained left lateral ankle sprain , four sprained their right ankles. All subjects sprained their dominant side. Similar results were reported by Ekstrand and Gilquist (1983) who noted that 92 % of ankle injuries affected the dominant limb. In the researchers opinion which is in line with the argument brought by Beynnon et al.(2002) together with Ekstrand and Gilquist (1983), that most athletes place great demands on their dominant limbs, the researcher is of the opinion that as the non dominant leg remained behind supporting the body of the netball player, the dynamic leg took the first step or landed first which puts it at risk for lateral ankle sprain injuries.

Finally, comparison between five and 95 subjects could skew the results towards not sustaining lateral ankle sprain. As a result, the researcher used Wilcoxon's rank sum test to take this into consideration. It is worth mentioning that dominance was not taken into account when fibularis muscle strength was analysed because it could have been a coincidence that all 5 who sprained their ankles sprained their dominant sides. only left and right fibularis muscle strength were analysed and not strength of dominant vs non-dominant sides.

5.4 The Relationship between Balance and Lateral Ankle Sprain

The results of this study, as tabulated in Table 4.10, showed that a player was 1.22 times more likely to sustain lateral ankle sprain if the balance was decreased. ($p= 0.042$). Similar findings were reported by Mcguine et al, (2000) who showed that subjects with increased postural sway scores, demonstrated by failure to maintain single leg stance for 15 seconds, had 7 fold increase in ankle sprains compared with those with normal sway. In line with the argument by Munn et al 2003, the researcher is of an opinion that, if the body's centre of mass is displaced laterally and ankle

invertors fail to control lateral displacement of the shank over the weight bearing foot such that limit of closed chain eversion is reached, excess lateral postural sway outside the base of support may result in the medial border of the foot rising from the ground, forcing the foot into rapid inversion and subsequent damage to the lateral ligamentous complex of the ankle joint.

5.5The Relationship between Demographic Characteristics (Age, Weight and Height) and Lateral Ankle Sprain

This section covers the demographic characteristics of the sampled population

5.5.1 Age and Lateral Ankle Sprain

The results of this study have shown that the age of the sampled population ranged between 13 and 19 years. The majority however (66%) were between 16 and 17 years (table 4.1 and figure 4.1). 60 % (i.e three out five) of those who sprained their ankles were in the 19 year category (figure 4.5). Furthermore from Table 4.10, this study has shown that the netball player was 6.5 times more likely to sustain lateral ankle sprain if they were older (p=0.010). Apparently 19 years age category happens to be the category that comprises of the oldest subjects in the study.

Therefore, the researcher is of the view that the above results show that age was significantly associated with lateral ankle sprain. The findings of this study with regard to age and sprain are in line with the observation made by Ostenburg and Roos, 2000; Stevenson et al., 2000 and Knapik et al, 2001 that there were higher Injury rates amongst older netball players than younger players. The researcher's opinion was that older netball players had more years of training and playing experience which meant they may have previous exposure to lateral ankle sprain. In accordance with the conclusion by Ekstrand and Tropp, (1990) and Milgrom et al, (1991) that previous exposure to lateral ankle sprain is a risk factor for subsequent lateral ankle sprain injuries, the researcher was of the view that older subjects were more at risk of spraining their ankles than younger players.

As shown in Table 4.7, the results of this study showed that the difference in mean age of players that sustained lateral ankle sprain and that did not was 1.68 years and was statistically significant (p=0.022) and further, the logistic regression (table 4.10) showed further statistical significance(OR=6.46). As evidenced by figure 4.5, 60 % (i.e three out of five) sprains that occurred in this study came from the 19 years old category. In the researcher's conclusion of older players being 6.5 times more likely to sustain lateral ankle sprain which is in keeping with the findings by Ostenburg and Roos, (2000) and Stevenson et al, (2000), the older the subject the higher the risk for sustaining lateral ankle sprain.

5.5.2 Height and lateral ankle sprain.

This study showed that height was not significantly (p=0.137) associated with lateral ankle sprain as shown in table 4.7. The results of this study differed with those by Watson (1999) who argued that height is a risk factor for sustaining lateral ankle sprain. Watson (1999) is of the opinion that an increase in height proportionally increases the magnitude of the inversion torque that must be resisted by the ligaments and muscles of the ankle.

5.5.3 Weight and lateral ankle sprain

This study further showed that weight was not significantly (p=0.412) associated with lateral ankle sprain (table 4.7). Similar findings were reported by Sitler et al. (1994) who found that weight is not a risk factor for sustaining lateral ankle sprain. However, contrary to the findings by this study which are in accordance with the findings by Sitler et al. (1994), Milgrom et al. (1991) found that weight is associated with lateral ankle sprain arguing that an increase in weight proportionally increases the torque that must be resisted by the muscles and ligaments that span the ankle.

5.6 Predictors of Lateral Ankle Sprain

As shown in table 4.10, this study has revealed that a netball player was 6.5 times more likely to sustain lateral ankle sprain if they were older(P=0.010) and that a netball player was 1.22 times more likely to sustain lateral ankle sprain if the balance is decreased. Furthermore, the results showed that age and balance explained 38 % of the variance. Therefore, the researcher is of the opinion that age and balance are strongly associated with lateral ankle sprain. Hence age and balance are predictors of lateral ankle sprain. These predictors have been discussed in the previous paragraphs.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents conclusions and recommendations based on the findings of this study. Also included are the limitations encountered when conducting the study.

6.2 Summary of findings from the Study

The findings from the current study enabled the researcher to draw conclusions as well as make recommendations to the scholars, netball players, coaches, clinicians and Ministry of Sports and Recreation in the field of management of sports injuries. The findings from this study are presented in the following subsections.

6.2.1 Findings from the study

Findings from this study were as follows:

- There was no relationship between Fibularis Muscles (evertor) Strength and Lateral Ankle Sprain.
- Point prevalence of lateral Ankle Sprain Injuries during the 2009 netball season was 5 %.
- Balance was significantly associated with Lateral Ankle Sprain.
- There was an association between Age and Lateral Ankle Sprain.
- Height was not associated with Lateral Ankle Sprain.
- There was no association between Height and Lateral Ankle Sprain.
- Age and Balance were identified as predictors of Lateral Ankle Sprain.

6.2.2 Recommendations to the stakeholders

Recommendations to clinicians, netball players and Coaches , based on the findings of this study are::

- Strengthening Fibularis Muscles should not form a fundamental component of rehabilitation protocol for lateral ankle sprain injury because this study did not find significant association between Fibularis Muscle Strength and Lateral Ankle Sprain.
- Netball players must focus on balance training, if balance is reduced, because this study has shown that a player is 1.22 time likely to sprain if balance is reduced.

- Coaches must ensure that netball teams comprise of younger players because this study has shown that older players are prone to sprain their ankles than younger players.

6.2.3 Recommendation for Further Research

Since the prevalence of lateral ankle sprain was low for this study (5%), a study with a wider age range and a larger sample size representative of more regions in South Africa, needs to be conducted to compare if similar results may be obtained. Furthermore, ankle /foot complex type and shoe type in association with lateral ankle sprain should be looked at for further research. Although it was outside the scope of this study to establish the role that dominance play in fibularis muscle strength as well as subsequent influence on lateral ankle sprains, further research on this subject is recommended.

6.2.4 Limitations and Weaknesses of the study

Several limitations and weaknesses of this study were identified.

- Secondary to some logistical reasons, this study was limited to using Hand Held Dynamometer and evaluating isometric strength of the ankle evertors instead of using isokinetic dynamometer which could have evaluated isometric ,concentric and eccentric strength of the ankle evertors. It would have been more appropriate to evaluate eccentric fibularis muscle strength instead of isometric fibularis muscle strength because fibularis muscles contract eccentrically to control inversion movement. The difficulties in carrying isokinetic dynamometer to different schools during data collection or bringing 100 subjects to a station where Isokinetic Dynamometer could be located, compelled the researcher to use a Hand Held Dynamometer which is reliable and valid (Bohannon, 1999) ,portable and less expensive but limited to measuring isometric strength. As argued by Munn et al 2003, because of the biomechanical role the evertors have in preventing ankle sprain and the need to measure strength specific to contraction type, it is important to evaluate eccentric evertor strength in functional ankle instability.
- The stork Balance Stand Test used in this study is not localised to the ankle region only but can be influenced by injuries anywhere in the kinetic chain.

6.2.5 Conclusion

This study was aimed at establishing whether a relationship exists between Fibularis Muscle Strength and Lateral Ankle Sprain. The findings of this study enabled the researcher to draw a conclusion that there is no relationship between Fibularis Muscle Strength and Lateral Ankle Sprain which is in line with current research which was of the view that Fibularis Muscle Strength is

not associated with Lateral Ankle Sprain. After looking at the aim as well as the outcome of this study, it is in the researchers' opinion that the study has achieved its purpose and the problem stated was adequately addressed.

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APPENDIX A1

Braamfontein
Johannesburg

Gauteng Province
Department of Education

Dear Sir/Madam

RE: REQUEST FOR PERMISSION TO CONDUCT A STUDY IN ALL HIGH SCHOOLS IN GAUTENG NORTHERN REGION,

My name is Lesley Phokontsi. I'm a Physiotherapy Masters student from University of the Witwatersrand, Johannesburg.

This serves to request permission to conduct a research in all high schools in Gauteng Northern Region. The aim of the study is to establish the relationship between fibularis muscle strength and lateral ankle sprain among high school netball players in Gauteng northern region. The results of this study shall determine if there is a need to devise an exercise programme that may be used to strengthen fibularis muscles thus preventing lateral ankle sprain among high school netball players.

Two weeks before the beginning of the 2009 netball season, I intend to record baseline measurements (fibularis muscle strength, height, weight, age and balance) for each player. At the end of each practice, match, game or tournament, only those subjects who sustain lateral ankle sprain shall be expected to fill in the injury assessment form and immediately return it to the coach.

Yours sincerely
Lesley Phokontsi

APPENDIX A2

PERMISSION LETTER FROM GAUTENG DEPARTMENT OF EDUCATION

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Enquiries : Shadrack Phele MIRMSA

Enquiries Shadrack P

Tel. No. : [+2711] 355 0285

Thursday, 12 May 2011

Mr. Phokontsi Lesley
F 19
West Campus Village
WITS
2050, BRAAMFOMTEIN

Dear
Mr. Phokontsi Lesley

PERMISSION TO CONDUCT RESEARCH: PROJECT

The Gauteng Department of Education hereby grants permission to conduct research in its institutions as per application.

Topic of research : "The relationship between fibularis muscle strength and lateral ankle sprain among high school netball players in Gauteng Northern Region."

Nature of qualification : M.Sc. [Physiotherapy]

Name of institution : University of the Witwatersrand

Upon completion of the research project the researcher is obliged to furnish the Department with copy of the research report (electronic or hard copy).

The Department wishes you success in your academic pursuit.

Yours in Tirisano,
p.p. Shadrack Phele [MIRMSA]

TOM WASPE
CHIEF INFORMATION OFFICER
Gauteng Department of Education

Office of the DDG: IS & KM (CIO)
Room 1807, 111 Commissioner Street, Johannesburg, 2001 P.O.Box 7710, Johannesburg, 2000
Tel: (011) 355-1514/1507 Fax: (011) 355-0734/0833 E-mail: tomw@gpg.gov.za or elridar@gpg.gov.za

APPENDIX B

REQUEST LETTER TO THE HIGH SCHOOL PRINCIPALS

Room F19
West Campus Village
Braamfontein
Johannesburg

The Principal

Dear Sir / Madam

RE: REQUEST FOR PERMISSION TO CONDUCT A STUDY IN YOUR SCHOOL

My name is Lesley Phokontsi .I ‘m a Physiotherapy Masters student from University of the Witwatersrand, Johannesburg.

This serves to request permission from your office to conduct a study in your school. The aim of the study is to establish the relationship between fibularis muscle strength and lateral ankle sprain among high school netball players in Gauteng northern region. The results of this study shall

determine if there is a need to devise an exercise programme that may be used to strengthen fibularis muscles thus preventing lateral ankle sprain among high school netball players.

Two weeks before the beginning of the 2009 netball season, I intend to record baseline measurements (fibularis muscle strength, height, weight, age and balance) for each player. At the end of each practice, match, game or tournament, only those subjects who sustain lateral ankle sprain shall be expected to fill in the injury assessment form and immediately return it to the coach.

Yours sincerely
Lesley Phokontsi (Cell 0834336239)

APPENDIX C

INFORMATION SHEET

Introduction

Hellow. My name is Lesley Phokontsi. I am a Masters student from University of the Witwatersrand in Johannesburg. I'm conducting a study to establish the relationship between fibularis muscle strength and lateral ankle sprain among high school netball players in Gauteng northern region.

Request to take part in the study

I therefore, request you to take part in the study.

Two weeks before the beginning of the 2009 netball season, I intend to record baseline measurements (fibularis muscle strength, height, weight, age and balance) for each player. At the end of each practice, match, game or tournament, only those subjects who sustain lateral ankle sprain shall be expected to fill in the injury assessment form and immediately return it to the coach.

The importance of taking part in this study

This study shall determine if there is a need to come up with a fibularis muscles strengthening exercise programme that can be used to prevent lateral ankle sprains.

You are allowed not to participate in this study if you don't want to. The study or the procedure shall not compromise your ability to take part in netball practices, games or tournaments. You may feel slight discomfort from pressure generated by hand held dynamometer

Contacts

Lesley Phokontsi (Researcher) **Tel**.0834336239 **Email**: Lesleyphokontsi@yahoo.com

Supervisors:

Dr. Nonceba Mbambo Tel: 0117173702

Ms Siphe Mtshali Tel: 0117173702

Loging complaint

You are allowed to loge complaint to the researcher, supervisors (above) or the secretary and the chairperson of the research committee: Prof P Cleaton. Jones Wits Research Office, 10 th floor Senate House, East Campus TEL; 011-717-1234 FAX: 011-339-570

APPENDIX D

INFORMED CONSENT FORM

(For netball players above 16 years of age)

I (Name of netball player)……of ……. (Name of high school) hereby give consent to participate in a study in which measurement of my age, height, balance and muscle strength around both ankles shall be obtained before the beginning of 2009 netball season. I further give consent to fill in injury assessment form after each netball practice, match or tournament with effect from two weeks before the beginning of the netball season until the end of the season. I also consent to such further or alternative experimental measures as may be found necessary during the cause of this study

I understand that pressure from the devise that shall be used to measure muscle strength around my ankle may be uncomfortable.

The nature and the purpose of the purpose of the study has been fully explained to me by the researcher (Mr. Lesley Phokontsi).The researcher has also given me an information sheet.

Date…… ……..signed……. (Subject)

I confirm that I have explained the nature the purpose of this study to the above mentioned subject.
Date……Signed…… …(Researcher)

APPENDIX E

INFORMED CONSENT FORM

(For netball players below 16 years of age)

I (Name of guardian/parent)……, parent/guardian of (Name of netball player)……..of … (Name of school…….…….. Hereby give consent that my child participates in a study in which measurement of her height, balance and muscle strength around both ankles shall be obtained before the beginning of 2009 netball season. I further give consent that she shall fill in injury assessment form after each netball practice, match or tournament with effect from two weeks before the beginning of the netball season until the end of the season. I also consent to such further or alternative experimental measures as may be found necessary during the cause of this study

I understand that pressure from the devise that shall be used to measure muscle strength around her ankle may be uncomfortable.

The nature and the purpose of the purpose of the study has been fully explained to her by the researcher (Mr. Lesley Phokontsi). The researcher has also given me an information sheet.
Date…… ……..signed…… (Subject)

I confirm that I have explained the nature the purpose of this study to the above mentioned subject.
Date……Signed…… …(Researcher)

APPENDIX F

INJURY REPORT FORM

Name of high School: _____

Player's code_____ Date_____

1. Date of Injury _____
2. Have you sustained ankle injury?

   Yes No. Other injury (specify) _____
3. Which ankle has been injured?

   Right ☐ Left ☐
4. Which type of Injury have you sustained?

   Lateral ankle sprain?

   Lateral ankle sprain refers to injury to the ankle joint as a result of twisting inwards when landing from a height.

   Yes ☐ No ☐

   Other injury (specify) _____
5. When did the injury occur?

   During training ☐ During a match ☐

   Other (specify)_____
6. How many hours did you spend on the field (practices and matches / net ball games) prior to your injury since the beginning of the season? _____
7. Have you previously sustained ankle sprain?

   Yes ☐ No ☐

   If yes,

   1. How many sprains did you previously sustain? _____
   2. Did you receive any treatment?

      Yes ☐ No ☐
   3. Did the injury stop you from participating in practices or games?

      Yes ☐ No ☐

   If yes, how long could you not play _____

APPENDIX G

PLAYER'S BASELINE INFORMATION

Name of School:…….

Netball team level:……

Players code no.	**Right Fibularis muscle isometric strength(Newton)**	**Left Fibularis muscle isometric strength(Newton)**	**Age (years)**	**Height (Meters)**	**Body weight (kg)**	**No. of previous lateral ankle sprains**	**Balance (L leg)**	**Balance (R leg)**

APPENDIX H

ETHICAL CLEARANCE CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Phokontsi

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M080957**
PROJECT	The relationship between Fibularis Muscles Strength and Lateral Ankle Prain among High School Netball Players in gauteng Northern region
INVESTIGATORS	Mr L Phokontsi
DEPARTMENT	Physiotherapy Department
DATE CONSIDERED	08.09.26
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 08.09.29 **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : S Mtshali

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

21/10/08